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PAULA ALBUQUERQUE PENNA FRANCA

NÃO BASTA SER SUSTENTÁVEL, TEM QUE SER SAUDÁVEL: ESTUDO DE INICIATIVAS DE PRODUÇÃO E CONSUMO DE ALIMENTOS PARA A REDUÇÃO DE ALIMENTOS DE ORIGEM ANIMAL NA DIETA HUMANA

RIO DE JANEIRO
2023

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Tese apresentada ao programa de Pós-Graduação em Nutrição, do Instituto de Nutrição Josué de Castro, no Centro de Ciências da Saúde, da Universidade Federal do Rio de Janeiro, como requisito parcial para o título de Doutor em Ciências Nutricionais

Orientadora: Professora Drª Anna Paola Trindade Rocha Pierucci

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Examinado por:

____
Professora Eliane Fialho de Oliveira
Doutora em Ciências/ UFRJ

____
Professora Maria Claudia da Veiga Soares Carvalho
Doutora em Saúde Coletiva/UFRJ

____
Professor António José De Almeida Simões Raposo
Doutor en Sanidad Animal y Seguridad Alimentaria / Universidad de Las Palmas de Gran Canaria

____
Professor Fabio de Almeida Oroski
Doutor em Engenharia de Processos Químicos e Bioquímicos /UFRJ

____
Pesquisadora Patrícia Duque-Estrada
Doutora em Ciência e Tecnologia de Alimentos / Wageningen University and Research, Holanda

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Chico Xavier

RESUMO

FRANCA, Paula Albuquerque Penna Franca**. Não basta ser sustentável, tem que ser saudável: estudo de iniciativas de produção e consumo de alimentos para a redução de alimentos de origem animal na dieta humana.** Rio de Janeiro, 2024. Tese (Doutorado em Ciências Nutricionais) – Instituto de Nutrição Josué de Castro, Universidade Federal do Rio de Janeiro, Rio de Janeiro, 2023.

A perspectiva de uma nova transição alimentar, direcionada à diminuição do consumo de alimentos de origem animal revela muitos desafios. Diante desse cenário, esta tese se propôs a investigar iniciativas de produção e consumo de alimentos para a redução de produtos de origem animal na transição para sistemas alimentares saudáveis e sustentáveis. Para isso, os produtos "plant-based" presentes no mercado brasileiro e mundial foram analisados quanto ao perfil de ingredientes, as características nutricionais, o estágio de desenvolvimento tecnológico e o posicionamento de mercado. Os resultados encontrados foram sistematizados em três manuscritos independentes. Dentre os principais resultados, destaca-se que os produtos "plant-based" podem ser utilizados dentro de uma dieta saudável pelo consumidor em busca de praticidade. Estes consumidores, no entanto, devem observar o rótulo dos produtos, já que muitos deles apresentam alta quantidade de sódio, gordura saturada e açúcar. Além disso, grande parte deles são classificados como alimentos ultra processados não devendo, portanto, ser a base da alimentação. Adicionalmente, investigou-se a campanha Segunda sem Carne (SSC), como exemplo de iniciativa para a conscientização do consumidor, objeto do quarto manuscrito da presente tese. Grande parte das postagens da campanha SSC abordam os aspectos éticos do consumo de carnes e elaboração de preparações saborosas e práticas. As inciativas analisadas neste estudo, apontam tendências para uma alimentação mais sustentável que, sem perder a saudabilidade, tenham potencial para promover uma nova transição nutricional.

Palavras-chave: alimentação sustentável, alimentos plant-based, substitutos de carne, segunda sem carne

ABSTRACT

FRANCA, Paula Albuquerque Penna Franca. **Sustainability is not enough. It also has to be healthy: study of food production and consumption initiatives to reduce foods of animal origin in the human diet**. Rio de Janeiro, 2024. Thesis (Doutorado em Ciências Nutricionais) – Instituto de Nutrição Josué de Castro, Universidade Federal do Rio de Janeiro, Rio de Janeiro, 2023.

The prospect of a new dietary transition aimed at reducing the consumption of foods of animal origin reveals many challenges. Given this scenario, this thesis proposed investigating food production and consumption initiatives to reduce animal products in the transition to healthy and sustainable food systems. For this purpose, the "plant-based" products in the Brazilian and global markets were analyzed regarding their ingredient profile, nutritional characteristics, technological development stage and market positioning. The results found were systematized in three independent manuscripts. Among the main results, it is highlighted that "plant-based" products can be used within a healthy diet by consumers in search of practicality. These consumers, however, must observe the product label, as many of the products contain high amounts of sodium, saturated fat and sugar. Furthermore, most of them are classified as ultra-processed foods and should not be the basis of the diet. Additionally, the Meat Free Monday campaign (MFM) was investigated as an example of an initiative to raise consumer awareness, the subject of the fourth manuscript of this thesis. Most MFM campaign posts address the ethical aspects of consuming meat and preparing tasty and practical preparations. The initiatives analyzed in this study point to trends towards a more sustainable diet that, without losing healthiness, can promote a new nutritional transition.

Keywords: sustainable food, plant-based foods, meat substitutes, meat-free Monday

LISTA DE ILUSTRAÇÕES

LISTA DE ABREVIATURAS E SIGLAS

ABRAS	Associação Brasileira de Supermercados
AUP	Alimentos ultra processados
CO_2	Dióxido de carbono
DIAAS	Digestible Indispensable Amino Acid Score
DCNT	Doenças Crônicas Não Transmissíveis
FAO	Food and Agriculture Organization
g	Gramas
GEE	Gases do Efeito Estufa
GFI	The Good Food Institute
HLPE	High Level Panel of Experts
IMC	Índice de Massa Corporal (kg/m^2)
IPCC	Intergovernmental Pannel on Climate Change
IPES-Food	International Panel of Experts on Sustainable Food systems
Kcal	Quilocaloria
Kg	Quilograma
MUT	Mudança do Uso de Terra
OCDE	Organização para a Cooperação e Desenvolvimento Econômico
ODS	Objetivos de Desenvolvimento Sustentável
ONU	Organização das Nações Unidas
RDC	Resolução de Diretoria Colegiada
SAN	Segurança Alimentar e Nutricional
SSC	Segunda sem carne
SEEG	Sistema de Estimativa de Emissões e remoções de Gases do efeito estufa

SUMÁRIO

APRESENTAÇÃO

A transição para um sistema alimentar mais justo que forneça alimentos para todos sem exaurir os recursos naturais permanece como algo ainda utópico. O alarme criado pela urgência do aquecimento global tem levado muitos setores a repensar o sistema alimentar, a investigar possibilidades de redução do impacto ambiental da alimentação. O consumo de alimentos de origem animal é frequentemente apontado como um dos maiores emissores de gases do efeito estufa, perda de biodiversidade, uso exagerado dos recursos hídricos, entre outros impactos ambientais.

Além das consequências ambientais da produção de alimentos, as iniquidades do sistema alimentar dizem respeito tanto a falta de acesso à alimentação adequada e saudável, quanto ao consumo exagerado de alimentos de alta densidade calórica e baixa qualidade nutricional, levando à população a insegurança alimentar e nutricional e a perda de saúde e qualidade de vida.

Assim, a sustentabilidade do sistema alimentar precisa ser muito discutida em todos os âmbitos. Dentro da nutrição precisamos nos dedicar a escolher e prescrever alimentos não só saudáveis, como também sustentáveis, precisamos de um olhar mais amplo sobre o que é alimentação saudável e sustentável e sobre os alimentos que compõem o prato. Esse olhar ainda precisa ser muito discutido, mas já despontam iniciativas no sentido de reduzir o consumo de alimentos de origem animal, soluções que sozinhas não serão suficientes, mas que apontam tendências e movimentos a favor da transição para sistemas alimentares mais sustentáveis.

Este estudo foi realizado em 2 etapas e os resultados apresentados na forma de 4 artigos independentes. A primeira etapa aborda os produtos "plant-based" e os resultados estão apresentados nesta tese, no formato de 3 manuscritos. No primeiro foram analisados os produtos substitutos de carne presentes no mercado brasileiro quanto a composição nutricional, o perfil de ingredientes e quanto a adequação à regulamentação brasileira. Os dados obtidos foram publicados na revista *Future Foods*/*Elsevier*.

No segundo manuscrito, os hambúrgueres lançados no mercado global foram analisados quanto ao posicionamento no mercado, características nutricionais e ingredientes de composição. Os resultados obtidos foram publicados na revista International *Journal of Food Sciences and Nutrition*/ *Taylor & Francis on line*; e no terceiro foi realizada uma revisão bibliográfica quanto ao potencial de saúde dos produtos "plant-based" a convite dos editores do *livro Handbook of Plant-Based Foods and Drinks: Innovation and Nutrition Project/ Elsevier*.

Na segunda etapa, foi realizado um estudo de caso sobre a campanha segunda sem carne enquanto agente incentivador de mudança do comportamento alimentar, o qual foi submetido à revista *British Food Journal/ Emerald Publishing.*

1 INTRODUÇÃO

A cadeia de produção de alimentos é reconhecida como um dos maiores geradores de mudanças ambientais globais, levando a degradação do solo, desmatamento e esgotamento dos recursos hídricos. Estimativas recentes mostram que a produção de alimentos é responsável por cerca de um terço das emissões globais de gases de efeito estufa (Crippa *et al.*, 2021a). No Brasil, o cenário é ainda mais preocupante devido as grandes áreas desmatadas para a produção de soja e para a pecuária. De acordo com o Sistema de Estimativas de Emissões e Remoções de Gases de Efeito Estufa (SEEG) a atividade rural – seja direta ou indiretamente – respondeu por 72% das emissões de gases do efeito estufa (GEE) para o ano de 2019, situando o Brasil como o 6º maior emissor mundial (GCEC *et al.*, 2020).

Nos últimos anos, as informações sobre desmatamentos e queimadas (GCEC *et al.*, 2020; Messias e Almeida, 2021), sobre insegurança alimentar e nutricional (IAN) (IBGEa, 2020; Neves *et al.*, 2021), genocídio da população indígena (Maria e Guerra, 2014), pobreza e expulsão do campo dos trabalhadores rurais (Alves *et al.*, 2019; Cazella, Capellesso e Schneider, 2020), chegam com tanta pressão e urgência quanto as notícias sobre a emergência climática (Lampis *et al.*, 2020) e sobre o aumento exponencial da obesidade e doenças crônicas que afligem a população (Brasil, 2021). As cadeias de produção e distribuição de alimentos adquiriram tal distanciamento do consumidor final que se torna difícil fazer o elo entre esses elementos (Swinburn *et al.*, 2019). No entanto, estão direta ou indiretamente associadas às escolhas alimentares e às decisões de ocupação do campo (FAO, 2014)

Um sistema alimentar sustentável é aquele que é capaz de gerar valor positivo simultaneamente nas três dimensões da sustentabilidade: econômica, social e ambiental, sem comprometer a possibilidade das gerações futuras de fazer o mesmo (FAO, 2018). As modificações na dieta têm grande potencial de contribuir com sistemas alimentares sustentáveis (Vermeulen *et al.*, 2020). A partir de mudanças no consumo alimentar pode-se exercer pressões na cadeia de produção e gerar impacto nas dimensões ambientais, sociais e econômicas do sistema alimentar (Pereira, Scalco e Lourenzani, 2020).

Produtos de animais ruminantes, incluindo carnes e laticínios, são os alimentos com as maiores emissões de GEE por quilograma, por quilocaloria e por porção, devido ao metano da digestão e óxido nitroso do esterco. O metano e o óxido nitroso têm efeitos de aquecimento climático muito maiores por unidade de massa que o dióxido de carbono (Meier e Christen, 2012).

Dentro do conceito de dietas sustentáveis, as recomendações para diminuir o consumo de alimentos de origem animal especialmente as carnes, encontram grande animosidade e resistência (Dagevos e Voordouw, 2013). Tanto por consumidores, que tem a carne como elemento central da dieta (Hartmann e Siegrist, 2020), por profissionais de saúde, que ainda consideram as proteínas animais indispensáveis para a manutenção da saúde (Dagevos, 2021), e pelos interesses comerciais, justificados pelo paradigma de crescimento econômico e pela prevalência neoliberal dos princípios de liberdade de escolha (Graça, Godinho e Truninger, 2019). A carne é um alimento simbólico com considerável valor identitário altamente valorizado dentro das culturas alimentares (Apostolidis e McLeay, 2016), e seu consumo aumenta conforme a renda familiar aumenta (Alvarez-Kalverkamp *et al.*, 2014; Belik, 2020).

A discussão por um sistema alimentar mais justo e sustentável perpassa todo o sistema alimentar e carece de todos os tipos de estudo (Brouwer, McDermott e Ruben, 2020). Diferentes iniciativas surgem como agentes de mudança do sistema alimentar, com propostas e iniciativas tanto do lado da produção quanto do lado do consumo (Béné *et al.*, 2019). Os produtos substitutos de carne podem ser considerados como um exemplo de inovação tecnológica aliada ao incentivo do consumo de alimentos proteicos à base de proteína vegetal (Sha e Xiong, 2020). São produtos elaborados com proteínas vegetais que se propõem a substituir a carne. São consumidos por vegetarianos há décadas (Bohrer, 2019), porém recentemente receberam muita repercussão midiática e de profissionais de saúde por terem despertado o interesse de um novo nicho de consumidores - os flexitarianos (Boukid, 2021).

A ideia por trás desses produtos é propiciar uma experiência semelhante ao consumo da carne, porém de origem vegetal (Kyriakopoulou, Keppler e Goot, 2021). No entanto, sua qualidade nutricional tem sido questionada (Boukid, 2021). Dessa forma, compreender o estágio de desenvolvimento tecnológico e a qualidade nutricional dos substitutos de carne é importante devido ao aumento exponencial do consumo e o seu potencial enquanto alimento proteico de baixo impacto ambiental.

Pelo lado do consumo, também pode-se destacar o papel exercido por *chefs* de cozinha como agentes de mudança do sistema alimentar na promoção da sustentabilidade (Pereira *et al.*, 2019). A exposição recente do chef de cozinha o coloca em um papel privilegiado de educador nutricional/ambiental pois tem articulação com diferentes atores do sistema alimentar (Bertoldo *et al.*, 2021). De um lado, pode escolher produtores e fornecedores mais sustentáveis, na outra ponta pode resgatar alimentos tradicionais, valorizar alimentos de baixo impacto ambiental e reintroduzi-los aos comensais (Pereira *et al.*, 2019). Também é possível promover a integração com a comunidade local visando a reflexão sobre sustentabilidade, dentre outras possibilidades (Batat, 2020). Todos esses aspectos podem ser explorados pela campanha segunda sem carne (SSC). A SSC é uma campanha internacional, presente em mais de 40 países (Meat Free Monday, 2023). No Brasil, acontece desde 2009 devido a iniciativa da Sociedade Vegetariana Brasileira (SVB). A adesão se dá de forma voluntária por restaurantes e indivíduos e através de parcerias entre a SVB e empresas ou municípios, que passam a adotar um dia de refeição sem carne por semana (Nakagawa e Noronha, 2019). Para estimular a adesão à campanha pratos atrativos, sem a presença de alimentos de origem animal, são divulgados como saudáveis e fáceis de fazer e implementados nos locais e serviços que aderem à campanha (Morris, Kirwan e Lally, 2014).

Apesar de muitos estudos sobre o sistema alimentar terem sido realizados até o momento, pouca atenção tem sido dada a análise de abordagens que visem identificar soluções inovadoras para enfrentar os principais desafios do sistema alimentar (Brouwer, McDermott e Ruben, 2020). Dessa forma, esse estudo se propõe a analisar diferentes iniciativas que facilitem a transição para um sistema alimentar sustentável.

2 REVISÃO BIBLIOGRÁFICA

2.1 SISTEMAS ALIMENTARES SUSTENTÁVEIS

Conceitualmente, um sistema alimentar sustentável é aquele que oferece segurança alimentar e nutricional (SAN) para todos, de tal forma que não ocorra o comprometimento das bases econômicas, sociais e ambientais do SAN para as gerações futuras (FAO, 2018).

Os componentes do sistema alimentar envolvem as cadeias de suprimentos, o ambiente alimentar e o comportamento do consumidor. A cadeia de suprimentos engloba todos os processos de produção, processamento, embalagem, transporte, distribuição e descarte de alimentos (Capone *et al.*, 2014). Os três componentes do sistema alimentar afetam a capacidade dos consumidores de adotar dietas sustentáveis (HLPE, 2017).

Para ser sustentável, o desenvolvimento do sistema alimentar precisa gerar valor positivo simultaneamente em três dimensões: econômica, social e ambiental (**Figura 1**).

Na dimensão econômica, um sistema alimentar é considerado sustentável se as atividades realizadas por cada ator do sistema alimentar ou prestador de serviços de apoio forem comerciais ou fiscalmente viáveis. As atividades devem gerar benefícios, ou valor econômico agregado, para todas as categorias de interessados: salários para os trabalhadores, impostos para os governos, lucros para as empresas e melhorias no abastecimento de alimentos para os consumidores (FAO, 2018).

Na dimensão social, um sistema alimentar é considerado sustentável quando há equidade na distribuição do valor econômico agregado, levando em consideração grupos vulneráveis categorizados por gênero, idade, raça, dentre outros fatores (HLPE, 2017). De importância fundamental, as atividades do sistema alimentar precisam contribuir para o avanço de resultados socioculturais importantes, como nutrição e saúde, tradições, condições de trabalho e bem-estar animal (Ericksen, 2008). Para o "High Level Panel of Experts", a obtenção da SAN seria uma condição capacitadora de sustentabilidade, indissociável da definição de sistema alimentar sustentável (HLPE, 2017).

O aumento na eficiência e produtividade dos sistemas alimentares acarretaram a redução da prevalência da fome em todo o mundo e na melhoria da nutrição. No entanto, esses sucessos são obscurecidos por sérias preocupações sobre os aspectos dos sistemas alimentares que representam risco aos objetivos sociais, econômicos e ambientais e, portanto, minam a segurança alimentar (GLOPAN, 2016).

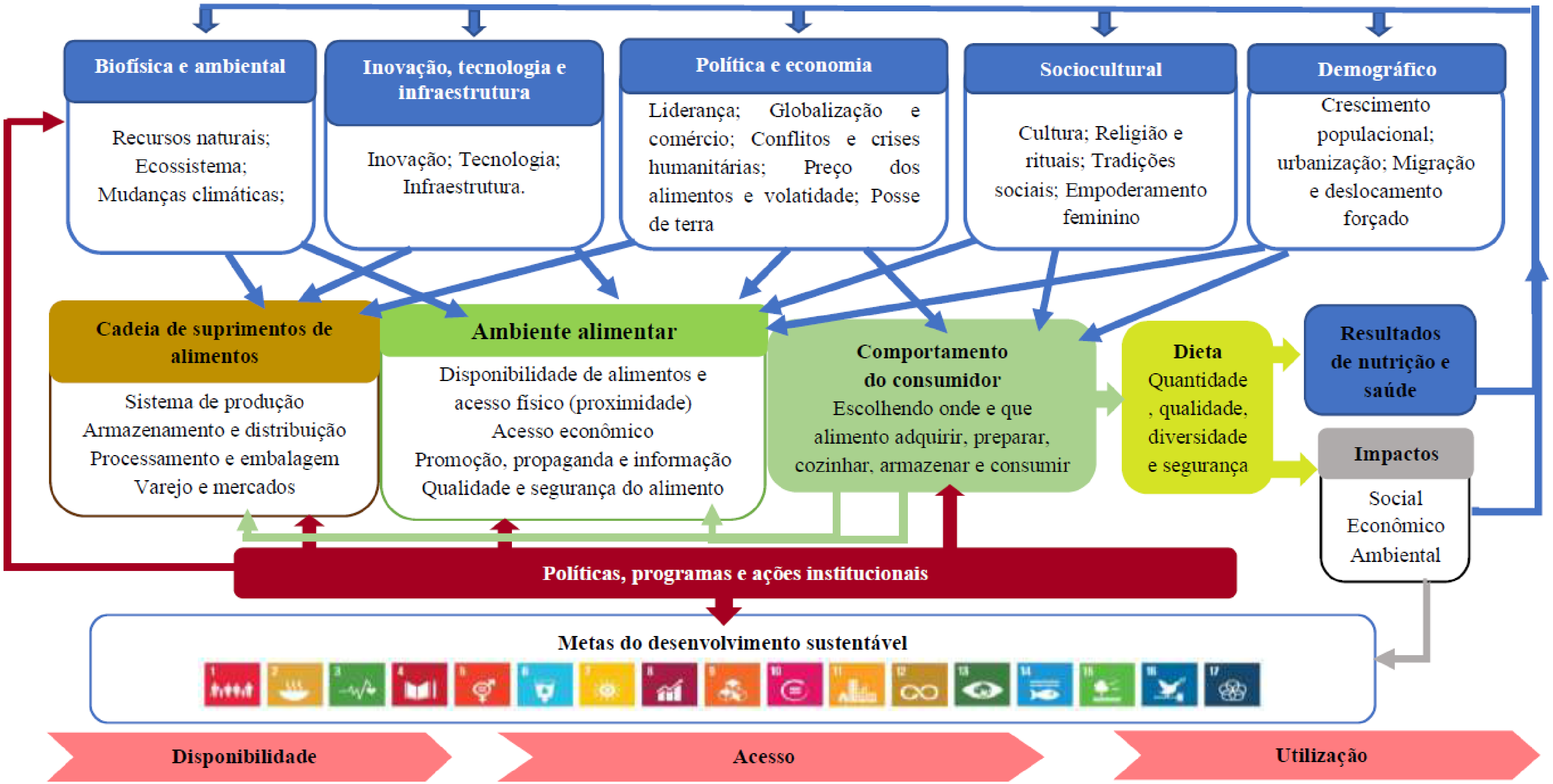


Figura1: Modelo conceitual de sistemas alimentares

Fonte: Pereira *et al*., adaptado de HLPE (2017).

Os sistemas alimentares influenciam não apenas o que está sendo consumido e como o alimento é produzido e adquirido, mas também quem pode comer e quão nutritivo é o alimento consumido (Capone *et al.*, 2014). Uma parcela considerável da população mundial enfrenta pelo menos uma das três formas da má nutrição- desnutrição, deficiência de micronutrientes ou excesso de peso. Embora as dietas estejam mudando rapidamente, elas não estão necessariamente melhorando (Popkin, Adair e Ng, 2013). A má-nutrição em todas as suas formas ainda afeta todos os países do planeta e é um grande impedimento para alcançar a SAN global adequada ao desenvolvimento sustentável (Swinburn *et al.*, 2019).

Atualmente, cerca de 0,8 bilhão de pessoas ainda passam fome, mais de 2 bilhões têm deficiência de vitaminas ou minerais essenciais e cerca de 1,9 bilhão de adultos sofrem de sobrepeso e obesidade (Melesse *et al.*, 2020). Embora a fome tenha diminuído nas últimas décadas, o sobrepeso e a obesidade estão aumentando rapidamente em todo o mundo, inclusive em países de baixa e média renda e, portanto, não devem ser esquecidos (GLOPAN, 2016).

As doenças crônicas relacionadas à nutrição, como obesidade, diabetes, doenças cardiovasculares e algumas formas de câncer, são os principais contribuintes para a carga global de doenças (Ericksen, 2008). Dietas não saudáveis podem ser consideradas como o principal fator de risco global para mortes e para a perda de Anos de Vida Perdidos Ajustados por Incapacidade, superando, por exemplo, o tabagismo e a hipertensão (Melesse *et al.*, 2020).

Na dimensão ambiental, a sustentabilidade é determinada garantindo que os impactos das atividades do sistema alimentar no ambiente natural sejam neutros ou positivos, tendo em consideração a biodiversidade, água, solo, saúde animal e vegetal, pegada de carbono, pegada hídrica, perda e desperdício de alimentos e toxicidade (FAO, 2018; Lang, 2017; Willett et al., 2019).

Dentro da complexa agenda sobre SAN, os sistemas alimentares estão sendo progressivamente reconhecidos como um ponto de entrada crítico para a ação. No entanto, nosso entendimento sobre a dinâmica do sistema alimentar ainda está em um estágio de desenvolvimento inicial. Embora progresso conceitual e teórico tenha sido feito em torno das definições, indicadores e métricas que descrevem os sistemas alimentares (Brouwer, McDermott e Ruben, 2020), os pesquisadores e analistas ainda estão lutando com um elemento central do problema: o quanto os sistemas alimentares são (in) sustentáveis e o que impulsiona esta (in) sustentabilidade? (Béné *et al.*, 2019a).

Parte da incapacidade coletiva de compreender adequadamente os sistemas alimentares deriva dos conjuntos de dados fragmentados e estáticos disponíveis em relação aos sistemas alimentares. Isso limita a capacidade de compreender holisticamente a dinâmica e a complexidade desses sistemas. As implicações são amplas e afetam não apenas a nutrição e a saúde humana, mas também o meio ambiente e o bem-estar social e econômico das pessoas (Béné *et al.*, 2019b).

No geral, estima-se que dietas "não saudáveis" sejam o fator de risco mais significativo para a carga global de doenças no mundo. Simultaneamente colocam pressão sobre o meio ambiente e sua base de recursos naturais, degradando solos, poluindo e esgotando os suprimentos de água doce, invadindo florestas, esgotando os estoques de peixes selvagens e reduzindo a biodiversidade (FAO, 2014; Melesse *et al.*, 2020).

Finalmente, o maior desafio do sistema alimentar emerge da pegada ambiental dos sistemas alimentares, o fato de que em todas as fases (produção, distribuição, varejo, consumo e gestão de resíduos) as atividades do sistema alimentar têm enormes efeitos prejudiciais sobre o ambiente (Béné *et al.*, 2020).

2.1.1 Impactos ambientais do sistema alimentar

Os sistemas alimentares são responsáveis por cerca de um terço das emissões antropogênicas de GEE (Crippa et al., 2021) e a produção agropecuária responde por cerca de 70% do uso da água doce global (Vermeulen, Campbell e Ingram, 2012). O uso de antibióticos na pecuária contribui para a disseminação global de bactérias multirresistentes (Alonso e Paim, 2020), o que pode gerar graves consequências à saúde em humanos (Lindgren et al., 2018). Dessa forma, uma abordagem nova, coletiva e integrada para administrar os recursos naturais do planeta é imperativa (HLPE, 2017).

De acordo com o relatório "Climate Change and Land", do Painel Intergovernamental para as Mudanças Climáticas (IPCC) da Organização das Nações Unidas (ONU), publicado em 2019, a conexão entre o uso da terra e seus efeitos sobre a mudança climática se dá em um efeito de retroalimentação, pois a produção de alimentos aumenta o aquecimento global, enquanto as mudanças climáticas decorrentes ameaçam a produção de alimentos. O relatório mostra, de forma inquestionável, que o crescimento da população mundial e o aumento do consumo *per capita* de alimentos têm gerado taxas sem precedentes de uso de terra e água doce (IPCC *et al.*, 2019). As mudanças climáticas afetam a produção de alimentos, ao diminuir a produção agrícola e aumentar a insegurança alimentar em algumas regiões do mundo (Crippa et al., 2021; Foley et al., 2011).

O relatório estima que qualquer magnitude de aumento no aquecimento global afete a saúde humana, com possíveis consequências negativas. Foram projetados riscos mais baixos para o aumento da temperatura até 1,5°C do que para o aumento de 2°C. A quantidade e disponibilidade de opções de adaptação variam de acordo com o setor (IPCC *et al.*, 2019). Pesquisadores consideram que as mudanças alimentares são essenciais para evitar o pior cenário de mudança de temperatura global (Bryngelsson *et al.*, 2016; Godfray *et al.*, 2018; Springmann *et al.*, 2018; Willett *et al.*, 2019).

De acordo com o relatório do observatório do clima (GCEC *et al.*, 2020), a situação atual do Brasil em relação ao cumprimento das metas da agenda 2030 é desoladora. Os dados referentes ao ano de 2019 demonstram aumento das áreas desmatadas para a produção agropecuária, a chamada mudança do uso da terra (MUT), que totalizou 44% das emissões no ano base de 2019. Isso representa o maior percentual de emissões do país e coloca o Brasil como um dos principais emissores do mundo (GCEC *et al.*, 2020). A MUT ocorre principalmente na Amazônia e no Cerrado, contribuindo, ainda que indiretamente, com o total de emissões do setor agropecuário, além de ser responsável por perda de biodiversidade (Meyer e Reguant-Closa, 2017). A emissão *per capita* no Brasil também é maior que a média mundial. Em 2021, a média de emissão de CO_2 (dióxido de carbono) por brasileiro foi de 11,1 toneladas brutas, contra 6,2 toneladas por pessoa da média mundial. O impacto da MUT pode ser observado nas médias de emissões por estado, Roraima lidera o ranking, com 94 toneladas de CO_2 emitidas por habitante em 2021 – mais de 15 vezes a média mundial (SEEG, 2023).

O impacto ambiental dos alimentos varia entre os grupos alimentares. A produção de produtos de origem animal gera a maioria das emissões de GEE relacionadas aos alimentos (72-78% do total das emissões agrícolas), o que se deve à fermentação entérica em ruminantes, emissões relacionadas ao esterco e a baixa conversão alimentar (transformação do alimento ingerido como ração, grãos ou pasto em produto de origem animal) (GCEC *et al.*, 2020). Os impactos relacionados à alimentação de produtos de origem animal também contribuem para as pressões sobre as terras agrícolas, bem como a aplicação de nitrogênio e fósforo (20–25% cada). Em comparação, as culturas básicas (trigo, milho, arroz, batata etc.) geralmente têm pegadas ambientais mais baixas (impactos por kg de produto) do que os produtos de origem animal, em particular para as emissões de GEE (IPCC, 2007). De acordo as estimativas de Springmann *et al*. (2018) as culturas básicas cultivadas para consumo humano são responsáveis por um terço à metade (30-50%) do uso de terras agrícolas, uso de água azul, que se refere a água dos rios, lagos e lençol freático, e aplicação de nitrogênio e fósforo.

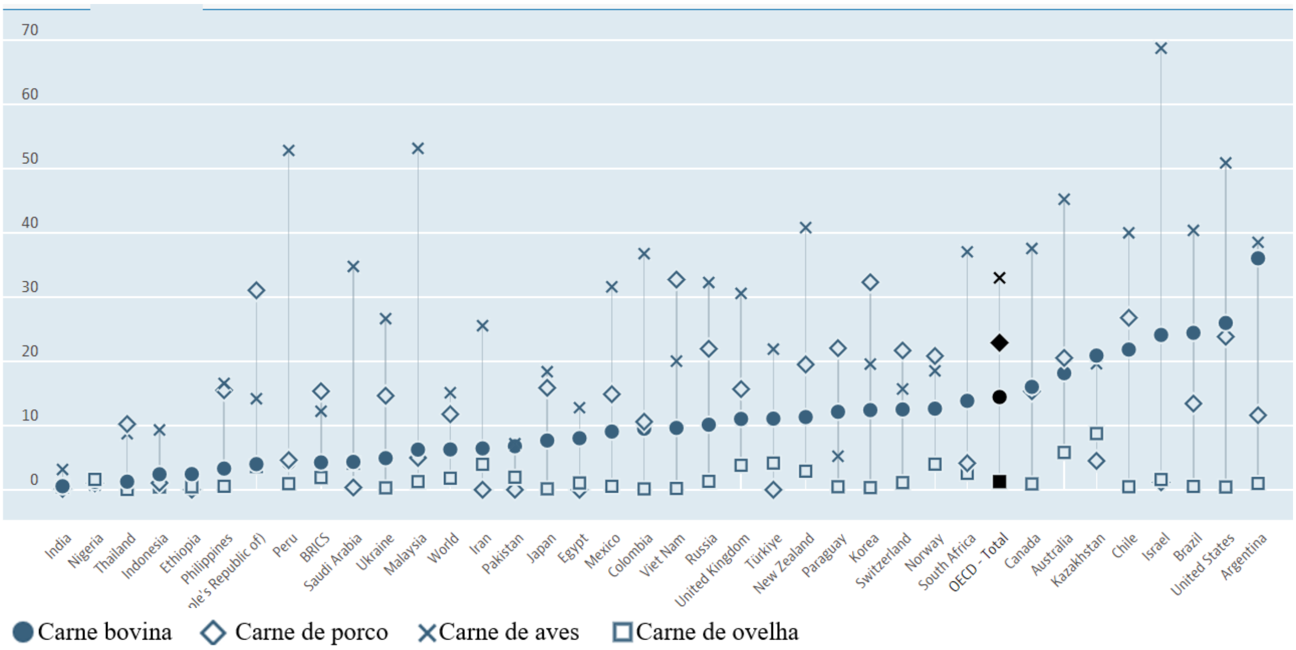
Diante desse cenário, torna-se claro que modificações nos sistemas produtivos, apesar de necessárias, não seriam suficientes para responder à natureza multifacetada do problema (Garnett, 2014). Evidencia-se a necessidade de reduções drásticas no consumo de alimentos de origem animal (Ritchie, Reay e Higgins, 2018), e mudanças nos padrões alimentares para dietas que apresentem baixo impacto ambiental e que sejam saudáveis e sustentáveis (Clark *et al.*, 2020).

A mudança de dietas predominantemente de origem animal para dietas com predominância de alimentos de origem vegetal é um elemento chave para a interface entre a saúde humana e ambiental (Tomova *et al.*, 2019). Com o aumento da renda e a urbanização, os padrões alimentares tradicionais, com pronunciadas diferenças regionais e culturais foram modificados por padrões de consumo com quantidades elevadas de produtos de origem animal, e consequentemente maior impacto ambiental (Capone *et al.*, 2014), como parte do processo conhecido como transição nutricional (Popkin *et al.*, 2013). A transição alimentar e nutricional teve início na metade do século XX nos países Ocidentais do Norte Global, e se estendeu por outras regiões do globo (Dagevos, 2021). Mais recentemente, países asiáticos vêm passando pela transição nutricional, o que representa um grande incremento na demanda mundial de carne (Vermeulen *et al.*, 2020). Com a transição nutricional observa-se aumento do consumo de carnes e produtos cárneos industrializados, a diminuição do consumo de alimentos de origem vegetal e alimentos tradicionais, o aumento do consumo de alimentos ultra processados (AUP) (Dagevos, 2021) e a valorização da carne como parte essencial e indispensável da refeição (Weis, 2013). Esse processo se deu de forma concomitante à intensificação da produção das atividades agrícolas e agropecuárias, que aumentaram a produtividade das atividades agrícolas e o custo ambiental da produção (Hawkes, 2006; Popkin, Adair e Ng, 2013).

Os consumidores urbanos também aumentaram a demanda por alimentos processados e refeições prontas, alimentos consumidos fora do lar e fast foods (IPES FOOD, 2017) e não apenas tendem a comer mais, mas também praticam menos atividade física, o que tem implicações importantes para obesidade e DCNT (Kearney, 2010).

Na **Figura 2** pode-se observar o consumo de diferentes tipos de carne *per capita* por país. Observa-se que o consumo brasileiro de carne bovina está entre os mais altos do mundo, abaixo somente do consumo dos EUA e da Argentina (OECD, 2023). Estimativas da Organização das Nações Unidas para Alimentação e Agricultura (FAO, 2012) indicam que até 2050, os mercados emergentes cobrirão apenas 46 % de sua ingestão calórica com grãos; outros 29 % virão de carne, ovos, leite e queijo. Para acompanhar essa demanda, a produção de carne bovina terá que saltar dos atuais 300 milhões de toneladas para 470 milhões de toneladas em 2050. Para alimentar tantas cabeças de gado, a produção de grãos para ração precisará quase dobrar de 260 para 515 milhões de toneladas, por ano, no mundo todo (Alvarez-Kalverkamp *et al.*, 2014).

Figura 2: Consumo de carne bovina, quilogramas *per capita*, por país.



Fonte: OECD, 2023. Ano base: 2021.

Uma série de revisões recentes da literatura resumiram os impactos ambientais dos padrões alimentares (Aleksandrowicz *et al.*, 2016; Lr Payne, Scarborough e Cobiac, 2016; Perignon *et al.*, 2017; Leydon *et al.*, 2023; Jarmul *et al.*, 2020). Essas revisões identificaram que os padrões alimentares que substituem os alimentos de origem animal por alternativas à base de plantas conferem os maiores benefícios ambientais. Em sua revisão de 210 cenários extraídos de 63 estudos, Aleksandrowicz *et al.* (2016) identificaram que as dietas veganas foram associadas às maiores reduções nas emissões de GEE e no uso da terra, e as dietas vegetarianas às maiores reduções no uso de água. As dietas que substituíram a carne de ruminantes por alternativas, como peixes, aves e suínos, também mostram impactos ambientais reduzidos, embora menos do que as alternativas vegetais (Auestad e Fulgoni, 2015; Hallström, Carlsson-Kanyama e Börjesson, 2015; IPCC, 2019).

Já os benefícios à saúde da adoção de dietas sustentáveis apresentam resultados mais heterogêneos (Leydon *et al*., 2023, Reger et al., 2024; Jarmul *et al*., 2020, Payne *et al*., 2016, Aleksandrowicz *et al.*, 2016). Uma revisão sistemática de 63 estudos que analisaram a mudança da dieta atual por diferentes padrões alimentares sustentáveis identificou modestos benefícios na saúde. A redução do risco de mortalidade variou de <1% para padrões vegetarianos a 19% para dietas veganas. O estudo concluiu que os efeitos na saúde planetária da adoção de dietas sustentáveis são de uma magnitude maior do que os efeitos na saúde das pessoas (Aleksandrowicz *et al.*, 2016).

Reger *et al*., (2024) realizaram uma revisão sistemática e metanálise sobre dietas sustentáveis em relação ao risco de sobrepeso e obesidade. Após analisarem 18 estudos, concluíram que dietas sustentáveis podem diminuir o risco de sobrepeso/obesidade e, portanto, servir como facilitadores para melhorar a saúde pública e planetária. Os autores salientam ainda que uma definição clara e reconhecida de dietas sustentáveis melhoraria a comparabilidade de estudos futuros.

Da mesma forma, a revisão sistemática de Jarmul *et al*. (2020) identificou que dietas sustentáveis melhoraram os resultados de saúde em 87% (n =151) dos desfechos de saúde analisados. No entanto os resultados dos estudos de modelagem e dos estudos empíricos não foram concordantes. Por outro lado, Payne *et al*. (2016) identificou que a redução dos GEE provenientes das dietas foi associada a piores indicadores de saúde em 64% (n=214) dos estudos analisados.

Em linhas gerais, os benefícios para a saúde de dietas sustentáveis podem derivar do aumento no consumo de frutas e vegetais, da redução do consumo de carne vermelha e processada, da redução do consumo de sódio, assim como menor ingestão calórica, que pode representar um benefício para aqueles em risco de sobrepeso/obesidade (Reger et al., 2024; Payne *et al*., 2016). No entanto, as deficiências de micronutrientes essenciais são uma preocupação em populações vulneráveis, o aumento do consumo de alimentos não saudáveis de baixa emissão de GEE, como o açúcar também são uma preocupação (Payne *et al.*, 2016). Assim, recomendações de dietas sustentáveis podem ser particularmente problemáticas, especialmente em países de baixa e média renda que já lutam com transições nutricionais e deficiências de micronutrientes (Capone *et al.*, 2014; HLPE, 2017).

Em 2014, a agência de câncer da OMS (“International Agency for Research on Cancer”) classificou o consumo de carne processada como carcinogênico para humanos e carne vermelha como provavelmente cancerígeno (grupo 2A de evidência) para humanos. A associação entre carne vermelha e câncer foi observada, principalmente, para o câncer colorretal, mas associações também foram observadas para câncer de pâncreas e câncer de próstata (IARC, 2014).

Além disso, o consumo elevado de carne processada e carne vermelha foi associado a riscos maiores de desenvolvimento de doença cardiovascular e Diabetes Melittus tipo 2 (Shi *et al*., 2023; Troy e Kerry, 2010; Gu *et al*., 2023), obesidade (Apostolidis e McLeay, 2016; Grosso et al., 2017) e mortalidade por todas as causas (Wang *et al*., 2016; Schwingshackl et al., 2017).

Reduzir a quantidade média de carne consumida na dieta ocidental, no entanto, pode exigir uma profunda transição social porque a carne tem um *status* especial em muitas sociedades (Verain e Dagevos, 2022), é um dos produtos alimentícios mais populares em muitos países (Dagevos, 2021; Dagevos e Voordouw, 2013) e é geralmente considerada como um alimento indispensável à dieta saudável uma vez que contribui com o aporte proteico da dieta e diversos nutrientes essenciais que podem ser difíceis de obter de outras fontes (Apostolidis e McLeay, 2016; Geiker *et al*., 2021).

2.2 TRANSIÇÃO PARA SISTEMAS ALIMENTARES SUSTENTÁVEIS

As mudanças nos sistemas alimentares ocorrem por meio de fatores externos e internos, bem como por meio de mecanismos de feedback entre esses fatores. Esses mecanismos de feedback podem ser de curto ou longo prazo, e alguns podem vir com longos atrasos, como o impacto das emissões de gases de efeito estufa que se manifestam nas mudanças climáticas (Béné *et al.*, 2019). Os agentes de mudança externos são forças externas aos sistemas alimentares, por exemplo, as mudanças climáticas ou os sistemas de saúde (Pereira, Scalco e Lourenzani, 2020). Os agentes de mudança internos são forças dentro dos sistemas alimentares, por exemplo, ganhos de produtividade como consequência de inovações. O crescimento populacional, a urbanização, os conflitos e as instabilidades geopolíticas são motores externos fundamentais que interagem com as mudanças nos sistemas alimentares. Mudanças nos hábitos de consumo, por exemplo, em decorrência do aumento da renda, são outro fator de grande importância (Braun *et al*., 2021).

Em muitos países de baixa renda, governos vem implementando programas de desenvolvimento agrícola e de saúde para reduzir a desnutrição e estão começando a tomar medidas para lidar com a má qualidade da alimentação. Porém, têm evitado abordagens mais abrangentes, que remodelassem os sistemas de produção, para obter resultados frente a segurança alimentar, nutrição, clima, meio ambiente e desenvolvimento socioeconômico (Vermeulen *et al.*, 2020). Dessa forma, a má nutrição não irá diminuir se os sistemas alimentares não forem reestruturados (GLOPAN, 2020).

Os sistemas alimentares não estão conseguindo promover um acesso a dietas seguras e de alta qualidade para todos, uma vez que não possibilitam que os consumidores tomem decisões por alimentos saudáveis a preços acessíveis e que, por consequência, obtenham resultados nutricionais melhores (GLOPAN, 2016; GLOPAN, 2020; HLPE, 2017).

Para se atingir um sistema alimentar sustentável serão necessários múltiplos esforços. Tanto esforços de governança que provoquem mudanças estruturais no sistema alimentar quanto mudanças individuais e pontuais (Brouwer, McDermott e Ruben, 2020).

2.2.1 Comportamento alimentar

Os resultados do sistema alimentar são representados pelas dietas, resultados de nutrição, saúde e impactos (social, ambiental e econômico). A sustentabilidade representa a resiliência do sistema alimentar e o impacto social o potencial de equidade e inclusão social do sistema alimentar (HLPE, 2017).

Os agentes de mudança do sistema alimentar são considerados fatores externos ao sistema alimentar tais como urbanização, desenvolvimento de tecnologia, mudança climática e crescimento econômico (HLPE, 2017). Porém, Béne *et al*. (2019) consideram que os agentes de mudança do sistema alimentar podem ser tanto fatores externos quanto fatores internos ao sistema.

O comportamento do consumidor é considerado como componente do sistema alimentar, portanto fator interno (HLPE, 2017). Contudo, caso o consumidor opte por mudar suas atitudes em relação a alimentação (ele) se constituirá em agente de mudança. De fato, pode-se considerar que as mudanças no comportamento do consumidor sejam um dos mais potentes agentes de mudança do sistema alimentar (Béné *et al.*, 2019). Os agentes de mudança (externos e internos) influenciam o comportamento do consumidor, e, portanto, as dietas e os resultados nutricionais (Pereira, Scalco e Lourenzani, 2020)

O consumo alimentar é um resultado fundamental dos sistemas alimentares, intimamente relacionado à utilização dos alimentos e aos resultados de saúde individual ou coletiva. Pode-se pensar o consumo alimentar como um processo global que inclui as decisões sobre o que comprar, bem como a preparação dos alimentos, os hábitos alimentares, juntamente com a ingestão real de alimentos (Pereira et *al*., 2020).

As dietas estão em fluxo constante, com grandes mudanças evidentes mesmo dentro de uma única geração e em culturas muito diferentes. Modificações na dieta não só são possíveis, mas muito comuns (Vermeulen *et al.*, 2020). Além disso, a pesquisa de comportamento do consumidor vem gerando um amplo conjunto de ferramentas e abordagens para situar a alimentação saudável e sustentável como a escolha normal, fácil e atraente (Apostolidis e McLeay, 2016). Abordagens holísticas que mudam as dietas em conjunto com a transformação de todo o sistema alimentar podem ter maior sucesso, uma vez que as preferências do consumidor estão longe de ser independentes da multiplicidade de motivadores do lado da oferta e da economia política da disponibilidade e acesso aos alimentos (Vermeulen *et al.*, 2020).

O comportamento do consumidor reflete as escolhas feitas pelos consumidores, em nível familiar ou individual, sobre quais alimentos adquirir, armazenar, preparar e comer, e sobre a distribuição de alimentos dentro do domicílio (incluindo repartição de gênero, alimentação das crianças). É influenciado por preferências pessoais determinadas pelo gosto, conveniência, cultura e outros fatores (Pereira, Scalco e Lourenzani, 2020). No entanto, o comportamento do consumidor também é moldado pelo ambiente alimentar existente. Mudanças coletivas no comportamento do consumidor podem abrir caminhos para sistemas alimentares mais sustentáveis que melhoram a SAN e a saúde (HLPE, 2017).

Embora todos os atores possam concordar que a melhoria da saúde e da sustentabilidade dos recursos são resultados positivos a longo prazo, as escolhas atuais dos consumidores e empresas ainda são determinadas por custos, preços, conveniência e valores culturais e sociais, entre outros fatores, todos os quais podem não refletir práticas de produção sustentáveis ou saudáveis (Melesse *et al.*, 2020).

Segundo Just e Gabrielyan (2016), compreender o comportamento de consumo alimentar pode (i) ajudar a vincular a demanda nutricional com valor econômico para criar oportunidades de negócios e (ii) abrir oportunidades para minimizar ameaças que podem ser apresentadas pelos processos de transição do sistema alimentar. Níveis de renda, gostos, preferências, valores sociais, estado de saúde, *status* socioeconômico, facilidade de acesso à alimentos, campanhas publicitárias e custo dos alimentos estão entre os principais fatores que determinam o tipo e a qualidade nutricional das escolhas alimentares dos consumidores (Ericksen, 2008; Melesse *et al.*, 2020).

Dados da pesquisa de orçamentos familiares (IBGEb, 2020) demonstram que alimentos tradicionais se mantém como a base da alimentação do brasileiro, ainda que tenha havido redução na frequência do consumo de arroz, feijão, frutas e carne bovina entre os inquéritos de 2007-2008 e 2017-2018 (Rodrigues *et al*., 2021). Em relação ao custo agregado, o maior consumo em termos de peso não se traduz em maior custo, assim a carne bovina é o sexto alimento mais consumido pelos brasileiros, mas representa a maior parcela de gasto com a alimentação dentro do domicílio (Belik, 2020; IBGEb, 2020; Rodrigues *et al*., 2021)

Embora o consumo alimentar esteja profundamente enraizado em suas culturas e comportamentos específicos, e a demanda que ele cria possa moldar a oferta, certas políticas governamentais, interesses comerciais e corporativos também podem moldar a demanda e as escolhas do consumidor (HLPE, 2017; O'Rourke e Lollo, 2015).

A escolha dos alimentos e consumo alimentar perpassam por diversas questões, como preferências pessoais, acesso aos alimentos, hábitos culturais e ocasião social (Barbosa, 2007). Recentemente, novas tendências têm influenciado o consumidor, o debate acerca da alimentação ética e política transformam o ato de se alimentar em uma prática consciente e política. Dentre os fatores que motivam essa transformação pode-se destacar a conscientização acerca do impacto ambiental da produção de alimentos, os movimentos sociais de defesa do modo de produzir tradicional, os movimentos em defesa dos animais, os grupos que defendem a alimentação planetária, entre outros (Barbosa, 2007; Portilho, Castañeda e Castro, 2011).

Diversos grupos vêm se unindo em torno de uma identidade alimentar com o intuito de expressar seu posicionamento político. Alimentação orgânica, vegana, “slow food”, “terroir” são alguns exemplos (Chuck, Fernandes e Hyers, 2016). Estes consumidores utilizam suas escolhas pessoais como solução para o enfrentamento de problemas sociais, ambientais ou éticos (Portilho, Castañeda e Castro, 2011; Tanaka e Portilho, 2019). Segundo Portilho (2005), o consumo político é caracterizado pela ação de incorporar ao ato da compra, valores e ideias relacionados à ética, direitos, solidariedade e outras razões que não especificamente econômicas.

Muitos desses movimentos têm como característica central tentar resgatar o elo produtor- consumidor e minimizar ou reverter o impacto ambiental e social gerado pelo modo de produção intensivo de alto custo ambiental (Cooper, 2018). Ao mesmo tempo, vêm ocorrendo o fortalecimento de movimentos sociais que procuram organizar a agricultura camponesa em resistência ao agronegócio e permitir o escoamento da produção desses produtores a partir da construção de alianças com consumidores urbanos (Tanaka e Portilho, 2019)

Com isso, se constrói um novo papel para o consumidor, o de consumidor consciente – que pauta suas compras em escolhas políticas e não somente em preferências sensoriais ou de conveniência (Portilho, Castañeda e Castro, 2011; Tanaka e Portilho, 2019). Agrillo e colaboradores (2015) ressaltam que ao assumir a responsabilidade pela forma como os alimentos são produzidos, o consumidor se torna “coprodutor”.

Compreender os agentes de mudança do sistema alimentar é importante para avaliar as opções políticas ou tecnológicas potenciais que podem afetar as decisões e comportamentos dos atores do sistema alimentar e, em última instância, moldar os resultados dos sistemas alimentares.

2.2.2 Dietas plant-based

Dentre as inúmeras motivações para a adoção de uma dieta com restrição ao consumo de alimentos de origem animal pode-se destacar os motivos éticos, relacionados ao abate de animais e/ou bem-estar animal; as razões ecológicas, em especial a baixa eficiência na produção de alimentos de origem animal e os grandes impactos ambientais da produção e as crescentes razões de saúde. Além disso, especialmente em países não ocidentais, o vegetarianismo pode estar relacionado à adesão cultural e religiosa sobreposta a outros determinantes tradicionais da dieta vegetariana (Dagnelie e Mariotti, 2017; Zenoff *et al.*, 2014).

O vegetarianismo é um conceito amplo que engloba vários padrões alimentares, de acordo com o nível de restrição à alimentos de origem animal (Hargreaves *et al.*, 2020). De acordo com a Sociedade Vegetariana Brasileira (SVB), vegetariano é “aquele que exclui de sua alimentação todos os tipos de carne, aves e peixes e seus derivados, podendo ou não utilizar laticínios ou ovos”. A classificação das dietas se dá de acordo com o grau de exclusão dos alimentos de origem animal variando do vegetariano estrito ao ovolactovegetariano (SVB, 2018a).

Importante observar que o vegetariano estrito, aquele que opta por não ingerir nenhum tipo de alimento de origem animal, excluindo laticínio, ovos, aditivos alimentares, entre outros, é diferente do vegano. O veganismo se constitui em um estilo de vida que não compactua com nenhuma forma de sofrimento animal. Assim, roupas, sapatos, medicamentos e cosméticos precisam ser livres de sofrimento animal, ou seja, não podem estar associados à morte, privação de liberdade ou teste em animais (Vilela, 2017). Assim, o veganismo é ao mesmo tempo dieta, filosofia de vida, expressão da identidade pessoal (Otávio e Esteves, 2017), postura ética e política e um ato de desobediência civil pelo abolicionismo animal (Catellano e Sorrentino, 2013).

O termo “plant-based” foi cunhado por Thomas Colin Campbell em 1980. Ele estava em busca de um termo que designasse dietas baseadas em alimentos integrais, sem o uso de alimentos refinados nem alimentos de origem animal, mas que não tivessem o cunho ideológico do termo vegetariano (Nutrition Studies, 2023). Recentemente a indústria alimentar incorporou o termo “plant-based” passando a utilizá-lo para designar qualquer produto alimentício isento de ingredientes de origem animal. Com isso, há margem para a produção de produtos destituídos de fibras, fitoquímicos e adicionados de gordura hidrogenada, açúcar e óleo de adição, assim como corantes e demais aditivos (Slywitch, 2022).

Nos estudos publicados sobre dieta “plant-based”, a definição varia amplamente, desde a exclusão de todos os produtos de origem animal para apenas a predominância do consumo de frutas, legumes, verduras, cereais e leguminosas, e menor frequência de consumo de peixes, aves e laticínios (Williams e Patel, 2017).

Em algumas referências o termo “plant-based” diz respeito à dieta estritamente a base de alimentos de origem vegetal dando preferência a alimentos *in natura* e minimamente processados, com restrição à ingestão de alimentos altamente refinados, como farinhas brancas, açúcares e óleos (Tuso et al., 2013), o que outros autores designam como “Whole food plant-based diet” (Storz, 2022). Outras publicações utilizam o termo “plant-based” para designar qualquer dieta baseada em alimentos de origem vegetal, e nomeiam os padrões alimentares de acordo com os diferentes graus de restrição aos alimentos de origem animal, não considerando a qualidade dos alimentos ingeridos (“*in natura*”, refinados, industrializados etc.) (Craig *et al.*, 2021; Orlich *et al.*, 2014).

Storz (2022) investigou como os pesquisadores usam o termo dieta “plant-based” em estudos de intervenção nutricional e quais alimentos compunham as dietas estudadas.

Cinquenta por cento dos estudos analisados usaram o termo dieta “plant-based” de forma intercambiável com uma dieta vegetariana estrita. Em contraste, cerca de 33% dos estudos incluíram produtos lácteos e 20% das intervenções dietéticas enfatizaram um padrão alimentar semi-vegetariano.

Assim, “plant-based” virou um termo guarda-chuva para dietas que restringem ou diminuem o consumo de alimentos de origem animal. Enquanto os termos específicos vegetariano, vegano, semi-vegetariano, pescetariano, flexitariano e vegetariano estrito se referem aos diferentes níveis de consumo de alimentos de origem animal (Tuso et al., 2013; Storz, 2022; Orlich *et al.*, 2014), como pode ser observado no **Quadro 1**.

Já o termo flexitariano é mais recente e diz respeito as dietas semi-vegetarianas. Flexitariano é uma neologia dos termos flexível e vegetariano referindo-se a um indivíduo que segue uma dieta principalmente, mas não estritamente vegetariana, com a inclusão ocasional de produtos de origem animal (Dagnelie e Mariotti, 2017). As dietas flexitarianas vêm ganhando popularidade – uma transição que parece ter sido alimentada por uma combinação de preocupações com a saúde, meio ambiente e bem-estar animal (Derbyshire, 2017). Os consumidores flexitarianos acabam existindo em uma categoria intermediária, entre os carnívoros ávidos e os não consumidores de carne. Apresentam diferentes graus de variação de consumo de carne e diferem em suas motivações de apoio às dietas com restrição de carne. Assim, o termo flexitariano é bastante heterogêneo (Kateman, 2017).

No campo acadêmico, a caracterização de dieta flexitariana também é muito ampla, variando de acordo com o que o pesquisador define para dieta flexitariana. Em muitos estudos, o termo é substituído por dieta semi-vegetariana. Alguns estudos definem a frequência de consumo dos alimentos de origem animal, principalmente de carne vermelha, aves e peixes, como as definições adotadas pelo “Adventist Health Study-2” que caracteriza o semi-vegetariano como aqueles que ingeriram carne vermelha e aves ≥1 vez/mês e <1 vez/semana (Derbyshire, 2017; Orlich *et al.*, 2014). Outros autores utilizam abordagem mais genérica: aqueles contendo níveis moderados de produtos de origem animal sem especificar a frequencia de consumo (Moore, McGrievy e Turner-McGrievy, 2015; Turner-McGrievy *et al.*, 2015).

Quadro 1: Denominações utilizadas para designar dietas com restrição ao consumo de alimentos de origem animal e suas características

Denominações de dietas *plant-based*	Tipos de alimentos						
	Ovos	Laticínios	Óleos/ açúcares	Ultra processados	Mel	Pescados*	Carnes**
Lacto-ovo vegetariana	X	X	X	X	X		
Lacto vegetariana		X	X	X	X		
Ovo vegetariana	X		X	X	X		
Pescetariana	X	X	X	X	X	X	
Vegetariana estrito			X	X			
Vegana			X	X			
Whole food plant-based	#	#	#	#	X		
Flexitariano/ semi-vegetariano	X	X	X	X	X	#	#

* peixes e frutos do mar; **carnes bovinas, suínas e aves
X = consumo sem restrição; # consumo ocasional; em branco = não consome
Fonte: Elaboração própria

Apesar das diferenças de nomenclatura e composição, tem sido demonstrado que dietas "plant-based" ricas em alimentos integrais e frescos, com uma variedade de vegetais, frutas, legumes, cereais e oleaginosas são capazes de melhorar a saúde, reduzindo o risco de DCNT (Hargreaves *et al.*, 2020). Ensaios clínicos randomizados e estudos epidemiológicos indicam que dietas "plant-based", particularmente as dietas vegetarianas estritas, estão associadas com melhora significativa nos eventos cardiovasculares e fatores de risco como obesidade, hipertensão, diabetes mellitus tipo 2 e doença cardíaca isquêmica (Dybvik, Svendsen e Aune, 2023; Medawar *et al.*, 2019). Dados transversais de 71.751 participantes do "Adventist Health Study-2" (2002–2007) mostraram que o índice de massa corporal (IMC) foi maior em onívoros (média de 28,7 kg/m^2), ligeiramente menor em semi-vegetarianos (média de 27,4 kg/m^2) e menor em vegetarianos estritos (média de 24,0 kg/m^2) (Rizzo *et al.*, 2013). Esses achados são semelhantes às tendências anteriores (análise de 2002–2006), mostrando que o IMC médio foi menor em veganos (23,6 kg/m^2) e cada vez maior em ovolactovegetarianos (25,7 kg/m^2), pesco-vegetarianos (26,3 kg/m^2), semi-vegetarianos (27,3 kg/m^2) e onívoros (28,8 kg/m^2) (Tonstad *et al.*, 2009).

Kim *et al*. (2019) analisaram se há diferença nos desfechos de saúde da adesão à dieta "plant-based" mais ou menos saudável em uma coorte de adultos de meia-idade. A maior aderência a dieta "plant-based" saudável foi associada a 19% menor risco de mortalidade por doença cardiovascular e 11% menor risco de mortalidade por todas as causas todos. Porém, não foram encontradas associações entre dieta "plant-based" menos saudável e os resultados do estudo. Em meta-análise de ensaios clínicos randomizados, Guasch-Ferré *et al*. (2019) observaram que a substituição da carne vermelha por fontes vegetais de proteína de boa qualidade (oleaginosas, principalmente nozes, soja e proteína de soja, leguminosas e outros alimentos proteicos de origem vegetal) reduziu os níveis de colesterol total e de lipoproteína de baixa densidade.

As dietas "plant-based", ricas em fibras e polifenóis, também estão associadas a uma maior diversidade de microbiota intestinal, produzindo metabólitos que têm funções anti-inflamatórias ou atividade antioxidante (Craig *et al.*, 2021). Diferentes mecanismos têm sido propostos para explicar os efeitos benéficos das dietas "plant-based" no estado metabólico incluindo melhor controle glicêmico, menor atividade inflamatória, e modulação de neurotransmissores através da ingestão alimentar ou da atividade da microbiota intestinal (Medawar *et al.*, 2019),

Em relação ao fornecimento adequado de nutrientes para crescimento e manutenção da saúde, a "American Dietetic Association" afirma em documento sobre dietas vegetarianas que tanto a alimentação (ovolacto) vegetariana quanto a vegana são adequadas, desde que bem planejadas, para todas as fases da vida, incluindo gravidez, lactação, infância, adolescência, velhice e também para atletas (ADA, 2009).

Ainda assim, diversos nutrientes requerem atenção especial no planejamento de dietas nutricionalmente adequadas para vegetarianos, incluindo ferro, zinco, iodo e vitamina B_{12}. Cálcio e vitamina D também podem exigir atenção, dependendo das escolhas alimentares e de outros fatores como exposição ao sol. Proteínas e ácidos graxos da família ômega 3 também precisam de atenção (Pawlak, Lester e Babatunde, 2014; Rocha *et al.*, 2019).

Indivíduos que seguem dietas vegetarianas geralmente obtém quantidades adequadas de proteína dietética, particularmente nos países ocidentais, embora a ingestão seja tipicamente menor do que a ingestão proteica dos onívoros. Além disso, desde que uma variedade de alimentos ricos em proteínas seja consumida e a ingestão energética esteja adequada, as dietas vegetarianas são capazes de fornecer todos os aminoácidos indispensáveis (Mariotti e Gardner, 2019). Embora não haja necessidade de combinar diferentes alimentos proteicos na mesma refeição, uma variedade de alimentos vegetais deve ser incluída diariamente. A maioria dos alimentos vegetais contém alguma proteína, sendo as melhores fontes as leguminosas, alimentos à base de soja (incluindo leite de soja fortificado, tofu e tempeh), nozes e sementes (Rogerson, 2017). Grãos e vegetais também contêm proteínas, mas em quantidades menores. Não só a quantidade de proteína é importante, como também a qualidade dessas proteínas, que precisam ser biodisponíveis e ter boa digestibilidade (Nikmaram *et al.*, 2017). A digestibilidade das proteínas é afetada por fatores internos (perfil de aminoácidos e presença de fatores anti-nutricionais) e fatores externos (preparo e composição das refeições). É geralmente aceito que a digestibilidade ileal das proteínas de fontes vegetais é menor do que a das proteínas de origem animal. Os diferentes métodos de processamento (cocção, remolho, extrusão, fermentação, germinação, cozimento sob pressão) melhoram a biodisponibilidade das proteínas pois reduzem os fatores anti-nutricionais (Ishaq *et al.*, 2022).

Embora a menor ingestão e qualidade de proteína em uma dieta vegetariana seja frequentemente citada como uma preocupação, há evidências crescentes dos benefícios para a saúde de consumir proteínas de fontes vegetais em vez de fontes animais, e essa pode ser uma das razões pelas quais os vegetarianos têm menor risco de obesidade e DCNT (Dybvik, Svendsen e Aune, 2023; Medawar *et al.*, 2019; Orlich *et al.*, 2014).

2.2.3 Substitutos de carne

Substitutos de carne são produtos à base de alimentos de origem vegetal que simulam as características estéticas, sensoriais e nutricionais de alimentos tradicionais a base de carne (Tziva et al, 2020). Nos últimos tempos, o mercado de substitutos de carne vem se expandindo rapidamente em todo o mundo, indo além do público vegetariano para incluir consumidores que comem e amam carne (Bohrer, 2019).

Em 2020 o mercado brasileiro de substitutos de carne apresentou um crescimento de 11,3% em volume e 16,6% em valor quando comparado a 2019 (ABRAS 2021). Atualmente, diversas “start ups” bem sucedidas e empresas tradicionais desenvolvem produtos alternativos à base de plantas, tanto para substituir carnes quanto para substituir laticínios e peixes e o mercado brasileiro já conta com mais de 100 empresas e exporta para mais de 30 países (GFI, 2020). Trata-se, portanto, de um mercado promissor e com grande potencial de crescimento (Révillion *et al.*, 2020).

Outras pesquisas de ponta que prometem revolucionar o mercado são as carnes de laboratórios e os produtos à base de insetos e algas (Sha e Xiong, 2020). Os custos de produção e, portanto, os preços ao consumidor de alternativas à carne de ruminantes são atualmente proibitivos para os mercados de massa, mas estão caindo muito rapidamente e têm o potencial de se tornarem menos caros do que a carne real, de modo que fator preço pode ser decisivo para impulsionar o consumidor ao consumo de alternativas de carne mais sustentáveis (e quiçá saudáveis) (Rubio *et al*., 2020).

Produzir proteína vegetal geralmente requer menor uso da terra, água e energia em comparação com a produção de proteína animal e resulta em menores emissões de GEE (Tulbek *et al.*, 2016). Entretanto, a qualidade nutricional desses produtos apresenta grande variação e não se sabe quais consequências o consumo contínuo desses produtos pode acarretar (Bohrer, 2019; Boukid, 2021). A substituição da proteína animal pela proteína vegetal requer a combinação de vários ingredientes e diferentes técnicas de processamento para alcançar o sabor, e a textura dos alimentos de origem animal (Asgar *et al*., 2010; Tziva *et al*., 2020). Uma grande variedade de ingredientes é utilizada para produzir substitutos de carne, os diferentes ingredientes proteicos entregam diferentes propriedades fisiológicas e valor nutricional (Curtain, Grafenauer, 2019). A proteína de soja e o glúten de trigo continuam sendo os principais ingredientes dominantes na produção de análogos de carne, enquanto outras fontes de proteína, como legumes/leguminosas e fungos, também são utilizadas (BOHRER, 2019). Muitas críticas vêm surgindo em relação a esses novos produtos, especialmente por terem em sua composição ingredientes ultraprocessados (Rubio *et al*., 2020).

A inovação tecnológica em alimentos poderá se tornar um divisor de águas para dietas saudáveis e sustentáveis (Vermeulen *et al.*, 2020). Os alimentos ultraprocessados, que ocupam proporções substanciais das dietas atuais, têm sido associados a diversos desfechos negativos de saúde (Monteiro *et al.*, 2018). Porém, se bem utilizado, o processamento pode aumentar a longevidade, a palatabilidade e a disponibilidade de nutrientes, ao mesmo tempo que fornece aos consumidores alimentos convenientes, e acessíveis que eles geralmente preferem (Derbyshire, 2019).

2.2.4 Segunda sem carne

A campanha SSC se propõe a conscientizar as pessoas sobre os impactos que os alimentos de origem animal provocam na saúde humana e no planeta, convidando-as a descobrir novos sabores ao substituir a proteína animal pela proteína de origem vegetal, pelo menos uma vez por semana (Sampaio e Carvalho, 2016). A campanha tem uma boa abrangência mundial, tendo sido adotado por mais de 40 países ao redor do globo e apoiada por líderes internacionais. A SSC baseia-se em instar o consumo eventual, uma vez por semana, de uma refeição fora do padrão habitual, e assim promover mudanças graduais, e dissociar o conceito do prato completo necessitar de uma proteína de origem animal como componente principal (Singer, 2017).

Segundo os organizadores do movimento, deixar de comer carne uma vez por semana contribui para a redução do risco de doenças cardiovasculares, diabetes, obesidade e câncer. Além de evocar a preocupação com a saúde dos indivíduos, a ação também procura alertar sobre a pegada hídrica e emissão de gases de efeito estufa associados a produção de alimentos e do abatimento e confinamento ilegal de animais (MFM, 2015).

A SSC remonta a primeira guerra mundial, quando o governo americano sugeriu a não ingestão de carne as segundas feiras ("Meatless Monday"*)* e a não ingestão de farinha de trigo as quartas-feiras como uma medida de economia de recursos durante o período de guerra (Morris, 2018). Em 2003, em virtude do alto consumo de carnes, a campanha foi relançada pela Escola de Saúde Pública "Johns Hopkins Bloomberg", propondo a substituição de carnes um dia por semana em benefício da saúde humana. Em 2009, ganhou notoriedade mundial ao ser lançada na Inglaterra pelo ex Beatle Paul McCartney e rebatizada de "Meat Free Monday". Desde então, diversos países adotaram campanhas semelhantes (Morris, Kirwan e Lally, 2014). A sugestão da segunda-feira como o dia sem carnes refere-se a simbologia do início da semana atrelado à realização de novas metas ou iniciativas (Morris, 2018).

No Brasil, a campanha foi lançada na cidade de São Paulo, em outubro de 2009, por meio de uma parceria da SVB com a Secretaria do Verde e Meio Ambiente da Prefeitura e, posteriormente, estendeu-se a vários outros municípios (Sampaio e Carvalho, 2016).

Nas escolas municipais de São Paulo, a introdução do cardápio vegetariano se iniciou gradualmente em 2011. Na rede municipal, cerca de 1 milhão de alunos são beneficiados, poupando 436 mil quilogramas de carne ao longo de um ano. Já na rede estadual de ensino de São Paulo, a SSC foi implementada em 2017, alcançando 100 municípios participantes em agosto de 2017. Porém, a campanha não se limita somente a ambientes escolares, a rede popular de restaurantes Bom Prato aderiu à campanha em 2015 e passou, ainda que parcialmente, a servir refeições livres de carne em suas unidades (SVB, 2018b). A campanha também estimula a realização de palestras em instituições sobre os impactos ambientais da alimentação. A educação com escolares visa criar vínculos e despertar a noção de cidadania e responsabilidade social ligadas as causas ambientais e de saúde (Nakagawa e Noronha, 2019).

Em 2016, a campanha ganhou notoriedade com o veto do ex-governador de São Paulo, Geraldo Alckmin, ao projeto de lei que estabelecia a SSC no estado. O projeto de lei (PL) número 87/2016 aprovado na Assembleia Legislativa, em 27 de dezembro, previa a proibição da venda e distribuição de carne e derivados em estabelecimentos de órgãos públicos as segundas-feiras, incluindo escolas, presídios e restaurantes populares (Bom Prato); hospitais e demais unidades de saúde pública estariam dispensadas de participar do projeto. As entidades contrárias a aprovação se justificaram com os argumentos de que a lei era autoritária e limitava o direito de escolha dos cidadãos. Essa resistência a lei pela população ilustra o descontentamento com a campanha e uma possível falta de esclarecimento da população sobre seus motivos (Sampaio e Carvalho, 2016; Singer, 2017).

Ainda que não tenha obtido o que seria considerado como um grande marco para a campanha brasileira, o movimento anunciou em 2017, ser a maior SSC do mundo, com 2 mil toneladas de carne deixando de ser consumidas, uma economia de 280 mil toneladas de CO_2, e 57 bilhões de litros de água. Em 2018, anunciou ter atingido 67 milhões de refeições somente naquele ano (SVB, 2018).

Porém, a forma como é transmitida à população e aos gestores determina como será a sua aceitação. Enquanto em locais como a cidade de Ghent, na Bélgica, o dia livre de carne engloba o apoio individual e coletivo atingindo restaurantes, lojas, escolas e hospitais, em outros locais a repercussão e consequente adesão não foi a mesma (Morris, Kirwan e Lally, 2014). Na cidade de Brighton, Inglaterra, a adoção da SSC pelas cantinas e restaurantes vinculados à prefeitura foi tão impopular que foi abandonada quase que imediatamente após estabelecida. Recentemente, a proposta do partido verde alemão de instituir um dia vegetariano por semana, quando as cantinas seriam obrigadas a servir pratos sem carne diminuiu as intenções de voto no partido e limitou a chance de sucesso eleitoral do mesmo (Morris, Kirwan e Lally, 2014).

Outros exemplos de campanhas de redução do consumo de carne são o “Protein Flip” e o desafio 21 dias sem carne. O primeiro é uma parceria da escola de saúde pública de “Harvard” com a “Culinary Institute of America”, que vem desenvolvendo pratos saborosos com menor quantidade de carne e investindo no conceito da carne como guarnição ou acompanhamento, ao invés de prato principal (CIA; 2023), o que pode ser considerado como uma grande mudança para o estereótipo de consumo americano (Malik, Willett e Hu, 2013).

3 HIPÓTESE

A perspectiva de uma nova transição alimentar, direcionada à diminuição do consumo de alimentos de origem animal revela muitos desafios. Diante desse cenário, foram formuladas duas hipóteses:

1- Os produtos “plant-based" podem ser aliados da transição para sistemas alimentares sustentáveis, apesar de todos os processamentos envolvidos em sua produção.
2- A campanha SSC tem potencial de comunicar os impactos ambientais da produção de alimentos de origem animal e incentivar a mudança de hábitos de consumo.

4 JUSTIFICATIVA

A transição para dietas mais sustentáveis é um elemento central da diminuição do impacto ambiental da alimentação. Diante disso, soluções para incentivar mudanças no padrão de consumo de alimentos de origem animal vem surgindo, soluções essas que precisam ser pensadas quanto ao potencial de saúde e a aplicabilidade. Nos últimos anos, muitos investimentos em inovação e produção de novos alimentos para substituição de alimentos de origem animal tem sido feitos, tanto na esfera nacional quanto internacional, ao mesmo tempo que campanhas de marketing para estimular o consumo desses alimentos têm sido lançadas sem que de fato haja a devida regulamentação desses produtos ou, mesmo, o conhecimento sobre a contribuição que os mesmos podem ter para o atendimento das necessidades nutricionais humanas. A identificação desses produtos e o mapeamento de suas características nutricionais são necessários nesse processo de transição proteica, além da criação de parâmetros e critérios para o estabelecimento de normas e padrões de identidade para a produção de alimentos seguros.

Por outro lado, são poucos os investimentos em campanhas sociais que poderiam incentivar a mudança de hábitos de consumo visando a redução do consumo de alimentos de origem animal por preparações culinárias a base de plantas, como a Segunda sem Carne. Sendo importante avaliar o potencial transformador dessas campanhas.

5 OBJETIVOS

5.1 OBJETIVO GERAL

Investigar iniciativas para a redução do consumo de alimentos de origem animal na transição para sistemas alimentares saudáveis e sustentáveis.

5.2 OBJETIVOS ESPECÍFICOS

5.2.1 Manuscrito I – Avaliação dos substitutos de carne disponíveis no mercado brasileiro

- Analisar os produtos substitutos de carne a venda no mercado brasileiro quanto ao estágio de desenvolvimento tecnológico, qualidade nutricional e adequação à legislação vigente.

5.2.2 Manuscrito II – Produtos plant-based do tipo hambúrguer presentes no mercado global

- Analisar o perfil de ingredientes, as características nutricionais, o estágio de desenvolvimento tecnológico e o posicionamento de mercado de hambúrgueres "plant-based" presentes no mercado global.

5.2.3 Manuscrito III - Solutions to improve human nutrition

- Analisar se produtos "plant-based" podem ser considerados saudáveis e incluídos em uma dieta saudável.
- Investigar as evidências cientificas em relação ao perfil nutricional, a digestibilidade, a classificação NOVA e o impacto na saúde do consumo de alimentos "plant-based".
- Levantar as evidências existentes em relação a equivalência nutricional dos produtos "plant-based" em comparação aos alimentos à base de proteína animal.

5.2.4 Manuscrito IV - A campanha segunda sem carne

- Investigar o potencial da campanha segunda sem carne como agente de conscientização sobre os impactos ambientais associados ao consumo de alimentos de origem animal.
- Estudar a percepção sobre a campanha segunda sem carne de clientes de um restaurante no Rio de Janeiro.
- Analisar o discurso da campanha segunda sem carne em suas redes sociais.

6. MÉTODOS

6.1 DELINEAMENTO DO ESTUDO

Este estudo foi realizado na forma de 4 ensaios independentes, os detalhes de publicação e submissão estão descritos abaixo.

6.1.1 Meat substitutes - Past, present, and future of products available in Brazil: changes in the nutritional profile

Os dados obtidos foram publicados na revista Future Foods, Elsevier (2022). Doi: 10.1016/j.fufo.2022.100133; endereço eletrônico: <https://www.sciencedirect.com/science/article/pii/S2666833522000211>

6.1.2 Analysis of ingredient list and nutrient composition of plant-based burgers available in the global market

Manuscrito publicado na revista *International Journal of Food Sciences and Nutrition*/ Taylor & Francis *online* (2024). Doi: 10.1080/09637486.2024.2303029; endereço eletrônico: <https://www.tandfonline.com/doi/full/10.1080/09637486.2024.2303029>

6.1.3 Solutions to improve human nutrition

Revisão bibliográfica realizada a convite dos editores do *livro Handbook of Plant-Based Foods and Drinks: Innovation and Nutrition, Elsevier*. Publicação prevista para 1º de Junho de 2024. ISBN: 9780443160172. Organizadores Fatma Boukid; Andrea Dulberger.

6.1.4 Diner's perception of the meat free Monday campaign in a restaurant in the city of Rio de Janeiro

Manuscrito submetido à revista *British Food Journal/ Emerald Publishing.*

6.2 MANUSCRITO I- AVALIAÇÃO DOS SUBSTITUTOS DE CARNE DISPONÍVEIS NO MERCADO BRASILEIRO

Para a avalição dos substitutos de carne, os produtos à venda nos supermercados, lojas de produtos naturais e lojas *on line* foram identificados e tiveram os rótulos analisados. Os produtos que fizeram parte da busca foram aqueles que se propõem a substituir carne, frango, peixe ou embutidos, que estão prontos para uso, não necessitando de preparo posterior. Esta busca foi realizada de setembro a novembro de 2020. Não foram considerados para a busca ingredientes culinários, e produtos sem informação nutricional disponível não foram incluídos na pesquisa.

6.2.1 Classificação dos produtos: estágio de desenvolvimento tecnológico

Os produtos foram classificados de acordo com a tecnologia empregada para elaboração do produto: Produtos tradicionais, feitos exclusivamente com ingredientes frescos ou minimamente processados e leguminosas integrais, como hambúrgueres de lentilha e salsichas de grão de bico (Lichstein, 2020); substitutos de carne de primeira geração - produzidos principalmente com proteína vegetal texturizada (por extrusão com baixa umidade) e/ou glúten, são direcionados ao mercado vegetariano, e estão no mercado desde a década de 1990 (Tziva *et al*., 2020); substitutos de carne de 2ª geração - baseados em extrusão por alta umidade para produzir novos produtos cuja aparência, conteúdo proteico, aroma e sabor são muito semelhantes aos produtos cárneos originais, como iscas de frango, filé de salmão e bacon. Normalmente, esses produtos têm distribuição nacional (He *et al*., 2020) e são voltados ao público flexitariano (Bohrer 2019). Os produtos foram classificados também de acordo com o produto que o tipo de produto cárneo que estão substituindo: carne/bife; frango; peixe e frutos do mar, hambúrgueres, carne moída e embutidos.

6.2.2 Composição nutricional e análise dos ingredientes

As quantidades de todos os nutrientes (carboidrato, proteína, gordura total, gordura saturada, fibras, ferro, vitamina B_{12}, zinco e sódio) e energia total (kcal) apresentadas no rótulo de cada produto foram calculados para 100 g, a fim de permitir a comparação entre produtos. Os ingredientes listados na embalagem foram analisados quanto a presença de formulações industriais, que caracterizam os produtos como alimentos ultra processados. Também foram analisados os ingredientes proteicos, lipídicos e aditivos, e a presença de açúcar (Brasil, 2014).

6.2.3 Perfil Nutricional

Para analisar o desempenho dos produtos quanto à sua qualidade nutricional, foram aplicadas as Normas Brasileiras Resolução de Diretoria Colegiada (RDC) nº 429 (BRASIL, 2020) e IN nº 75 (BRASIL, M. da S. M., 2020). Adicionalmente, foi avaliado se o tamanho da porção declarada no rótulo da informação nutricional estava adequado com o estipulado na RDC nº 360 (Brasil, 2003). A densidade calórica dos produtos foi calculada de acordo com a RDC nº 360 (Brasil, 2003), dividindo-se 150 kcal por 80 g de porção. Produtos dentro do intervalo permitido na legislação (-20% a +20%) foram classificados como contendo densidade calórica adequada.

6.2.4 Análise Estatística

Os resultados da composição nutricional foram expressos em mediana, mínimo e máximo. Os produtos agrupados por estágio de desenvolvimento tecnológico foram comparados pelo teste não paramétrico de Kruskal Wallis, seguido do teste post hoc de Dunn com ajuste de Bonferroni. O nível de significância estatística foi estabelecido em $p < 0,05$. A análise foi feita no RStudio Desktop versão 1.4.1106.

6.3 MANUSCRITO II- PRODUTOS PLANT-BASED DO TIPO HAMBÚRGUER PRESENTES NO MERCADO GLOBAL

Os dados para esse estudo foram obtidos da base de dados *Mintel Global New Products Database* (Mintel GNPD). A pesquisa para a busca de produtos foi realizada em 13 de maio de 2022, usando os parâmetros de pesquisa:

- Data: 1º de janeiro de 1998 - 13 de maio de 2022
- Categoria: Alimentos
- Subcategoria: Substitutos de Carne

• Nutrição: energia, carboidratos, açúcar, proteína, gordura, ácido graxo saturado, fibra, sódio

• Região: global

A busca identificou 3.218 produtos, após aplicar as palavras chaves: *burger*, *hamburger*, *patty* ou *patties* e descartar produtos com a lista de ingredientes e/ou informação nutricional incompletas e a amostra final foi composta por 807 produtos. Os produtos selecionados foram organizados por ano de lançamento, compreendido entre setembro de 1998 a maio de 2022. Os resultados da pesquisa foram exportados para o Microsoft Excel (Microsoft Office, Washington, WA, EUA).

6.3.1 Estágio de desenvolvimento tecnológico

Os produtos foram classificados de acordo com o estágio de desenvolvimento tecnológico, proposto por Franca et al., 2022, com algumas modificações. Para classificar os produtos como primeira e segunda geração seria necessário entrar em contato com os fabricantes para definir qual tecnologia foi utilizada na elaboração de seus produtos. Portanto, foi aplicada uma classificação simplificada, diferenciando apenas os produtos tradicionais destes últimos (substitutos de carne de Primeira Geração e substitutos de carne de Segunda geração) que foram classificados neste estudo conjuntamente como "Generation Products".

6.3.2 Posicionamento de mercado e região de lançamento do produto

Com base na lista de ingredientes, os produtos coletados foram classificados em produtos veganos e vegetarianos, os produtos que continham qualquer ingrediente de origem animal (leite, queijo, ovos e produtos derivados) na lista de ingredientes foram classificados como vegetarianos, enquanto os produtos que não continham ingredientes de origem animal foram classificados como veganos. O país de lançamento dos produtos também foi considerado.

6.3.3 Análise dos ingredientes

Considerando a grande variedade de ingredientes utilizados nas formulações dos produtos estudados, foram definidos critérios de agrupamento para nominá-los a fim de permitir a análise da frequência de palavras. A classificação completa pode ser vista na Tabela S2. Os ingredientes foram organizados de acordo com grupo de alimentos (FAO, 2022a) e nível de processamento (BRASIL, 2014).

6.3.4 Análise Nutricional

Foram analisadas as informações nutricionais obrigatórias, de acordo com o Regulamento UE 1169/2011 e o Codex Alimentarius, relacionadas à energia (kcal/100 g), gordura total (g/100 g), ácidos graxos saturados-SFA (g/100 g), carboidratos (g/100 g), açúcares (g/100 g), proteínas (g/100 g), fibras (g/100 g) e sódio (mg/100 g).

6.3.5 Análise Estatística

A análise multivariada de variância (MANOVA) foi usada para determinar os efeitos do estágio de desenvolvimento tecnológico, região e posição de mercado dos produtos selecionados para análise. A MANOVA foi realizada com base em fatores fixos usando o teste de rastreamento de Pillai. As porcentagens das variações totais foram computadas para determinar a contribuição dos fatores e suas interações na variância de cada parâmetro. A porcentagem da variação total foi calculada para explicar a variância de cada parâmetro em função da soma dos quadrados dos principais fatores e sua interação. Diferenças significativas entre os valores médios foram analisadas pelo teste não paramétrico de *Mann-Whitney* ($p < 0,05$) para duas amostras independentes. Uma análise de componentes principais (PCA) foi realizada com base na matriz de correlação. A análise estatística foi realizada com o software Statistical Package for the Social Sciences (IBM SPSS Statistics, versão 25.0, IBM corp., Chicago, IL, EUA). Para representação visual dos ingredientes, foi utilizado o WordClouds® 2022.

6.4 MANUSCRITO III- SOLUTIONS TO IMPROVE HUMAN NUTRITION

Como a saudabilidade é um conceito amplo que pode ser medido e avaliado de várias maneiras, a realização de uma revisão permitiu que uma série de questões relevantes fossem levadas e consideradas no estudo.

Para responder à questão se os produtos à base de plantas podem ser considerados saudáveis e incluídos em uma dieta saudável, esta revisão de abordou os seguintes pontos em detalhes: 1) Investigar as evidências científicas sobre perfil nutricional, digestibilidade, classificação NOVA e o impacto na saúde ao consumir alimentos de origem vegetal. 2) Analisar as evidências existentes sobre a equivalência nutricional de produtos de origem vegetal em relação aos alimentos de origem animal.

Os critérios utilizados para identificar os diferentes aspectos de saúde dos produtos *plant-based* foram: conteúdo nutricional, perfil nutricional, comparação com o conteúdo nutricional de alimentos de origem animal, o efeito do consumo a curto e a longo prazo, evidências de saúde de estudos populacionais. Assim, foi realizada uma busca no Web of Science, Pubmed e Scopus por artigos em inglês publicados entre 2000 e 2023 com termos a produtos “plant-based” (“meat analog”, “meat substitutes”, “alternative protein”, “plant-based meat”, “plant-based dairy”, “vegan alternatives”, “milk analog”, “plant-based milk”, “milk substitutes”) e nutrição (“nutritional quality”, “nutrition facts”, “nutritional profile”,” diet quality”, “nutrient content”, “antinutrients”, “protein digestibility”). Os resultados apresentados resumem a literatura sobre saudabilidade de produtos *plant-based.*

6.5 MANUSCRITO IV - A CAMPANHA SEGUNDA SEM CARNE

A abordagem de pesquisa é qualitativa e procura estabelecer o significado do fenômeno estudado a partir do ponto de vista dos participantes. A pesquisa qualitativa permite uma concepção participativa entre os entrevistados viabilizando a realização de pesquisas em movimentos e contextos sociais (Creswell, 2010).

Inicialmente, foi realizada uma pesquisa *on line* utilizando o buscador *Google* sobre a SSC, a fim de identificar como a campanha é representada no Brasil. Kozinets (2015) ao tipificar a pesquisa etnográfica em ambiente virtual, denominada pelo autor como netnografia, assume que uma das etapas primordiais da netnografia é a fase exploratória, de *sites* e páginas relevantes ao tema estudado, a fim de se obter uma perspectiva cultural mais profunda sobre o grupo estudado. Nesse momento, pode-se identificar a página oficial da campanha *on line* no Brasil e através da mesma identificar os restaurantes participantes em cada cidade brasileira. No Rio de Janeiro foram apontados dois restaurantes participantes da campanha, no entanto, somente em um foi obtido consentimento para participação na pesquisa.

Os consumidores foram convidados a participar da pesquisa e, caso concordassem, foram informados sobre o objetivo da pesquisa e deram seu consentimento por escrito. No total, 6 comensais e a proprietária do restaurante concordaram em participar da pesquisa. Os participantes foram orientados a preencher o Termo de Consentimento Livre e Esclarecido e informados sobre os riscos da participação na pesquisa. Os comensais que aceitaram participar da entrevista informaram nome, idade, sexo e raça. As entrevistas foram realizadas por duas entrevistadoras treinadas na primeira e na segunda segunda-feira do mês de dezembro de 2018, após o almoço dos clientes. As entrevistas semiestruturadas cobriram uma variedade de tópicos. Na entrevista semiestruturada, o entrevistador tem uma lista clara de itens que fará, mas a estrutura das perguntas é flexível, o que permite a inclusão de novas perguntas à medida que a entrevista avança (Canesqui, 2009; Draper e Swift, 2011).

As questões norteadoras foram enquadradas em torno de 4 temas conceituais: (a) motivações para escolher aquele restaurante na segunda-feira, (b) conhecimento prévio sobre a campanha, (c) preocupações com o impacto ambiental do sistema alimentar e (d) dieta atual e/ou estilo de vida alimentar. A ordem e o enunciado específico das questões variaram de acordo com cada participante e o fluxo da entrevista. Os entrevistadores anotaram as respostas e comentários dos entrevistados para análise.

A partir da página oficial da campanha foram analisadas as postagens no endereço eletrônico @segundasemcarne. Um perfil no Instagram sem foto, biografia, seguidores ou publicações foi criado para facilitar a busca e evitar confusões. Todas as postagens dos meses de novembro e dezembro de 2018 foram selecionadas para análise, totalizando 133 postagens.

6.5.1 Análise de dados

O processo de interpretação dos dados foi dividido em etapas, permitindo a construção de categorias estruturantes que posteriormente foram analisadas em profundidade (Draper e Swift, 2011). As postagens foram codificadas e as imagens foram classificadas e descritas. O conteúdo das entrevistas foi submetido à Análise Fenomenológica Interpretativa (IPA) (Smith e Fieldsend, 2021). As etapas de análise permitiram a consideração do contexto, linguagem, conteúdo e interpretações pactuadas pelos pesquisadores e a posterior construção de temas emergentes. Em seguida, foram identificados temas abrangentes que refletiam as experiências compartilhadas e divergentes no corpus de entrevistas. Como resultado, emergiram as categorias “amor de animais”, “cozinha descomplicada” e “informativo”.

7 RESULTADOS E DISCUSSÃO

7.1 MEAT SUBSTITUTES - PAST, PRESENT, AND FUTURE OF PRODUCTS AVAILABLE IN BRAZIL: CHANGES IN THE NUTRITIONAL PROFILE

O manuscrito original se encontra no APÊNDICE 1

7.2 ANALYSIS OF INGREDIENT LIST AND NUTRIENT COMPOSITION OF PLANT-BASED BURGERS AVAILABLE IN THE GLOBAL MARKET

O manuscrito original se encontra no APÊNDICE 2.

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7.3 SOLUTIONS TO IMPROVE HUMAN NUTRITION

CHAPTER
21

Anna Paola, Trindade Rocha, Pierucci,
Paula, Albuquerque Penna, Franca,

1.0 Introduction

Decreasing meat consumption has been pointed out as essential to the transition to sustainable diets, in addition, it is indisputable that plant-based diets are healthy, associated with longevity and protective of various non-communicable diseases (Clarys *et al.*, 2014; Gili *et al.*, 2019; Leitzmann, 2014). However, plant-based products still generate a lot of debate whether they can be considered a healthy option or not.

A healthy diet is easily defined as "health-promoting and disease-preventing as it provides adequacy, without excess, of nutrients and health-promoting substances from nutritious foods and avoids the consumption of health-harming substances" (UN Food Systems Summit, 2021), whereas the definition of a healthy food is somewhat intangible.

The notion of healthy food has become ubiquitous in medical, political, media, and general public discourses. The criteria for defining healthy food refers to diverse scientific, symbolic, and moral rationalities (de Moraes Prata Gaspar, Garcia and Larrea-Killinger, 2020). Thus, the definition of healthy food is a complex matter because it depends on the characteristics of the diet, of the person, and of the context.

To determine how healthy or unhealthy a food is, different aspects can be taken into consideration, such as the nutrient composition, the effect of long-term consumption, the short-term effect of including it in the diet, its effect on the gut microbiota, the inflammatory potential of the food, the effect on biochemical markers, on weight change and body composition, and the association with the development of non-communicable diseases and cardiovascular diseases. Besides, the social, cultural, economic, and environmental dimensions that permeate food should also be considered as they determine the form and frequency of food consumption thus influencing health.

For industrialized foods, some metrics have been used to help in this decision-making process: nutritional claims (Kaur *et al.,* 2016), comparison of nutrients with Dietary Reference Intake (IOM *et al.,* 2002), nutritional profile (Labonté *et al.*, 2018), presence of additives, and characterization according to NOVA classification (Monteiro *et al.*, 2019; Monteiro *et al.*, 2018).

Plant-based foods are not a new phenomenon, they have been on the market for a long time (Bohrer, 2019; Boukid, 2021) but consumption was widespread among the vegetarian public and had not awakened the interest of the large consumer market, the media, and science (Penna Franca *et al.*, 2022). With the growing interest of these actors, this chapter aimed to carry out a review of whether plant-based products can be considered healthy and included in a healthy diet and identify nutritional issues that can be improved to promote good practices in human nutrition.

2.0 Methods

To address the question of whether plant-based products can be considered healthy and included in a healthy diet, this review addressed the following points: 1) Investigate the scientific evidence regarding nutritional profile, digestibility, NOVA classification, and the health impact of consuming plant-based foods. 2) Analyze the existing evidence regarding the nutritional equivalence of plant-based products in relation to animal-based foods.

The criteria used to identify the different health aspects of plant-based products were nutritional content, nutritional profile, comparison with the nutritional content of animal-derived foods, the effect of short-term and long-term consumption, and evidence of health from population studies. The presented results summarize the literature on the healthiness of plant-based products.

Thus, a search was conducted on Web of Science, Pubmed and Scopus for articles in English published between 2000 and 2023 with terms related to plant-based products (“meat analog”, “meat substitutes”, “alternative protein”, “plant-based meat”, “plant-based dairy”, “vegan alternatives”, “milk analog”, “plant-based milk”, “milk substitutes”) and nutrition (“nutritional quality”, “nutrition facts”, “nutritional profile”,” diet quality”, “nutrient content”, “antinutrients”, “protein digestibility). Mendeley Reference Manager was used for the management of the results.

3.0 Setting the concepts about plant-based food and drinks

Does the adoption of a plant-based diet for a more sustainable lifestyle and health pervade the increased consumption of processed or ultra-processed foods? While this is being questioned by health professionals there is a growing market for plant-based alternatives to animal products.

To follow this trend, the food industry has developed new plant-based products using various processing methods and a diversity of ingredients. These products include imitation of processed ‘meats’ (e.g., ‘sausages’, ‘nuggets’, ‘burgers’, etc.), beverages (e.g. almond or oat ‘milk’) as well as plant-based ‘cheese’ and ‘yoghurt’ (Wickramasinghe *et al.*, 2021). As a result, different nomenclatures are used to designate the products.

Plant-based products are finished products formulated with plant-derived ingredients. However, the use of ingredients of animal origin, such as milk, eggs and cheese is also common. Therefore, plant-based products can have different positioning in the market: vegan or vegetarian. Products can also be classified according to the stage of technology development. Traditional or artisanal products are made from whole grains, vegetables and condiments. Second-generation products or advanced products are formulated with refined ingredients, such as protein concentrates and textured vegetable proteins, which include meat and milk analogues (Penna Franca *et al.*, 2022). Regardless of market positioning or level of technological development, all plant-based products have been called "alternatives" to foods of animal origin (Gastaldello *et al.*, 2022). Meat, milk, and cheese alternatives are examples of terms used to identify these products. Eventually, the term “substitute” is also used as a reference (Elzerman *et al.*, 2021; Salomé *et al.*, 2023). Usually, the product name is preceded by the animal counterpart or animal-derived product it intends to replace, which may confuse consumers about the nutritional equivalence between plant-based products and animal-based products. Currently, the terms that designate dairy products are protected by the European Union law so the terms milk, cheese or yoghurt cannot be used for purely plant-based products. However, products designated to replace meat, chicken and fish are not regulated (Leialohilani and de Boer, 2020) which could cause consumers to expect that the nutritional content of those products mirror animal-based products (De Marchi *et al.*, 2021). In this sense, how should be the nutritional evaluation of these products? Should processed ingredients be compared to the whole-food ingredient they are derived from? Or would it be more logical to compare the animal-based products to the plant-based products?

4.0 Nutritional composition of plant-based x animal-based products

It is essential to know the nutritional value and nutritional profile of plant-based products to decide whether they can be part of a healthy diet (Andreani *et al.*, 2023). Most of the existing studies only analyzed the nutritional labels of commercial products, and there is little evidence of protein and nutrient quality and digestibility (De Angelis *et al.*, 2022). In addition, the products vary in nutrition and ingredient composition so it´s difficult to draw health recommendations.

4.1 Meat substitutes

Several studies analyzed the nutrition facts label of meat substitutes present in the local markets (Alessandrini *et al.*, 2021; Bryngelsson *et al.*, 2022; Curtain and Grafenauer, 2019; Cutroneo *et al.*, 2022; Huybers and Roodenburg, 2023; Penna Franca *et al.*, 2022; de las Heras-Delgado *et al.*, 2023), or global market (Boukid and Castellari, 2021; Boukid *et al.*, 2022), plant-based burgers compared to animal-based counterparts (Cutroneo *et al.*, 2022; de las Heras-Delgado *et al.*, 2023) or compared to national dietary guidelines (Bryngelsson *et al.*, 2022; Huybers and Roodenburg, 2023).

Most studies classify the products according to animal-based counterparts and product types. Product´s types vary from each study demonstrating great variability between countries. Burgers, sausages, steaks, chicken cutlets, and minced meat are the most studied types. Other products also studied are meatballs, fish, cold cuts, cutlets, schnitzel, eggs, seafood, bacon, chicken nuggets, fillet, strips, salami, bratwurst, and meat sausage (Cutroneo *et al.*, 2022; Pointke and Pawelzik, 2022; Romão *et al.*, 2023).

While some studies found similar nutritional content for plant-based versus animal-based meats (Andreani *et al.*, 2023), others found a diverse nutrient composition. Variability is seen between studies. In general, plant-based meat substitutes have lower energy values and higher carbohydrate values than their animal-based counterparts (Romão *et al.*, 2023). As for protein content, most studies showed similar or lower protein values than animal-based products despite differences in amino acids profile (De Marchi *et al.*, 2021). Usually, meat substitutes do not present trans fats.

In studies performed in the Italian market (Cutroneo *et al.*, 2022), the US (Cole *et al.*, 2022), Sweden (Bryngelsson *et al.*, 2022), Brazil (Costa-Catala *et al.*, 2023; Romão *et al.*, 2022), Norway (Tonheim *et al.*, 2022), and other European markets (Boukid, 2021), carbohydrates and dietary fibre were found in higher amounts than animal-based counterparts. In all studies except one total and saturated fat contents had lower values than animal-based products (Tonheim *et al.*, 2022). Energy was usually lower (Cole *et al.*, 2022; D'Alessandro *et al.*, 2022; Tonheim *et al.*, 2022), sometimes equivalent (Bryngelsson *et al.*, 2022; Romão *et al.*, 2022) or higher than animal-based counterparts (for sausages only) (Costa-Catala *et al.*, 2023). Protein content was lower (Cole *et al.*, 2022; D'Alessandro *et al.*, 2022; Tonheim *et al.*, 2022), equivalent (Bryngelsson *et al.*, 2022; Romão *et al.*, 2022) or higher (for sausages and meatballs in one study only) (Costa-Catala *et al.*, 2023).

Accurate information about nutrient content tends to be limited, particularly micronutrients, since the nutrient analysis reported in the literature is mostly based on commercial products' nutritional labels, and several micronutrients do not have compulsory label declaration (Lawrence *et al.*, 2023). Vitamin B_{12} and zinc were found in smaller amounts compared to animal-based products (Cole *et al.*, 2022; Romão *et al.*, 2023), iron content was found in higher amounts than animal-based counterparts by De Marchi *et al.*, 2021; Pointke and Pawelzik, 2022; lower amounts by Andreani *et al.*, 2023 and similar amounts by Cutroneo *et al.*, 2022.

Conversely, salt content showed contrasting results. In studies performed in American (Cole *et al.*, 2022) and Italian markets (D'Alessandro *et al.*, 2022) salt content in plant-based products was higher than animal-based counterparts. In a Norwegian study (Tonheim *et al.*, 2022) salt content was higher for plant-based meat but not for other product`s categories (Tonheim *et al.*, 2022). Salt content in plant-based products was equivalent to meat products in a Swedish study and in a Brazilian study (Romão *et al.*, 2022; Tonheim *et al.*, 2022). In a study performed in Spain, salt content was lower for plant-based products than values for the animal counterparts (Costa- Catala *et al.*, 2023).

Regarding micronutrients, bioavailability should also be observed. Legumes are good sources of essential micronutrients such as iron and zinc, but bioavailability might be lower than in meat-based products. Although researchers have demonstrated that plant-based products are good sources of iron, calcium and zinc, future investigations should analyse the absorption and bioavailability of these minerals (Andreani *et al.*, 2023). Cyanocobalamin is only found in animal-based foods, and people following a vegan diet are in danger of presenting vitamin B_{12} deficiency. Therefore, fortification of meat substitutes with B_{12} is critical.

Also, several studies have used nutrient profiling (NP) to analyse plant-based products (Alessandrini *et al.*, 2021; Bryngelsson *et al.*, 2022; Cutroneo *et al.*, 2022; Huybers and Roodenburg, 2023; Pointke and Pawelzik, 2022; de las Heras-Delgado *et al.*, 2023). NP is increasingly used to improve public health nutrition as it rates and evaluates the nutritional quality of foods. It uses a scoring system that considers the amount or the presence of nutrients and other related food components (e.g., whole grain) that should be encouraged versus nutrients that should be avoided. The degree of healthfulness of a product is expressed either as a numerical score or as a qualitative classification (e.g., eligible/not eligible) and may be used to assist consumers in making informed decisions, regulating food products and nutrition claims (Alessandrini *et al.*, 2021; Labonté *et al.*, 2018; Santos *et al.*, 2021). NPs are useful in the analysis of plant-based products because they allow easy comparison between products. Besides, NPs can indicate if individual foods might be part of a healthy diet, facilitating the decision-making process of choosing products (Alessandrini *et al.*, 2021).

Table 21.1 summarises NPs findings of plant-based products from different studies. Product quality varies by product type and country. Overall, cold cuts and cheese had low nutritional profile scores. While products that replace meat, burgers, fillets, and nuggets usually have a better nutritional profile than meat-based products, due to the higher amount of saturated fat and sodium found in meat-based products, lower caloric density, and higher amount of fibre in plant-based products.

To date, only two studies analysed the nutritional composition and physicochemical characteristics of commercial plant-based meat. De Marchi *et al.*, 2021, described the amino acid, fatty acid, and mineral profiles of 3 commercial plant-based burgers compared to meat-based burgers. Although the protein content was similar, six amino acids differed between categories. Hydroxyproline was exclusively found in meat-based burgers while alanine, glycine, and methionine were less abundant in plant-based burgers than in meat-based burgers. Carbohydrate content was greater in plant-based burgers (Median, 8.37% of the raw product) than in meat-based burgers (Median, 2.04% of the raw product) presumably due to dietary fibre (Median, 4.27% versus 0,74% of the raw product in plant-based and meat-based burgers respectively) and not starch or fructose content. Total fat and saturated fat contents were similar among categories, whilst plant-based burgers had much lower cholesterol content (Median, 3.98 mg/100 g of the raw product) than meat-based burgers (Median, 50.60 mg/100 g of the raw product). Omega-6 fatty acids were four times greater in plant-based burgers. As for vitamins and minerals, sodium content was equivalent in both categories. Zinc was less abundant in plant-based burgers than in meat-based burgers, and iron content was twice as great in plant-based burgers than in meat-based burgers, although the proportion of heme-Fe was not identified (De Marchi *et al.*, 2021).

Another study analysed 58 products available in the Danish market (Loĭnjak Švarc *et al.*, 2022). Products from different protein sources (derived from egg white, mycoprotein, pea, soy, wheat, and combinations) were grouped into different plant-based categories (cold cuts, minced, pieces, sausages, minced balls, tofu, and seitan) and analysed, so they could be included in the Danish Food Composition Database. Contrary to previous studies, protein content was the most abundant among macronutrients, followed by carbohydrates. Protein content was highly dependent on the protein source, and nutritional characteristics varied according to protein source and product type. The relative content of essential amino acids found in plant-based protein products was equivalent to products based on egg white protein. The relative content of lysine was significantly lower in wheat-based products (~1.5% of the total protein content) compared to the products based on legumes or egg white protein (~6%) and mycoprotein (~8%). Methionine, threonine and valine were found in higher amounts in egg white and mycoprotein-based products than in legume and wheat-based products. Except for mycoprotein-based products and soy pieces, all products showed high carbohydrate content, possibly due to the presence of different types of sugar. The fatty acids composition indicates a predominance of unsaturated fatty acids. However, pea protein-based products contained the highest level of saturated fatty acids (SFA). The lowest content of fat and SFA was reported in mycoprotein-based products. As for sodium, the content was higher in cold-cut products corresponding to the sodium content of animal-based cold cuts (Loǐnjak Švarc *et al.*, 2022).

The variation in the composition of amino acids and fatty acids between different textured proteins was demonstrated in a recent study (De Angelis *et al.*, 2022). The texturized protein made by dry fractionated pea plus oat differed from isolated pea plus oat and isolated soy plus oat for leucine, sulfur amino acids (methionine + cystine) and aromatic aminoacids (phenylalanine + tyrosine). However, only sulfur amino acids were below FAO/WHO protein standards (FAO, 2011). As for the fatty acid profile, dry-fractionated pea mixes had the highest polyunsaturated fraction, whereas the soy plus oat mix had the highest monounsaturated fraction. These data demonstrate that the protein source used influences the final quality of the protein.

These findings are reinforced by a study that calculated the Digestible Indispensable Amino Acid Score (DIAAS) values for different plant-based proteins based on published datasets (Herreman *et al.*, 2020). Great variation in protein quality from different sources was observed. Potato protein obtained an excellent protein quality range (DIAAS ≥100) as defined by FAO, similar to most animal-derived proteins. Soy and whey proteins obtained a DIAAS score above 75, defining them as high-quality proteins. Corn, wheat, rice, fava bean, oat, and hemp proteins average scores were below 60. Combination of protein sources to ensure complementarity of their amino acids and reach a higher DIAAS is also possible, the study demonstrated different optimized combinations such as oat/lupine and potato plus soy, and oat plus canola plus pea which improved DIAAS of the plant proteins (Herreman *et al.*,2020).

In addition to differences in amino acid content, plant-based and meat-based proteins differ in digestibility and the absorption rate of the hydrolysed products formed in the human gastrointestinal tract. Legumes and cereals have antinutrients that can reduce the absorption of minerals and proteins and generate undesirable gastrointestinal symptoms. Antinutrients are naturally occurring compounds present in abundance in legumes and cereals (Nikmaram *et al.*, 2017). They can occur endogenously or may be formed during heat/alkaline processing of proteins. They affect nutrient utilization by binding to proteins, vitamins and minerals, or binding to digestive enzymes, leading to reduced absorption in the gastrointestinal tract, and occasionally to greater nutrient excretion (Gilani, Xiao and Cockell, 2012; Nikmaram *et al.*, 2017). Processing may reduce antinutrients considerably, dehulling, cooking, pressure cooking, extrusion, fermentation, and seed germination are suitable processes. Usually, combining different processing methods has a better effect on antinutrients than applying individual methods (Nikmaram *et al.*, 2017). The impact of these processing techniques on the digestibility of plant proteins needs further exploration (Ishaq *et al.*, 2022).

Phytic acid or phytates are substances naturally occurring in plants, mainly found in seeds, grains, and nuts used during germination (Gilani, Xiao and Cockell, 2012). Phytate chelates several nutrients in the gastrointestinal tract such as iron, calcium, and zinc, and interferes with protein digestibility. Phytate is relatively heat-stable, only a small fraction is destroyed during heat processing. Phytate content can be reduced by extrusion, while the classical heat treatments affect little phytate levels (Gilani, Xiao and Cockell, 2012).

Tannins have the ability to complex and precipitate proteins in aqueous solutions, reducing protein digestibility and therefore affecting amino acid bioavailability. Tannins are present in sorghum, millet, fava beans, cowpeas, peas, and chickpeas, among other grains. Tannins are known to cause reduction (up to 23%) in protein and amino acid digestibility in rats, poultry, and pigs. In general, tannins are resistant to heat. The content of tannins of navy beans, chickpeas, cowpeas, and lentils can be reduced by extrusion with decreases ranging from 31 to 76% compared to raw legumes (Gilani, Xiao and Cockell, 2012; Nikmaram *et al.*, 2017; Pasqualone *et al.*, 2020).

Trypsin inhibitors are found in many pulses and cereals, and in large quantities in soybean. This antinutrient inactivate trypsin by complexation, resulting in decreased protein digestibility in the intestinal phase High levels of dietary trypsin are associated with a reduction in protein and amino acid digestibility (up to 50 %) and protein quality (up to 100 %) in rats and/or pigs (Lawrence *et al.*, 2023). Adequate heat treatment can inactivate up to 80% of the trypsin inhibitor activity in raw soya flour. Extrusion markedly decreases the content of trypsin inhibitors, due to heat and intense mechanical stress (Nikmaram *et al.*, 2017; Duque-Estrada *et al*., 2023).

Despite similar nutritional label content between plant-based meat and animal-based meat, the food matrix is different, therefore nutrient hydrolysis and absorption rate might differ. Therefore, to better understand nutrient bioavailability, *in vitro* studies were conducted. In this perspective, Santos-Hernández *et al.*, 2020 explored the behaviour of 4 legume protein isolates (garden pea, grass pea, soybean, and lentil) during gastrointestinal digestion, using INFOGEST digestion protocol. Soybean protein isolate had the highest insoluble nitrogen percentage after the end of the digestion process i.e., 12% primarily containing hydrophobic amino acids. Free amino acids, comprising 21–24% of the total nitrogen content, were mainly released during intestinal digestion. Legume globulins resisted gastric digestion, although they were hydrolyzed into peptides and amino acids during the intestinal phase. The study concluded that legume protein isolates were an efficient source of essential amino acids (Santos-Hernández *et al.*, 2020).

Another study compared the differences in the extent and rate of protein and lipid digestion of plant-based ground beef and animal-based ground beef by using an *in vitro* digestion model (INFOGEST). They concluded that the presence of dietary fibre in the plant-based beef increased viscosity in the gastrointestinal fluids, which may have inhibited lipid digestion in the small intestine leading to variances in the lipid digestion, which was lower for the plant-based product. Differences in protein type (globular soy and fibrous beef proteins) structure, led to variances in the protein digestion among both groups. They observed rapid digestion of plant proteins in the stomach phase followed by lower digestion than animal-based meat in the small intestine phase. The higher viscosity of the gastrointestinal fluids after gastric digestion of the plant-based beef associated with a higher rate of protein digestion of the plant proteins in the stomach could induce greater satiety effects, which requires further investigation preferably using human sensory studies (Zhou and colleagues, 2021).

Indeed, it´s been demonstrated that a meal composed of plant-based meat produces a greater satiating effect than traditional meat products in a single meal exposition and that this is not associated with greater energy intake at a subsequent meal occasion (Muhlhausler *et al.,* 2022). Furthermore, an increase in postprandial secretion of gastrointestinal hormones was observed after a single vegan meal compared to a meat-based meal in healthy, obese, and diabetic men (Klementova *et al.,* 2019). The enhanced satiety observed might be explained by the higher dietary fibre content (Costabile *et al.,* 2018) and resistant starch (Maziarz *et al.,* 2017) which are associated with increases in PYY secretion and the presence of bioactive compounds such as polyphenols, which increase secretion and half-life of GLP-1 secretion and stimulate B-cells to secrete insulin (Avila *et al.,* 2017).

4.2 Milk and dairy alternatives

Plant-based or non-dairy alternatives are derived from aqueous extracts of plant ingredients, including nuts, legumes and grains, designed to mimic the texture and quality of dairy products, most often milk but also cheese, yoghurt, ice cream, and butter (Ramsing *et al.,* 2023). Among all types of plant-based non-dairy alternatives, milk analogues are so far the most produced and consumed. The term milk to designate plant-based beverages, such as soymilk and rice milk, has been the subject of criticism and there has been legal debate regarding its use, as the term milk is protected by legislation in many countries (McClements, Newman and McClements, 2019; Mylan *et al.*, 2019). In these regions, plant-based fluid products are usually referred as drinks, beverages, dairy alternatives, or some other name rather than "milk." Despite that, the popularity of non-dairy plant-based alternatives has been on the rise (Panescu *et al.*, 2023).

In addition to the already known reasons for adopting plant-based foods in the diet, which include health, animal welfare and environmental sustainability (Clark *et al.,* 2019), the consumption of plant-based beverages has been an important issue for people who are allergic to milk protein or lactose intolerance (Haas *et al.*, 2019). Therefore, plant-based milk can also be part of an omnivorous diet. In addition, the consumption of plant-based milk is not restricted to its use as a drink, but also as an ingredient in culinary recipes replacing animal milk.

Plant-based milk substitutes have become increasingly popular over the past few years and numerous commercial products are already available. Soybeans have been a major raw material for plant-based dairy alternatives. However, concerns about its allergenicity and use of genetically modified variants (Vogelsang-O'Dwyer, Zannini and Arendt, 2021) motivated the search for other plant sources. Other common sources of dairy alternatives are cereals (rice, oats), nuts (almonds), oilseeds (flaxseed), pulses (pea, lupins) and fruits (coconut) (Chalupa-Krebzdak, Long and Bohrer, 2018; McClements, Newman and McClements, 2019; Paul *et al.*, 2020; Sethi, Tyagi and Anurag, 2016).

Due to the nature of the ingredients used in the formulations of milk and dairy alternative products, considerable variability in nutritional composition is observed. Some studies have investigated the nutritional information contained in the labels of commercially available products, as well as identified the declared ingredients. A description of the food products identified as plant-based non-dairy alternatives commercialized in Spain was provided by Rodríguez-Martín and colleagues (2023), as shown below:

- Almond "milk": Plant-based milk with a watery texture manufactured from organic or non-organic almonds with or without sugar, with or without additional flavouring (coffee, chocolate, vanilla), and with or without vitamins and minerals added (calcium, vitamins A, D, E).
- Oat "milk": Plant-based milk with a watery texture manufactured from organic or non-organic oat with or without sugar, with or without additional flavouring (coffee, chocolate, vanilla), and with or without vitamins and minerals added (calcium, vitamins A, D2, E, B2, B6, B9, B_{12}). This milk was also available as dehydrated oat "milk".
- Soy "milk": Plant-based milk with a watery texture manufactured from organic or non-organic soybeans with or without sugar, with or without additional flavouring (coffee, chocolate, vanilla, caramel), and with or without vitamins and minerals added (calcium, vitamins A, D, B2, B9, B_{12}).
- "Cheese alternatives": A product made from a variety of non-dairy and non-animal products, such as nuts, other seeds, legumes, and oil, mainly coconut oil.
- "Yoghurt alternatives": This group includes different fermented or non-

fermented plant-based dairy products manufactured by oat or soy, with or without sugar, flavours, fruits, emulsifiers and stabilizers.

Although the study of Rodríguez-Martín and colleagues (2023) involved only plant-based products sold in Spain, the description presented by the authors can be widely used to identify these types of foods. Plant milk products vary concerning their nutrients, and the addition of vitamins, minerals, and proteins is a common practice (Mäkinen *et al.,* 2016). The comparison of the nutritional composition between milk alternatives has already been carried out and reported in the literature recently (Chalupa-Krebzdak, Long and Bohrer, 2018; Dhankhar, 2023; Haas *et al.*, 2019; Ramsing *et al.*, 2023; Rodríguez-Martín *et al.*, 2023; Zhang, Hughes and Grafenauer, 2020). The protein content of milk alternatives can vary enormously depending on the base ingredient and the type of production process. Chalupa-Krebzdak and colleagues, 2018 demonstrated that there was significant variation in the protein contents of the plant-based milk alternatives, even between products derived from the same plants. Such variation was attributed to differences in product formulations as well as different dilutions of the vegetable extract used. In general, formulations based on legumes have the highest protein values in g per 100 ml of beverage than other plant ingredients. The protein content of milk alternatives in Australia ranged from 0 to 4.2 g/100 mL versus 3.2 to 4.7 g/100 mL from cow's milk, with median values of 0.9 g (grains), 0.9 g (mixed), 0.2 g (coconut), 0.6 g (tree nuts/seeds) and 3.1 g (legume) per 100 mL (Zhang, Hughes and Grafenauer, 2020). However, in the USA the average content of protein ranged from 0.5 (coconut) to 7.5 (pea) g/100 mL compared to 8.2 g/100 mL from cow milk; other plant ingredients showed the following protein values (g/100 mL) in descending order: soy (6.1), oat (2.7), hemp (2.3), cashew nut (1.8), almond (1.0) and rice (0.7) (Ramsing *et al.*, 2023). In the review published by Dhankhar (2023), which included many references to plant-based milk nutrient composition, the highest overall protein content was from peanut milk, bean milk, and oat-based milk, ranging from 17 to 26 %, while sesame milk, almond milk, and rice milk had the lowest protein content. Regarding the variety of other plant milk (hemp, soy, pistachio, coconut, amaranth, millet, tiger nut), the protein content is almost equivalent to cow's milk (Dhankhar, 2023). As seen by Rodríguez-Martín and colleagues (2023), soy milk can provide up to 6% of human protein requirements, which is similar to that provided by cow milk. However, other types of plant-based milk alternatives can provide only 1.5 to 2% of the recommendations for protein intake (Rodríguez-Martín *et al.*, 2023).

Therefore, it is clear that the protein content of plant-based milk alternatives can reach values compatible with human needs in many products commercially available or under development. Nonetheless, cow milk is important for human nutrition due to the biological form of its components characterizing it as a high protein quality food source apart from its protein content. Casein is the major protein fraction in animal milk, being a reference as concerns essential amino acids profile and digestibility. The protein quality score of bovine milk is mentioned to be superior to the protein of any plant-based milk substitute (Dhankhar, 2023).

In the review study of Paul and colleagues (2020), the amino acid profile of many plant-based milks from different references in the literature (soy, almond, oat, rice, cocoa nibs, kidney bean, peanut coconut, hemp) were compared to the bovine milk. Rice milk presented amounts of histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine and valine as high as bovine milk. Almond milk had also high amounts of histidine, isoleucine, methionine, phenylalanine and threonine. While peanut milk was high only in histidine, isoleucine, and threonine (Paul *et al.*, 2020). In this review, data about tryptophan was not available for all the products presented and, besides, soy was not included as a good source of essential amino acids, which conflicts with other references in the literature. In the study carried out by Khalesi & Fitzgerald (2021), protein isolates from soy, pea and rice were analysed and compared to milk protein concentrate in the formulation of milk alternatives. The Protein Digestibility Corrected Amino Acid Score (PDCAAS) of soy protein isolate (1.08) and pea protein isolate (1.03) were higher than the rice protein isolate (0.7). Tryptophan appeared as a limiting essential amino acid in all the samples analysed except for the pea isolate where cysteine and methionine were the limiting amino acids. Blends of plant isolates and milk protein concentrate were also pointed out as a way of producing milk alternatives as a source of good-quality proteins (Khalesi and Fitzgerald, 2021).

Given all the criticisms that have already been discussed in the literature regarding the use of PDCAAS to predict protein quality, Mathai and colleagues (2017) analysed some common ingredients used in the production of milk alternatives concerning DIAAS. Whey protein isolate (DIAAS=100) and concentrate (DIAAS= 107) had histidine as the first limiting amino acid, milk protein concentrate (DIAAS=120), skimmed milk powder (DIAAS=105), pea protein concentrate (DIAAS=62), soy protein isolate (DIAAS=84), and soy flour (DIAAS=89) had the sulfur amino acids (methionine + cysteine) as first limiting, and lysine was first liming in wheat (DIAAS=45). In the study of Chalupa-Krebzdak and colleagues (2018) the PDCAAS and DIAAS values of various dairy proteins as well as various plant proteins were discussed. Based on the data collected, only the dairy proteins met the criteria for an excellent source of protein regarding the DIAAS. Of the different types of ingredients used to produce plant-based milk alternatives, soy protein had the highest PDCAAS and DIAAS values, which were comparable to bovine milk. In general, protein quality studies vary in the reference values of amino acid requirements used to calculate amino acid scores. As a result of this, controversial data are found on the protein quality of the different food sources. To minimize such discrepancies scoring patterns for several age groups of children, teenagers and adults were suggested (FAO, 2007; Reynaud *et al.*, 2021).

A relevant aspect that greatly interferes with the protein content or quality of plant-based milk alternatives is the processing used for protein extraction, whether to obtain protein concentrates or isolates or simply to obtain the protein-rich aqueous extract. There are many possibilities to produce drinks that mimic cow's milk. The process conditions for plant-based milk substitute production were deeply studied by Aydar et al. (2020). Among the several methods for producing cereal, grain, and nut milk substitutes, there are common processes and steps between them, and a wide range of chemical and physical conditions. Depending on the raw materials used to formulate milk substitutes, if shelled or unshelled, dried, or fresh, for example, the process steps may vary. Dehulling, roasting, grinding, peeling, soaking, blanching, wet milling, filtration, addition of ingredients, fortification and enrichment, sterilization, homogenization, aseptic packaging, and cold storage are normally present in a flow chart for the production of plant-based milk substitute. The use of acids or alkaline substances, heating and the addition of micronutrients highly influence milk substitute nutrient content and nutritional quality. Novel technologies such as ultrasound, pulsed electric field, high-intensity ultrasound irradiation, ohmic heating, and ultra-high and high-pressure homogenization are also being applied in the production of plant-based milk substitutes aiming to improve the nutritional quality and stability of such products (Aydar, Tutuncu and Ozcelik, 2020).

There are many health benefits associated with plant-based milk alternatives, which are related to the various components present in the foods that serve as the basis for the formulations. Leaving aside the issue of protein content, focusing on other aspects such as the balance between certain amino acids, the presence of bioactive substances, the profile of polyunsaturated fatty acids, and essential fatty acids, in addition to fibres, several beneficial effects on health are described. The prevention and improvement of dyslipidaemias and atherosclerosis can be provided, for example, by the well-balanced ratio of lysine to arginine, as observed in hazelnuts (0:19), walnuts (0:20) and almonds (0:24) (Brufau, Boatella and Rafecas, 2006) and the high amount of unsaturated fatty acids usually present in plant-based ingredients in general (Eslami and Shidfar, 2019; Wang *et al.*, 2019). In addition to a high level of unsaturated fatty acids, plant-based milk substitutes are cholesterol-free.

The micronutrient content of plant-based milk alternatives is low and highly variable. However, when fortified they can reach overall amounts even higher than bovine milk. Many plant-based products are fortified with calcium, vitamins D, A, B_{12}, and other micronutrients to better match the nutritional content of dairy milk (Ramsing *et al.*, 2023). The concern over the bioavailability of micronutrient supplements commonly used in the fortification of plant-based milk beverages may be attenuated by the use of high-absorption efficiency chemical forms. Specifically considering calcium, it has been discussed that calcium carbonate has the same absorption as bovine milk calcium, being better than tri-calcium phosphate which is only 75% efficiently absorbed (Chalupa-Krebzdak, Long and Bohrer, 2018). However, it is also pointed out that the reduced solubility of calcium carbonate compared to calcium caseinate, and the occurrence of sedimentation can reduce the total amount of calcium ingested, needing the beverage to be shaken properly by the consumer (Heaney and Rafferty, 2006). So, it appears that the physical stability of plant-based beverages is a problem for nutrient availability.

Although there is a reduction in the content of bioactive compounds from plant sources during processing to obtain milk alternatives, important antioxidant activity is still observed, attributed to several substances. As examples, the water-soluble polyphenols present in sesame milk, sesamin and sesamolin are cited, which can act in detoxifying the liver, reducing tumours, and protecting neuronal cells from oxidative stress. Besides, anti-hypertensive, anti-inflammatory, and anti-allergic activities are also described (Jan and Ho, 2014). The phytoestrogens genistein, daidzein, and glycitein present in soy milk, known as isoflavones, have diverse positive health effects against dermatological diseases, cancer, osteoporosis, cardiovascular disease, and neurodegenerative disorders, among others (Hamza and Mahmoud, 2013). The essential fatty acids such as oleic acid, linoleic acid, and α-linolenic acid have positive effects on Alzheimer’s disease (Gorji, Moeini and Memariani, 2018). Despite the many nutritional health-benefits attributes exhibited by plant-based milk alternatives, some aspects can be negatively attributed to antinutrients naturally present in plant-based sources. Phytic acid, oxalate, lectins, and saponins are the main antinutrients identified in plant-based milk alternatives. These substances are present in cereals, beans and nuts and they can reduce nutrient availability in many ways. The presence of phytic acid commonly found in cereals and legumes, and oxalate found in soy, almonds, cashews, and other nuts can reduce the availability of minerals by binding to them and forming salts reducing their absorption (Dendougui and Schwedt, 2004; Ritter and Savage, 2007).

Lectins present in soy, peanuts, and other beans can inhibit glucose absorption affecting total caloric intake (Santiago, Levy- Benshimol and Carmona, 1993). Saponins present in soy, oats, peas, and beans have been shown to impact the digestion of proteins by creating insoluble saponin-protein complexes that are resistant to digestion (Francis *et al.*, 2002). Furthermore, the addition of sugars and additives such as flavouring and aromatizing characterize these beverages as ultra-processed. According to Rodríguez-Martín and colleagues (2023) among the products with NOVA information available in their study (n = 313), there were more than 40% of the milk alternatives classified as ultra-processed food. Various sweeteners such as sugar cane and sea salt are added to improve the flavour of the product as well as ingredients such as vanilla or cocoa. Lecithin, bean gum, gellan gum and xanthan gum are used to enhance physical stability. To improve the silky appearance sunflower oil, olive oil and coconut oil are broadly added. Ascorbic acid and some other antioxidants are added to prevent oxidation (Aydar, Tutuncu and Ozcelik, 2020).

In the plant-based dairy alternatives market, yoghurts and cheeses are less numerous than milk alternatives. In the study by Rodríguez-Martín and colleagues (2023), 12 and 21 yoghurt and cheese items were found, respectively. The analysis carried out by the authors showed few differences regarding the nutrient composition between plant-based and animal-based yoghurts, the only difference found was for the saturated fat content, which was higher in yoghurts made with cow's milk. However, there were significant differences in the comparison of cheese products (plant-based versus animal-based). The median content of proteins was higher in animal-based cheese, while fibre, carbohydrates and salt were higher in plant-basd cheese alternatives. Unexpectedly, the amounts of fats and saturated fats in plant-based cheese alternatives were as high as those found in animal-based cheese (Rodríguez-Martín *et al.*, 2023).

Yoghurts and cheeses obtained from milk exhibit physicochemical and sensorial characteristics derived from the intermolecular interactions of proteins, induced by medium acidification or enzymatic reactions producing a complex structure. To achieve such properties in plant-based products, it is necessary to use different ingredients and additives and many processing routes. The list of ingredients commonly used for these products is extensive and varied. The studies of Grasso and colleagues (2020) and Grossmann & McClements (2021) present in detail the aspects involved in the production processes, as well as the variety of ingredients used in the production of plant-based yoghurts and cheeses.

As pointed out by Grasso and colleagues (2020), the major challenges faced by producers of plant-based yoghurts are associated with the appearance and texture properties as such products generally have textural issues caused by phase separation. On acidification of such plant-based systems, destabilisation of the proteins results in the formation of a non-continuous, weak gel, resulting in serum separation (Bernat *et al.*, 2014). For this reason, hydrocolloids are usually employed in the formulation of plant-based yoghurts to stabilize the particles in suspension, contribute to structure formation and to help with the imitation of the characteristics of a dairy-based yoghurt (Guo and Yang, 2015). Combinations of gelling agents (e.g., natural gums, proteins, starches, pectin and agar) are often used in the food industry to provide gel-type food products (e.g., yoghurts and puddings) with acceptable texture (Banerjee and Bhattacharya, 2012).

Starches are one of the most used polysaccharide-based ingredients in plant-cheese analogues. Most commonly, tapioca, potato, and corn starches are used in plant-based cheese formulations (Grossmann and McClements, 2021). Starches are used in plant-based cheeses because of their ability to form a viscous paste or gel upon heating (gelatinization) and cooling (retrogradation/setback), which entraps fluids and other ingredients within the 3D-polysaccharide network formed (Kasprzak *et al.*, 2018).

Commonly, different starch types are combined to obtain an optimum degree of retrogradation, softening temperature, and final gel strengths as well as viscoelastic properties. Moreover, the starches used in plant-based cheeses are modified to various degrees to alter their physicochemical and functional properties (Schirmer, Jekle and Becker, 2015). For example, acid hydrolysis is carried out to decrease the paste viscosity during gelatinization and increase the gel strength upon retrogradation, octenyl succinate derivatization is carried out to minimize oiling-off effects, and cross-linking increases the heat and shear stability of the starch granules (Klemaszewski *et al.*, 2016).

The proteins used in plant-based cheeses are mainly derived from peas, soy, lupin, potatoes, nuts, and corn. The physicochemical and functional attributes of proteins such as emulsification, gelation, and water holding are the most important ones for producing plant-based alternatives (Kasprzak *et al.*, 2018). The fat content is also variable, and it is common to have blends of different types of vegetable oils and fats. The length of the carbon chain and the number of unsaturation are important to obtain the required textural and melting characteristics. Many common plant-based oils (such as sunflower, corn, and canola oils) contain substantial amounts of unsaturated fatty acids so they tend to be liquid at ambient temperature and cannot form fat crystal net works. Due to that manufacturers of cheese analogues often blend natural sources of plant-based solid fats (e.g., coconut oils). These oils also have relatively high amounts of saturated fats that might also have adverse effects on human health (Ludwig *et al.*, 2018). Unsaturated fats, particularly polyunsaturated ones (like flaxseed or algal oils), may have beneficial health effects (Saini and Keum, 2018). On the other hand, they are highly susceptible to lipid oxidation leading to the creation of rancid odors. The use of antioxidant agents such as phenolic substances and organic acids is therefore a commonly used practice (McClements, Newman and McClements, 2019).

5.0 Food quality concepts and classifications

5.1 NOVA

According to the NOVA classification, foods are categorized into i) unprocessed and minimally processed foods; ii) processed culinary ingredients; iii) processed foods; and iv) ultra-processed foods (UPF) (Monteiro *et al.*, 2019). In general, by this definition, plant-based products with a "traditional" characteristic (artisanal) can be classified as processed food while the "generation" products are considered ultra-processed food (Penna Franca *et al.*, 2022). NOVA food classification is being increasingly used, but it is far from being unanimous among health experts (Messina *et al.*, 2022; Weaver *et al.*, 2014). NOVA brings an unprecedented component to food classification which is to classify foods as healthy or not according to the food itself, instead of a nutritional rating system based exclusively on nutrients (Brasil and Saúde, 2014). Emerging evidence indicates that UPF consumption is associated with an increased risk of obesity, type 2 diabetes and other non-communicable diseases and overall mortality (Canhada *et al.*, 2023; Chen *et al.*, 2020, 2023; Monteiro *et al.*, 2018). UPF foods are high in energy density, total fatty acids, saturated fatty acids, trans-fat, and sodium while having a low content of fibre and nutrients. However, not all UPF foods have these characteristics (Messina *et al.*, 2022). Besides, the consumption of plant-based products is not at the expense of in natura foods such as legumes, but at the expense of processed meat products, which are also UPF (Bryant, 2022).

de las Heras-Delgado and colleagues (2023) characterized the plant-based alternatives available on the market in Spain in comparison to animal products and found that 37% of plant-based products and 72% of animal-based products were ultra-processed food. High consumption of ultra-processed foods (UPFs) is considered to be one of the main factors for an unsustainable diet, as it is related to both lower dietary quality and intensive food production (Martínez Steele *et al.*, 2017). Nonetheless, animal-based products have a high environmental impact and replacing them with plant-based ones tends to lower one´s diet`s environmental impact.

5.2 Ingredients

The use of processed protein ingredients, as seen, allows for higher protein content, inactivation of antinutrients and better protein digestibility. A wide variety of ingredients is used for the production of plant-based products. In general, the most discussed ingredients are protein-source ingredients, fat-source ingredients, binding ingredients, and additives. Natural seasonings and vegetables are also very common in product formulation (Zahari *et al.,* 2022). The use of processed protein ingredients, as seen, allows for higher protein content, inactivation of antinutrients and better protein digestibility (Pasqualone *et al.,* 2020). The use of non-textured protein ingredients, on the other hand, increases the fibre content of the products and attends to the public that opts for natural products.

Adding vegetable fats and oils increases the energy density of the products and imparts flavour, juiciness, tenderness, and overall palatability to plant-based products. Vegetable oils from different plants and seeds are the most common fat ingredients. Besides, solid vegetable fats are also used mostly to obtain the marbling effect in meat substitutes (Zahari *et al.,* 2022).

An essential ingredient in most formulations is binding agents used for their holding water capability and for conferring stability, gelling and thickening. An array of different ingredients can be used for that: fibres, soy and milk proteins, a variety of hydrocolloids, egg solids, methylcellulose, carrageenan and modified starches (Kyriakopoulou, Keppler and van der Goot, 2021).

Engineering flavour and aroma profiles are important to recapitulate the taste and smell of meat, so many ingredients and additives are used to enhance product quality (Rubio, Xiang and Kaplan, 2020) such as vegetables, herbs, spices, savoury yeast extract, paprika and natural seasonings such as garlic and onion. These are used in large quantities, both to flavour and to disguise the beany flavour of leguminous proteins (Boukid, 2021). These ingredients usually have a low energy density, and are good sources of vitamins and bioactive compounds, giving plant-based products “extra healthy benefits” (Samtiya *et al.*, 2021). Processing can decrease or inactivate vitamins and bioactive compounds; more research is needed with ready-made products to understand how much of these compounds are still present when they reach the consumer.

Additives give attributes of texture, bite, consistency, and colour that are expected by the consumer. Besides, they are necessary for product stability and shelf-life. Antioxidants are incorporated to inhibit oxidative reactions and rancidity. The inclusion of organic acids, spice extracts, and phosphate compounds also contributes to microbial stability and shelf-life, in addition to modifying the flavour (Sha and Xiong, 2020). Since the majority of extruded meat analogues lack colour, adding colouring ingredients is a crucial part of meat substitute formulation. Colouring ingredients may be natural or artificial (Ishaq *et al.*, 2022)

There are many concerns about the safety of food additives, but the potential impact on human health from long-term exposure to additives is not yet conclusive. However, many *in vitro* and animal-based studies have suggested potential hazards of several widely used additives (Chazelas *et al.*, 2021). Despite that, the causality between disease development and additive intake is not well established, so alternatives to reduce additive use are necessary since the effect of long-term exposure is uncertain.

It is important to emphasize that the more the product resembles meat, both in terms of nutritional content and flavour, the more the ingredients are processed and the greater the use of additives and flavourings. On the other hand, those that are more distant from the original product, use less processed ingredients and also have a have a more diverse nutritional profile (Kyriakopoulou, Keppler and van der Goot, 2021; Rubio, Xiang and Kaplan, 2020).

5.3 Metabolite Profile

Metabolomics is a field of omics science that allows researchers to measure and compare large numbers of metabolites present in biological samples. It can be used to extensively characterize the thousands of chemicals in foods (Levatte *et al.*, 2022). As such, it allows a comprehensive analysis, demonstrating the presence and differences between compounds that go far beyond the nutritional table.

van Vliet and colleagues (2021) carried out the metabolomic profile of plant-based x animal-based products with the same nutritional profile. Despite the same nutritional value, metabolomics revealed 90% differences in metabolite profiles between plant-based and animal-based ground beef. Plant-based ground beef reported a high quantity of 67 metabolites, such as phytosterols, antioxidants, and vitamins, which were absent in animal-based ground beef. Another 51 metabolites were found exclusively in the animal-based product including docosahexaenoic acid (α-3), niacinamide, glucosamine, hydroxyproline, and antioxidants.

These large differences were to be expected, because if the food matrix is different, the metabolites will be too (van Vliet *et al.*, 2021). Most of the benefits attributed to plant-based diets are due to the bioactive compounds present in plants (Samtiya *et al.*, 2021), which are derived from plant`s secondary metabolism, much more abundant than the metabolism of humans or other animals that need to ingest various compounds they cannot synthesize (Aydar, Tutuncu and Ozcelik, 2020).

6.0 Health impact of consumption of plant-based products: Empirical and theoretical evidence

To understand the extent to which meat and dairy substitutes comprise an individual's diet and whether the overall diet is healthy, different types of studies have taken place, such as clinical trials (Bianchi *et al.*, 2022; Crimarco *et al.*, 2020; Toribio-Mateas, Bester and Klimenko, 2021), observational (Tonheim *et al.*, 2023) and modelling (Lawrence *et al.*, 2023; Salomé *et al.*, 2021; Tso and Forde, 2021) studies.

To understand the nutritional contribution of plant-based products within the daily diet, Tonheim et al., (2023) assessed the consumption of plant-based meat and dairy substitutes in vegans, lacto-ovo vegetarians and pescatarians in Norway. The total macronutrient intake of the participants was within recommendations, except for omega-3 fatty acids, which was only within range for pescatarians, and salt, which was higher than recommendations for pescatarians. Their results demonstrate that the majority of vegans (90%) consumed meat or dairy substitutes, while consumption among vegetarians (68%) and pescatarians (64%) did not differ. Vegans had the lowest intake of saturated fatty acids (5.8% contribution to total energy), but a higher share of saturated fatty acids (26.7%) from plant-based products. Pescatarians` intake of proteins (14.9%), was higher than the other groups but (the lowest share from plant-based products was 6.9% as opposed to 19.1% from vegans). In addition, plant-based products contributed to 16% of total salt intake in participants' diets.

Modelling studies in which dairy milk and animal-source meat were replaced with plant-based 'milk' and plant-based 'meat', for the Australian population and various sub-populations (young children, young women, young men and older adults) in conservative and accelerated dietary transition scenarios revealed that nutrients already at risk of inadequate intake would likely be adversely impacted in an accelerated scenario. The theoretical decline in nutrient intake varied according to the population groups and the transition scenarios modelled. For the accelerated scenario, vitamin B_{12} and iodine intake declined by 19% and 14%, respectively, and the intake of n-3 long-chain fatty acids, riboflavin, niacin, phosphorus and zinc declined by 6–8%. In contrast, iron and sodium intake markedly increased by 15% and 7%, respectively. On the other hand, only slight changes in nutrient intake were predicted with the Conservative Scenarios (Lawrence *et al.*, 2023).

Another study compared a standard omnivore Western diet to plant-based alternative diets (traditional and newer versions of flexitarian, vegetarian and vegan diets) (Tso and Forde, 2021). The findings of this study demonstrate that traditional flexitarian and vegetarian diets (based on whole grain unprocessed ingredients) were considered the healthiest. They were the only ones to meet all daily micronutrient requirements, including calcium, potassium, magnesium, phosphorus, zinc, iron, and Vitamin B_{12}. Besides, they were lower than the reference diet in saturated fat, sodium, and sugar. Diets with novel plant-based substitutes (meat and dairy substitutes) fell below daily requirements for calcium, potassium, magnesium, zinc and Vitamin B_{12} and exceeded the reference diet for saturated fat, sodium and sugar. All diets met daily requirements for phosphorus and iron (Tso and Forde, 2021).

The findings of a modelling study in the French population were more heterogeneous, but the impact on the overall diet quality was considered small. Nutrient intake varied according to food substituted and the types of substitutes. Substitutes that are formulated with legumes were found to be more nutritionally adequate than other substitutes. Globally, substitutions led to better adequacies for fibre, linoleic acid, α-linolenic acid, vitamin E, folate, and saturated fatty acids, but lower adequacies regarding vitamin B_{12}, riboflavin, bioavailable zinc and iron for substitution of meat and calcium and iodine when substituting milk/dairy desserts (Salomé *et al.*, 2021).

Excess weight is one of the world's major health problems, one of the main causes of death and annual Disability Adjusted Life Years (DALYs), in addition to billions spent on health due to overweight and obesity (Malik, Willett and Hu, 2013). Numerous interventions, diets and medications have been proposed to help reduce and control weight with little success, obesity continues to be one of the biggest public health problems in the world (Popkin, Adair and Ng, 2013; Swinburn *et al.*, 2019). Plant-based diets have been reported to be positively associated with better weight management by several factors (Eichelmann *et al.*, 2016; Najjar and Feresin, 2019). Thus, it is speculated that the substitution of meat-based products for plant-based protein products may result in weight loss (Medawar *et al.*, 2019; Tran *et al.*, 2020). Thus, a clinical intervention study, which had as its main outcome behavioural change concerning the consumption of plant-based products, had as a secondary result the weight loss of the participants, but no other changes in cardiovascular risk factors could be seen, possibly due to the short duration of exposure (Bianchi *et al.*, 2022).

Trimethylamine-N-oxide (TMAO) is an emerging risk factor for cardiovascular disease and certain cancers. Red meat is rich in carnitine and choline, which are precursors to TMAO. Therefore, meat consumption is supposed to raise TMAO blood concentrations (Wang *et al.*, 2019). In addition, a randomized controlled trial demonstrated that plant-based diets have lower TMAO levels compared with meat eaters (Park *et al.*, 2019). Indeed, results from a single-site, randomized crossover trial (Crimarco *et al.*, 2020) demonstrated differences in serum TMAO after 8 weeks of consuming plant-based meat compared with consuming animal meat, modest differences in participants' weight and LDL-cholesterol concentrations were also observed despite similar reported total energy intake and physical activity levels between each treatment (Crimarco *et al.*, 2020).

Although there is some evidence that consuming plant-based diets can improve inflammation (Craddock *et al.*, 2019; Eichelmann *et al.*, 2016) the same study by Crimarco et al. (2022) accessed changes in biomarkers of inflammation but found no difference between the treatments (plant-based meat x animal meat). Only four out of ninety-two inflammatory biomarkers reached statistical significance, demonstrating that only replacing meat with meat substitutes might not be enough to improve chronic inflammation (Crimarco *et al.*, 2020; Toribio-Mateas, Bester and Klimenko, 2021). The authors concluded that consumption of plant-based products without changing the diet as a whole will not transform an individual´s eating pattern into a healthy, high-quality, and anti-inflammatory diet (Crimarco *et al.*, 2022).

The gut microbiome has become a new frontier of health knowledge with numerous studies demonstrating the relationship between gut microbiota and health (Bidell, Hobbs and Lodise, 2022; De Vos *et al.*, 2022). Scientific evidence demonstrates that plant-based diets may increase the diversity of health-promoting bacteria (Sidhu *et al.*, 2023). Plant-based products usually have a high amount of fibre, which should have benefits for intestinal health (Bryant, 2022). However, changes in the food matrix due to the processing of vegetable proteins and the addition of additives, especially emulsifiers, raise concerns regarding the consumption of plant-based products (Naimi *et al.*, 2021).

Results from a randomized controlled trial with a group of 20 participants (Toribio-Mateas, Bester and Klimenko, 2021) who replaced meat-containing meals with meals cooked with plant-based products increased butyrate metabolizing potential (chiefly in the 4-aminobutyrate/succinate and glutarate pathways), an increase in the joint abundance of butyrate-producing taxa and a decrease in the *Tenericutes phylum* in the intervention group compared to control.

7.0 Trends in solutions to improve nutritional quality and human nutrition

Considering the potential of plant-based foods for dietary sustainability, improving products' nutritional quality is necessary. According to the various nutritional aspects observed in plant-based foods, different paths can be pointed out as trends in solutions for human nutrition.

7.1 Variability of nutritional composition and nutrient requirements

The nutritional composition of plant-based foods varies considerably, due to the great diversity of ingredients used in the formulation in terms of type and quantity. Protein content can be considered the most critical point since these foods are intended to replace the consumption of foods of animal origin, which are the main sources of proteins of high biological value for human nutrition. Adequate amount of proteins in view of the nutritional recommendation can be obtained with the consumption of protein concentrates or isolates in food and beverage formulations. Considering the necessary supply of essential amino acids, mixtures of proteins from different plant sources for example from legumes plus cereals, provide better amino acid scores. Still regarding the qualitative aspect, the elimination of antinutrients naturally present in vegetables contributes to greater protein digestibility.

Micronutrients such as calcium, zinc, iron, vitamin B_{12}, and omega-3 are also important because they are found abundantly or exclusively in foods of animal origin. In general, there is high variability in the amount of these nutrients among different types of plant-based foods. Higher amounts of these nutrients can be easily obtained through the fortification of plant-based products. The practice of fortification with essential nutrients is a solution found by manufacturers to achieve a greater contribution to nutrition considering the recommended daily values.

However, although the use of protein concentrates/isolates contributes positively to the quantity and quality of nutrients, it is considered by the NOVA classification of food as an ultra-processed ingredient. And for that, they are criticized by many nutritionists and health professionals. The solution to this issue seems to be more associated with the interpretation of the impact of these foods on the diet than with adaptations of formulations and ingredients. The frequency of consumption of ultra-processed plant-based food and the quality of the diet as a whole are crucial points for the interpretation of healthy eating. The few studies that investigated the impact of these foods on health pointed out that there were better health indicators in consumers who adopted a plant-based diet. Therefore, it is essential to investigate the nutritional aspects involved with the consumption of plant-based food in different dietary patterns and eating habits.

7.2 Fat, sweetening practices and use of additives

Transforming vegetable ingredients into products that have the appearance, texture, and taste of animal products is a major challenge for manufacturers. In practice, this has been achieved by the addition of saturated fat, sweeteners, emulsifiers, gelling agents, and flavour enhancers, among other ingredients. As a result, better sensory characteristics are achieved to the detriment of nutritional quality, reinforcing how plant-based foods can be ultra-processed. The use of naturally sweet foods, condiments, natural herbs, and ingredients with natural emulsifying and gelling functional properties is seen as a possible solution to reduce the use of food additives.

Controlling the amount of saturated fat is an important measure. It is also necessary to highlight the profile of unsaturated fatty acids, since a greater amount of omega-6 and a low amount of omega-3 can contribute negatively to the omega 3:6 ratio with an inflammatory potential if consumed in excess. Additionally, the excessive use of salt in similar amounts to processed animal foods is a negative factor for plant-based products. The use of salt to promote flavour can be avoided by the use of condiments that provide good palatability, and also contribute to health with bioactive compounds.

Mimicking animal foods using plant-based ingredients has been seen as a marketing strategy to encourage consumers who are omnivores but are concerned about environmental issues, such as flexitarians. Perhaps this is indeed a start for promoting changes in habits. However, the question remains whether this approach is really effective, considering that in the face of greater environmental awareness, these consumers could be directed to value the natural characteristics of plant foods in plant-based products.

7.3 Alternative processing conditions

The consumption of legumes has been pointed out as one of the possible solutions to reduce the environmental impact of diets. The application of protein texturizing processes in the production of plant-based meat substitutes, such as extrusion and sheer cell techniques, can transform legumes into more palatable foods for the consumer, reducing antinutrients, increasing the bioavailability of nutrients and improving their acceptance.

However, more research still needs to be done to improve the instrumental conditions of these processes, prioritizing the use of less processed ingredients, and reducing the use of salt, fat, and additives, which have been used as adjuvants in the protein texturing process to achieve the desired sensorial characteristics. Other interesting points would be:

- Controlling lysine loss in extrusion processes
- Controlling the inactivation of antinutrients that reduce protein digestibility and chelate minerals in production processes.

In the production of plant-based milk alternatives, the improvement of nutritional quality and stability can be achieved with the application of novel technologies such as ultrasound, pulsed electric field, high-intensity ultra-sound irradiation, ohmic heating, and ultra-high and high-pressure homogenization. These technologies can promote better homogenization and the formation of stable emulsions, contributing to the reduction of emulsifiers and gelling agents, in addition to allowing the use of functional vegetable oils instead of saturated fats.

7.4 Food accessibility

Despite the fact that plant-based proteins have a lower cost of production compared to those of animal origin, plant-based foods are not necessarily cheaper than processed foods of animal origin, mainly in developing countries. Reducing the cost of producing plant-based foods is a prominent factor in allowing broad access to these foods by more economically vulnerable populations. Otherwise, the intended gains for greater sustainability of the human diet and nutrition would be threatened. Therefore, in addition to advances in studies on improving nutritional quality, studies that can assess the feasibility of purchasing these foods and implementing them in social programs, and schools, among others, are necessary. The democratization of access to foods with good sources of protein and other essential nutrients at a low cost should be a priority for solving problems in human nutrition.

8.0 Conclusion

Different aspects of the health effects of consuming plant-based products have been investigated. Together these results can help the analysis of the healthiness of the products. The nutrient content of products, the type of ingredient and the level of processing are the main attributes that are being investigated in the literature concerning the health aspects of plant-based products. However, as protein is the main nutrient focused on the transition to a more sustainable diet, the essential amino acid content and protein digestibility should also be discussed. No industrialized food has had as much scrutiny about its nutritional composition as plant-based products, this movement is great to allow the development of foods of better nutritional quality. Despite the wide range of studies, to determine if plant-based products are healthy or not, it is necessary to analyse the health effects of chronic consumption of these products, that is, the health effect of the substitution of meat-based products for plant-based products in the long run. Studies indicate variation in nutritional composition requiring that consumers look at the label to choose the best product. How healthy those products are depends on the choice of ingredients that were used for their production. Finally, it is not enough to improve the nutritional aspects of the products, there must be a reduction in production costs of plant-based food.

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Table 1: Nutrient Profile of plant-based products available in different countries

Study	Products analysed and market	Nutrient profile model and extratification criteria	Main results
de las Heras-Delgado et al., 2023	A total of 2,790 PBAPs* marketed in Spain were classified into 15 categories.	Nutrient profile of the products was evaluated using the FSAm-NPS (modified version of the Food Standard Agency Nutrient Profiling System) score criteria. The FSAm-NPS score was computed by using the nutrient content per 100 g of product, using Nutri-Score calculation tool The FSAm-NPS score was classified into 5 categories: from - 15 to - 1 (Category A), 0 to 2 (Category B), 3 to 10 (Category C), 11 to 18 (Category D), and 19 or higher (Category E)	Among the 15 categories of plant-based products studied, 31% were classified under Nutri-Score A category. Most plant-based products 75.8% (n = 2114) were classified into Nutri-Score categories A and B, 8.14% (n = 227) in category C and 16.1% (n = 449) in categories D and E. Cheese alternatives and animal-based cheese were predominantly (40%) classified as belonging to Nutri-Score category E.
Huybers & Roodenburg, 2023	916 plant-based meat, fish, and dairy alternatives from eight Dutch supermarkets.	The Nutri-Score of the products was calculated according to the guidelines of Santé Publique France. Positive points (between 0 to 5) were obtained for positive to health nutrients Negative points (between 0 to 10) were attributed for each nutrient that negatively affects health. The final Nutri-Score is based on the cut off points as indicated in - 15 to - 1 (Category A, light green color), 0 to 2 (Category B, light green color), 3–10 (Category C, yellow color), 11 to 18 (Category D, Orange color), and 19 or higher (Category E, red color	The results show that over 70% of meat, fish, and dairy alternatives had an A/B Nutri-Score (indicating high nutritional quality). Meat alternatives (67%) and fish alternatives (75%) were classified in the highest Nutri-Score levels A and B qualities. Of the cold cuts alternatives, 85% falls into the Nutri-Score levels C, D, and E Among milk alternatives products 30% scored grade A quality; 55% grade B and 5% grade C. Cheese alternatives had low nutritional quality with Nutri-Score D and E for 70% of the products.
Cutroneo et al., 2022	269 commercial meat analogues currently sold on the Italian market.	For all the products, the Nutri-Score was determined by using the Excel sheet provided by the Santé Publique France	**Steak**- A (61.8%) B (19.1%) C (14.7%) D (4.4%) E (0%) **Burger**- A (30.5%) B (15.2% C (3.8%) D (50.5%) E (0%) **Meatballs**- A (18.2%) B (22.7%) C (59.1%) D (0%) E (0%) **Cutlets**- A (0%) B (11.8%) C (61.8%) D (23.5%) E (2.9%) **Cured meats**- A (12.5%) B (20%) C (35%) D (30%) E (2.5%)
Bryngelsson et al., 2022	Nutritional quality of 142 plant-based meat analogues on the Swedish market.	Nutrition quality was assessed by calculating the Nutri-Score.	**Sausage**- A (6%) B (13%) C (61%) D (19%) **Bite/fillet**- A (60%) B (5%) C (15%) D (20%) **Burger**- A (37%) B (16%) C (37%) D (11%) **Cold cut**- A (19%) B (13%) C (0%) D (69%)

			Mince- A (56%) B (25%) C (13%) D (6%) **Ball**- A (25%) B (42%) C (33%) D (0) **Schnitzel**- A (45%) B (27%) C (27%) D (0%) **Nugget**- A (57%) B (0%) C (43%) D (0%) **Bacon**- A (20%) B (20%) C (20%) D (40%) **Other**- A (60%) B (0%) C (20%) D (20%) **Total**- A (35%) B (17%) C (30%) D(19%) No PBMAs** showed the lowest quality level (score E).
Alessandrini *et al.*, 2021	Survey of 207 plant-based products and 226 meat-products available from 14 retailers in the UK.	To assess the products' nutrient profile, it was used the UK's Nutrient Profiling Model The model uses a simple scoring system where points are allocated based on the nutrient content per 100 g of food. The final product score is obtained by subtracting points for "positive" nutrients and ingredients from "negative" nutrients Healthier products are those that score under 4 points	"less healthy" products with score > 4 was 13.7% (n = 23) **Sausages**- 1.7 ± 5.9 **Burgers**- 0.8 ± 3.7 **Plain poultry**-1.5 ± 5.5 **Breaded Poultry**- 0.9 ± 3.6 **Mince**- 3.4 ± 5.4 **Meatballs**- 4.0 ± 2.0
Pointke & Pawelzik, 2022	Online market analysis of plant-based meat and cheese alternative in 2019 and 2021 of German Market. 150 products in 2019 and 236 products in 2021.	The calculation of the Nutri-Score was based on the German table adapted by the Federal Ministry of Food and Agriculture (2021). On a scale from -15 points (A) to +40 points (E), the nutrient content per 100 g of food was evaluated. Positive points (0–10) were assigned for dietary energy, total sugars, saturated fatty acids (SFA), and sodium. Negative points (0–5) were scored for fruits, vegetables, and nuts, fiber, protein, and canola, walnut, and olive oil content.	Significantly higher scores were calculated for the meat products in nine of the twelve product groups, mainly due to the high proportion of SFA and salt. The results for cheese alternatives were the opposite; in four out of five product groups, the plant-based alternatives had a higher Nutri-Score than the animal products. This can be explained by the very low protein content of plant-based products. The calculated Nutri-Score was generally lower for plant-based meat and higher for plant-based cheese than for the respective animal products.

PBAPs*- Plant based alternative products. PBMAs**- Plant based meat analoges.

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7.4 DINER'S PERCEPTION OF THE MEAT FREE MONDAY CAMPAIGN IN A RESTAURANT IN THE CITY OF RIO DE JANEIRO, BRAZIL

Paula Albuquerque Penna Franca[1], Ivan Bursztyn[1], Anna Paola Trindade Rocha Pierucci[1*].

[1]Instituto de Nutrição Josué de Castro, Universidade Federal do Rio de Janeiro, Brazil

*** Correspondence:**

Corresponding Author: Anna Paola Trindade Rocha Pierucci.

E-mail: pierucci@nutricao.ufrj.br

Abstract

Purpose

The transition to plant-based diets is a central element of sustainable food systems. Campaigns such as Meat Free Monday (MFM) raise awareness about the environmental impact of excessive meat consumption on regional and global ecosystems. The purpose of this case study is to understand how customers at a Rio de Janeiro restaurant perceive the MFM campaign and explore the discourse of the MFM campaign in their social network.

Design

The data for this study was obtained from semi-structured interviews with the customers that were submitted to Interpretative Phenomenological Analysis and the MFM campaign's Instagram posts were analysed in depth.

Findings

From the testimonials of the clients and the analysis of the posts, it was possible to perceive the impressions about the campaign and the efforts of its implementation. The MFM campaign has great potential to communicate the environmental impact of animal-based food and encourage sustainable eating. However, the findings from this case study demonstrate that this potential is underdeveloped.

Originality

Due to climate urgency, many studies have sought to understand the motivations and obstacles to sustainable eating. The MFM campaign is one of the oldest movements that encourages the reduction of meat consumption, however, no study has analysed MFM's potential to communicate the environmental impact of animal-based foods. The originality of our research is circumscribed by the understanding of the meanings perceived by actual dinners and the deepening of these meanings by the analysis of the campaign Instagram posts.
Keywords: Food politics, sustainable diets, vegan diets, vegetarianism, sustainability, meat free Monday.

1.0 Introduction

The Meat Free Monday (MFM) is one of the first movements to encourage reduction of meat consumption. The campaign promotes gradual dietary changes by encouraging a plant-based meal, and dissociating the concept that a complete dish requires protein of animal origin as the main component of the meal (Singer, 2017). The campaign dates back to the First World War when the American government suggested not eating meat on Mondays (Meatless Monday) and not eating wheat flour on Wednesdays as a measure to save resources during the war period (De Backer and Hudders, 2014). However, it was in 2009 that it gained worldwide notoriety when it was launched in England by former Beatle Paul McCartney and renamed Meat Free Monday. Since then, several countries have adopted similar campaigns (Meat Free Monday, 2023).

In Brazil, the campaign was launched in the city of São Paulo, in October 2009, through a partnership between the Brazilian Vegetarian Society and São Paulo's Environment Secretariat, and later extended to several other municipalities (Lacerda *et al.*, 2013). As a citizenship exercise and alert to the environmental and social impacts related to meat consumption, the MFM campaign has the potential to raise awareness and awaken people to ethical and sustainable food concerns (Laestadius et al., 2014).

In recent decades, concerns about the environmental impact of food choices have increased considerably (Heller *et al.*, 2018). Livestock has been pointed out as one of the main agents of environmental degradation through the deforestation of native forests, intensification of agriculture (to obtain cattle feed), reduction of biodiversity, great use of water resources and competition for natural resources (Alexandratos & Bruinsma, 2012; FAO, 2018; HLPE, 2017; IPCC, 2021). In addition, livestock production is considered one of the economic sectors that most contribute to greenhouse gas emissions (IPCC, 2021).

The increase in purchasing power and the intensification of production in addition to globalization, which standardizes tastes and decreases regional customs, are the main factors responsible for the increase in meat consumption worldwide (Milford *et al.*, 2019). As income and urbanization increased, traditional eating patterns, marked by pronounced regional and cultural differences, gave room for eating patterns marked by high amounts of food of animal origin, and consequently greater environmental impact (Capone *et al.*, 2014), a process named by Weis (2013) as *Meatification.* This process describes how meat became more central to diets, a trajectory that reflects the industrialization of livestock production, the course of agrarian change and its search of increasing profits (Weis, 2021).

In Brazil, meat is considered an irreplaceable food item. Meat eating is a social practice culturally established as an essential part of the meal. Restricting meat consumption may be seen as a rejection of one's roots and might compromise community life (Happer & Wellesley, 2019). The Brazilian consumption of red meat is among the highest in the world, second only to the consumption of the United States of America (USA) and Argentina (Alvarez-Kalverkamp *et al.*, 2014). In addition, cattle farming in Brazil has been identified as responsible for dozens of serious labor violations, such as forced labor, exhausting working hours, degrading working conditions and slave labor through debt bondage (Garreto *et al.*, 2021; Hobbs, 2023). Besides, modern slavery and the deforestation of the Amazon rainforest and Cerrado are intrinsically connected. Slave labour is used for deforestation, land clearing, cattle farming and agricultural plantations in the deforested areas (Hobbs, 2023).

Estimates by the Food and Agriculture Organization (FAO, 2014) show that by 2050, emerging markets will cover only 46% of their caloric intake with grains; another 29% will come from meat, eggs, milk, and cheese. To keep up with this demand, meat production will have to jump from the current 300 million tons to 470 million tons in 2050. To feed those numerous cattle, feed grain production will need to almost double from 260 to 515 million tons per year worldwide (Alvarez-Kalverkamp *et al.*, 2014).

The shift from predominantly animal-based diets to diets with a predominance of plant-based foods is seen as a central element of the so-called sustainable diets (Capone *et al.*, 2014; FAO, 2018; Willett *et al.*, 2019). However, despite widespread media coverage and growing scientific literature (Clark *et al.*, 2020), public awareness about the environmental and social implications of meat consumption is still low (O'Keefe *et al.*, 2016).

The MFM campaign is pioneer in raising awareness of the impacts associated with meat consumption. In this sense, understanding how the MFM motivates people to reduce meat consumption is essential for understanding sustainable food choices. Thus, this article proposes to investigate the perceptions about the MFM campaign in a restaurant in Rio de Janeiro and to analyze the posts about the campaign on one of its main social networks.

2.0 Methods

This study has a qualitative approach to data collection and analysis. Exploratory and interpretative studies are considered an adequate method to investigate a contemporary phenomenon in its real context (Yin, 2010). The data discussed in subsequent sections of the article were derived from a combination of research strategies. Online posts from the MFM campaign on the social network Instagram were analyzed, as well as interviews with diners at a vegetarian restaurant in the city of Rio de Janeiro that supports the MFM campaign.

The restaurant was on the nomination list of supporters of the MFM campaign's Instagram. The restaurant in question is located in a high-income neighborhood in the city of Rio de Janeiro and specializes in vegetarian meals.

2.1 Participants

Data were collected in December 2018. Consumers were invited to participate in the research, and if they agreed, they were informed about the purpose of the research and gave their written consent. In total, 6 diners and the owner of the restaurant agreed to participate in the research. The study was approved by the Research Ethics Committee of the Clementino Fraga Filho University Hospital/UFRJ 87 CAAE 58179716.3.0000.5257. The diners who agreed to participate in the interview informed their name, age, sex, and race. The names of the research participants were withheld to preserve their identity.

2.2 In-depth interviews

The interviews were conducted by two trained interviewers on the first and second Mondays of December 2018 after the participants customers had their lunch. The semi-structured interviews covered a range of topics. In the semi-structured interview, the interviewer has a clear list of items he will ask, but the structure of the questions is flexible, which allows the inclusion of new questions as the interview progresses (Canesqui, 2009; Draper & Swift, 2011).

The guiding questions were framed around 4 conceptual themes: (a) motivations for choosing that restaurant on a Monday, (b) previous knowledge about the campaign, (c) concerns about the environmental impact of the food system, and (d) current diet or food lifestyle. The order and specific phrasing of the questions varied according to each participant and the flow of the interview. The interviewers wrote down the answers and comments of the interviewees for later analysis (Draper & Swift, 2011).

2.3 Analysis of the campaign's Instagram posts

Posts on the campaign's Instagram social network, @segundasemcarne were analyzed. The Instagram profile was public, so it was not necessary to obtain written consent to analyze their publications. An Instagram profile without a photograph, biography, followers or publications was created to facilitate the search and avoid confusion. All posts from November and December 2018 were selected for analysis, totaling 133 posts.

2.4 Data analysis

Data interpretation process was divided into stages, allowing the construction of structuring categories that were later analyzed in depth (Draper & Swift, 2011). The content of the interviews was submitted to Interpretative Phenomenological Analysis (Smith & Fieldsend, 2021). The analysis steps allowed the consideration of context, language, content, and interpretations agreed upon by researchers and the subsequent construction of emerging themes. Then, overarching themes were identified that reflected the shared and divergent experiences in the corpus of interviews. The posts were coded, and the images were classified and described. As a result, the categories "animals love", "uncomplicated cooking", and "informative" emerged.

3.0 Results

3.1 Sample Description

The demographic profile of the study participants is depicted in **Table I**. Of the 6 interviewees, four were female, all were white, and the age range was diverse. Participants followed different diets, as can be seen in the **Table I**.

3.2 Motivations for going to the restaurant on the day of the campaign.

The restaurant located in the neighborhood of Leblon, in the South Zone of Rio de Janeiro, offered dishes of the day and à la carte options. The restaurant offered only vegan dishes. For MFM, the house offered a 10% discount on the dish of the day to encourage the consumption of vegan dishes to new customers. They publicized the campaign through a notice on the blackboard placed in front of the restaurant. The owner reports that several customers joined the campaign and started adopting the practice, even if they couldn't come on Mondays.

Restaurant Owner

"*.........People come to try it and like it, then they come more often, most are not vegetarians, but as they like the food, they feel it's not a heavy food, so they come back. Some people start making MFM at home too and come tell us, and we think it's cool".*

"*........If the public is different? I don't think so, it's not bigger on Mondays because the dish is cheaper, usually those who come on Mondays also come on other days."*

However, respondents did not report choosing the restaurant on Monday for that specific reason. The restaurant was selected for numerous reasons, including a pleasant atmosphere, affordable prices (cited several times), tasty vegan food made from natural ingredients without chemicals or hydrogenated fat, and a flexible lunchtime.

Participant 1

"I come here a lot. The food here has a home-cooked feel to it, and no cilantro! In Rio de Janeiro, vegan food is very bland, always the same thing, always has cilantro."

3.3 Knowledge about the Meat Free Monday campaign

A recurrent report was the lack of perception and knowledge about the campaign, demonstrating that the MFM campaign wasn´t being spread well in the space.

Participant 2
"I come randomly. I don't even remember that it's MFM. Before coming here, I didn't know about MFM, but I never remember that it was campaign day....
".......I come and when I arrive, I realize it's MFM, I hadn't noticed the price difference".

Participant 4

> *"I didn't know about MFM before, only later I saw that they had this campaign here."*

In fact, when asked about the campaign, the owner of the place expressed surprise about the lack of knowledge about the MFM campaign in the city of Rio de Janeiro. Another interviewee reiterates that in São Paulo the campaign is much stronger.

> *Participant 3*
> *"In São Paulo many non-vegan restaurants joined the campaign...."*
> *".... it's a cool, social action that works with change, helping to reduce consumption little by little. Where are the activists in Rio de Janeiro to take the campaign to restaurants? In São Paulo, even hospitals do the MFM, it is a very strong movement..."*

Among the few reports on adherence to the MFM campaign in Brazil and veganism, Barbosa and Cordeiro (2019) found that students in a nutrition course in Brazil had a low understanding of the MFM campaign and were not willing to adhere to it. In Teresina, the capital city of Piaui, Brazil, a law proposed to institute one MFM day per year met significant resistance and was called "good fascism" and an "unreasonable law". The tendency to adhere to the campaign was greater when informed about the benefits to human health and the planet (Sampaio & Carvalho, 2016).

3.4 Symbolism and Meanings of Veganism and Meat Free Monday

Veganism is negatively portrayed in the media, and its supporters are called hostile and too sensitive (Doyle, 2016), which would justify the distancing of the MFM campaign from the vegan activism and the vegan/animal cause (Singer, 2017). When asked about the importance of the MFM campaign, responses varied but did not include animal suffering or the intention to become vegan.

> *Participant 1*
> *"Meat is still not seen as a problem, as cigarettes were not seen as a problem and that has changed. Today it is unimaginable, but in the past doctors prescribed cigarettes for pregnant women."*
>
> *Participant 4*
> *"The main thing is food without chemicals, whole foods, without chemicals, without hydrogenated fat."*

The discussion about the imposition of the MFM is pertinent, as it can be seen as a restriction of freedom and an Estate interference in individual choices (Morris *et al.*, 2014). These concerns oppose to the slogan campaign "try new flavors". This apparent contradiction can be resolved by changing the way people think about the meal's main dish. Not eating meat does not have to mean having an incomplete meal. It can be seen as a way to try main dishes based on plant-based foods. It would not be an imposition, but an opportunity to change the diet weekly in favor of environmental sustainability (De Boer *et al.*, 2014). These perceptions were sensed by the interviewees and by the owner of the restaurant.

> *Participant 3*
> *"Talking about meat or dairy is still taboo today. That's why the campaign is important, if the approach is invasive, you have the opposite effect. You have to go slowly. The cool thing is the transformation, it's working with the change, reducing consumption little by little. Change has to be slow, food is culture, belief, habit, food messes with everything, change has to be slow, if everything changes at once, the person even gets depressed."*

> *Restaurant owner*
> *... (people) leave the cultural business of rice, beans and meat and open the range to many other things - vegetables, legumes, pulses. Beans, chickpeas, lentils, and legumes are used in many ways; there are chestnuts, there are also many proteins, brown rice, black rice, collared rice, collared rice is wonderful."*

3.5 Environmental sustainability as an influencer of consumption

The MFM campaign can contribute by enlightening consumers about their choices and the consequences global warming is (already) bringing to society (Morris, 2018). Some interviewees reported knowledge about the association between meat consumption and the environmental impacts of livestock and reported that concern for the environment was the reason for choosing vegetarian meals.

> *Participant 5*
> *"After I discovered the environmental impact generated by meat production, I don't eat meat anymore."*

> *Participant 2*
> *"It is a question of the survival of the planet. The people who produce the meat and the government do not care about it."*

3.6 Meatless Monday campaign posts analysis

The campaign aims to raise awareness about the impact of animal-based food products on animals, society, human health, and the planet. The slogans "discover new flavors" and "for people, for animals, for the planet" reflect these objectives. Thus, inviting people to take animal-based foods off their plates at least once a week and try new foods and ways of cooking that are different from the usual (SVB, 2018).

The top part of the Instagram page had information regarding the campaign - an icon with a list of participating restaurants in different cities in Brazil and a link to download an explanatory leaflet about the MFM. According to information obtained from Instagram, the

Brazilian MFM is the biggest campaign in the world. In 2018, there were 67 million plant-based meals linked to the campaign. The analysis of the MFM campaign's online posts sought to understand which contents are prioritized in the campaign's posts and what they intend to communicate. The categories and themes identified in the analysis are shown in **Table II**.

The MFM online campaign promotes MFM and veganism as practices linked to happiness and well-being. It uses pictures of people and children smiling, showing love and peaceful coexistence with animals in green spaces, as seen in **Image 1**. This way of communicating veganism was identified by Wilson (2019) as soft veganism, which avoids confrontation while increasing awareness.

Posts with photos of animals aim to raise awareness of animal rights, highlighting the contrast between pet love and animal exploitation of food (Beck & Ladwig, 2020). The campaigns´ conciliatory tone has been criticized for not being activist enough. In fact, Singer (2017) criticizes the neoliberal practices and rhetoric used in the MFM's discourse and actions, as they perpetuate the prevailing Western thinking of speciesism and anthropocentrism and distance themselves from activism for animal rights.

The informative category brings data related to health and the environmental impact of meat consumption, in the form of infographics and/or drawings, as can be seen in **Image 2**. Despite the campaign slogan "for people, for animals, for the planet", the theme "sustainability" appeared in only 6 posts.

Although global warming can already be perceived by the population through climatic phenomena, melting of the polar ice caps and an increase in natural disasters, sustainability still does not influence purchasing decisions in Brazil (O'Keefe *et al.*, 2016).

Even though the MFM and Meatless Monday campaigns have the potential to facilitate the transition to a more sustainable food system (Laestadius *et al.*, 2014), as long as commercial organizations, the media, and the state continue to promote high and unsustainable levels of meat consumption, the ability to disseminate an innovative social practice is limited (Morris *et al*., 2014).

Sampaio and Carvalho (2016) analyzed the population's perception of MFM in Teresina, in the State of Piauí, Brazil, concluded that as an environmental political strategy, MFM represents a possibility for consumers to exercise their citizenship and assume their social, historical, political and ethical role. In common, the aforementioned authors agree that the campaigns in the respective countries studied are failing to communicate the social, ethical, political and environmental issues involved in food choice.

The component of the slogan "for the people" was not clear. It possibly refers to the health benefits of avoiding animal-based foods, which in recent years received a growing volume of scientific evidence (Carrero *et al.*, 2020; Hemler & Hu, 2019; Kim *et al.*, 2018). The health-related posts discussed the benefits of plant-based foods or compared the nutritional composition of animal-based foods with plant-based alternatives. The positive health effects of restricting meat consumption were not identified in the posts, nor the social impacts associated to the meat industry.

Most of the posts in the uncomplicated culinary category were related to the theme of Christmas dinner. The Christmas dinner and comfort food posts had easy, delicious recipes that tasted like home-cooked meals, as shown in **Image 3.**

The focus on food has been an increasingly common approach among campaigns that promote meatless days/or veganism, allowing the construction of their own identities in order to make these movements more attractive to people (Wilson, 2019). The Protein Flip campaign, a partnership between the Harvard School of Public Health and the Culinary Institute of America (2022), also uses this approach. The aim of the campaign is to develop tasty dishes with less meat and promote the concept of meat as a side dish instead of the main course. This can be considered a big change from the typical American diet that puts a lot of emphasis on animal protein (Wiriyaphanich *et al.*, 2021).

Final Considerations

In this work, a case study was carried out on perceptions regarding the MFM campaign in the city of Rio de Janeiro. From the analyzed data, it was noticed that part of the interviewees did not associate the day of the week with the meal consumed. Exposure to the campaign at the restaurant did not make them join the campaign on Mondays, except for those who had already adopted a vegan/vegetarian diet. The reasons for choosing the restaurant on a Monday varied, but the quality of the food, either because it is associated with natural food or because of its flavor, stood out among the results, demonstrating that the focus on tasty dishes is a good campaign strategy. Concerns about the environmental impacts of meat production were cited by some of the interviewees as one of the reasons for restricting meat.

According to Poulain and Proença (2003), food norms refer to the food structure of a given group or population, eating models socially accepted or convenient. Food norms can be distinguished into social norms and dietary norms. The first refers to the typical composition of the dish to a given group or society. Thus, the Brazilian social norm is represented by rice, beans, a "mixture" (animal-based protein main dish), salad and dessert. The dietary norms are supported by scientific-nutritional knowledge and represent what would be the best in terms of nutrients and food for a given population (Barbosa, 2007; Poulain & Proença, 2003). Reducing meat consumption generates substantial levels of attitudinal conflict for many people (Trent Grassian, 2020), since the omission of meat from the plate, leads to a disruption of social and dietary norms, requiring a restructuring of food, culinary and food consumption practices. Therefore, the campaign's focus on uncomplicated food that can be seen as plant-based main course seeks to address these issues.

Piazza *et al*. (2022) point out that individuals who engage with pledges are often those who express conflict about the target behavior. This highlights an important consideration when generalizing pledge-based interventions to the larger population: not everyone will be interested in engaging with such an intervention or benefit from it, thus, it may be more resource-effective to focus the interventions on those who have prior intentions to change, which raises whether commitments to eat meat-free have the potential to galvanize individuals without preexisting reduction goals.

Singer (2017) emphasizes that food is a cultural institution that is undeniably political since it inflects power relations within the nature-culture-society spectrum. Therefore, boycotts of certain foods and/or companies and intentional purchases can be considered significant tools for political action and expression (Portilho, 2005).

Political eaters choose their meals by ethical, social or political issues such as the treatment of animals and the protection of the environment (Chuck *et al.*, 2016), outlining a new role for the consumer -of a conscious consumer - who bases his purchases on political choices and not only on sensory or convenience preferences. These consumers use their personal choices as a solution to face social, environmental, or ethical problems (Portilho et al., 2011; Tanaka & Portilho, 2019).

Conversely, the space of a restaurant can be used to make diners aware of different aspects of the food system. Today, consumers are very disconnected from their food, there is no connection between the food consumed and the way this food is produced (HLPE, 2017). By selecting the foods to be used, selecting suppliers, choosing the menu, training employees, reducing food waste, carrying out campaigns, promoting debates, and defining menus that play this pedagogical role, restaurants have several opportunities to provide a sustainable food environment in order to normalize healthy and sustainable food choices (Pereira *et al*., 2019).

In recent years, different approaches have been used to promote debate and awareness about the environmental impact of food, especially meat consumption. All these movements are important in proposing a reflection on new ways of eating that are less dependent on protein foods of animal origin. In this sense, the MFM campaign is one of the oldest movements promoting the reduction of meat consumption. Despite little exploration of the climate issue, the campaign has the potential to generate debate and reflection on food and sustainability and emphasize how individual adherence can generate impacts for the community as a whole, in terms of individual and collective sustainable consumption.

Limitations

As the research was carried out in a restaurant that doesn't serve any type of meat, possibly most of the participants were already keen to reduce or abstain from meat consumption. So, we fail to learn whether the campaign could successfully engage people without a prior history of reducing meat. Another limitation of the study is that the restaurant is located in a high-income area, which may represent an income restriction.

Future Perspectives

The research can be continued by including a larger number of restaurants, in different locations, to better understand the adherence to the campaign and the motivations that led to adherence. Another very promising field of research is to investigate other initiatives promoted by restaurants and caterers to raise public awareness for sustainable eating and meat reduction.

Conflict of Interest

The authors declare that the research was carried out in the absence of any commercial or financial relationships that could be interpreted as potential conflicts of interest.

Authors Contributions: Paula Albuquerque Penna Franca: conceptualization, methodology, investigation, writing – original draft, visualization**. Ivan Bursztyn**: writing, proofreading, and editing **Anna Paola Trindade Rocha Pierucci:** conceptualization, methodology, resources, writing – proofreading and editing, project management, fundraising**.**

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Table I: Sample description of the 6 interviewees.

Participants	**Age**	**Sex**	**Race**	**Diet**
1	48	Female	White	Vegan
2	64	Male	White	Omnivorous
3	54	Female	White	Vegan
4	60	Male	White	Pescetarian
5	24	Female	White	Red meat avoider
Owner	N/A	Female	White	Vegan

Table II: MFM campaign posts organized into categories.

Category	**Theme**	**Number of posts**
Animals love	Influencers	2
Animals love	Living peacefully with animals' companion	23
Uncomplicated cooking	Confort food	10
Uncomplicated cooking	Christmas meals	60
Informative	Restaurants and companies supporting the campaign	11
Informative	Sustainability	6
Informative	Influencers	7
Informative	Health	8
Informative	Slogan and campaign results in Brazil	6
Total		**133**

Image 1: Instagram post from November 30, 2018, @segundasemcarne. The image conveys a message of MFM and veganism as practices linked to happiness and well-being.
Transcript: @Meat-free Monday- Any doubts that animals deserve our love???? Start to change your dietary habits, do not leave it for later…. Try #MeatFreeMonday

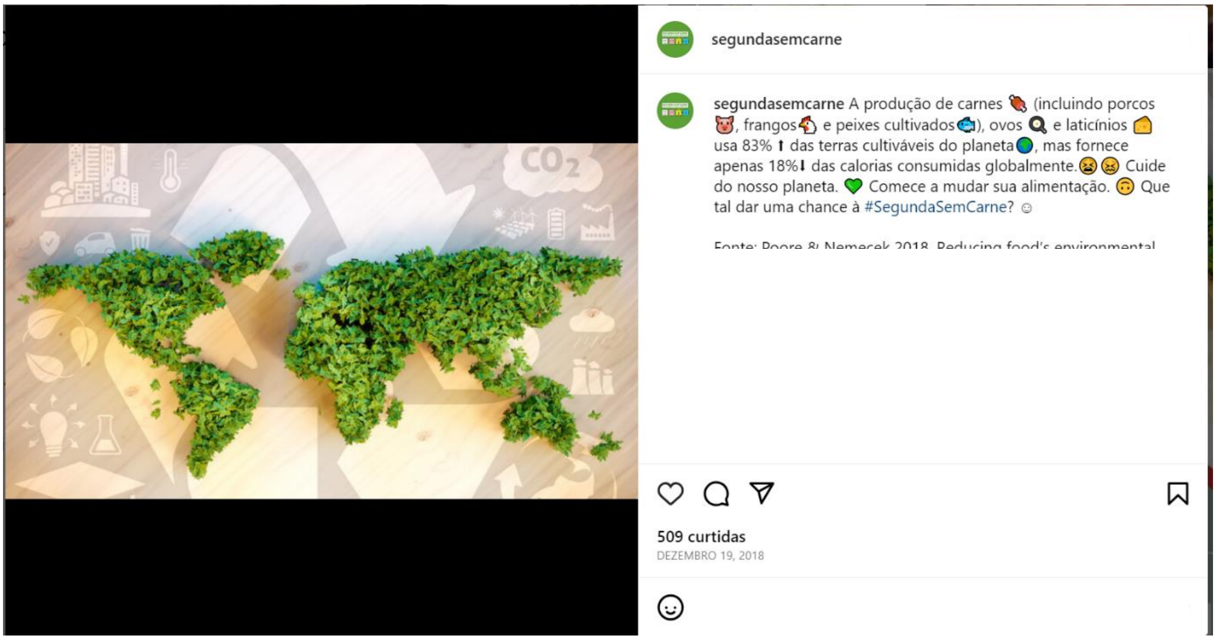

Image 2: Instagram post from December 19, 2018, @segundasemcarne. Informative data related to health and the environmental impact of meat consumption.
Transcript: @Meat-Free Monday- Meat production (including pigs, chicken, and farmed fish), eggs, and dairy use 83% of the arable land on the planet but provide only 18% of the calories consumed globally. Take care of our planet. Star changing your diet. What about giving Meat-Free Monday a chance?

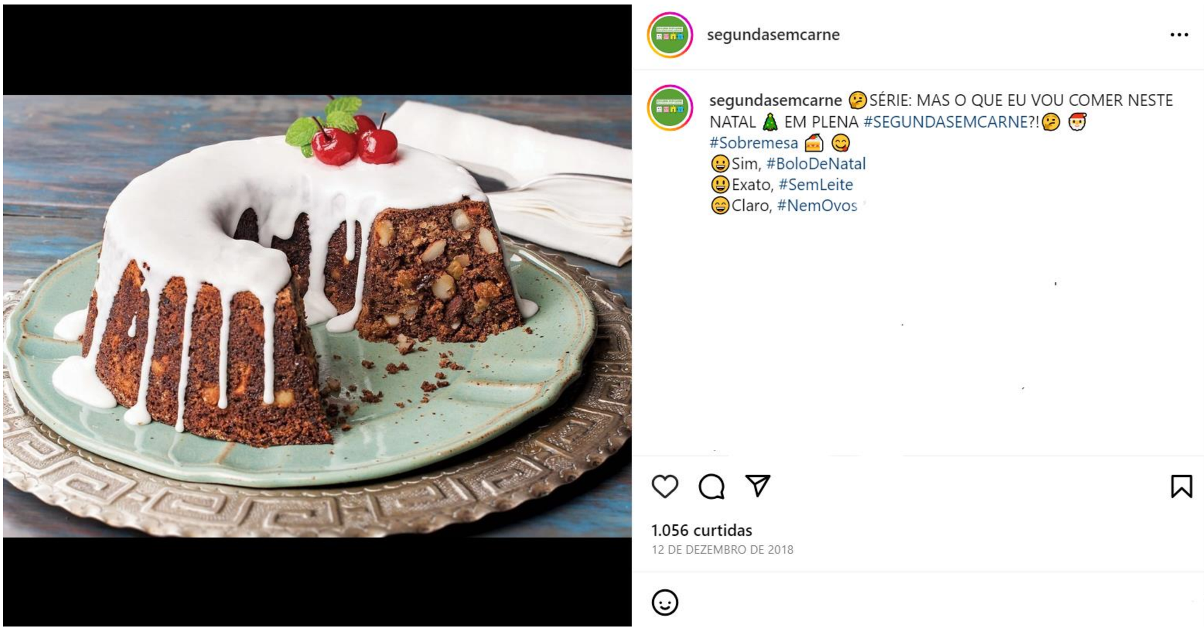

Image 3: Instagram post on December 12, 2018, @segundasemcarne. The Christmas dinner and comfort food with easy and delicious recipes that taste like home-cooked meals.

Transcript: @Meat-Free Monday- Serie: What will I eat this Christmas on Meat-Free Monday?
#Dessert
Yes, Christmas cake
Exactly, no milk
Of course, no eggs

8 CONSIDERAÇÕES FINAIS

Essa tese se propôs a investigar iniciativas de produção e consumo de alimentos para a redução de produtos de origem animal na transição para sistemas alimentares saudáveis e sustentáveis. Para isso os produtos “plant-based” presentes no mercado brasileiro e mundial foram analisados quanto às características nutricionais e quanto aos ingredientes de composição. Além disso, avaliamos o discurso de comensais em um restaurante do Rio de Janeiro a fim de compreender o potencial da campanha segunda sem carne como agente de conscientização sobre os impactos ambientais associados ao consumo de alimentos de origem animal.

Serão necessárias muitas iniciativas e movimentos para promover mudanças reais no sistema alimentar. Dentro dessa perspectiva, os produtos “plant-based” podem ser uma solução para o consumidor que busque soluções rápidas, mas devido a heterogeneidade da composição nutricional dos produtos, à presença de muitos aditivos e a quantidade de sódio e gordura saturada em parte deles, não deveriam ser a base da alimentação, podendo fazer parte de uma dieta variada.

As iniciativas analisadas sozinhas não são capazes de promover uma nova transição nutricional, mas múltiplos esforços são bem-vindos e precisam continuar acontecendo para levarem a mudanças maiores e necessárias. Nesse sentido, a campanha segunda sem carne tem um grande potencial de conscientizar sobre os impactos ambientais da alimentação, potencial este que pode ser mais bem explorado caso os organizadores da campanha tenham como intuito explorar o aspecto ambiental além do foco na questão ética associada ao consumo de alimentos de origem animal.

É urgente que os aspectos da sustentabilidade passem a ser tratados integradamente aos aspectos de saudabilidade nos estudos de sistema alimentar. Tanto a nutrição quanto os demais ramos da ciência necessitam trazer a sustentabilidade para o cerne das ações e esforços coletivos. Por fim, pesquisas futuras podem se voltar a mapear os atores e iniciativas do sistema alimentar para estimular a transição proteica. A definição de como se constituiriam as dietas sustentáveis dentro das possibilidades locais também deverá ser aprofundada.

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APÊNDICE 1 MANUSCRITO MEAT SUBSTITUTES- PAST, PRESENT AND FUTURE OF PRODCUTS AVAILABLE IN BRAZIL: CHANGES IN THE NUTRITIONAL PROFILE

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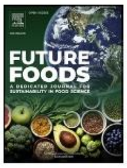

Meat substitutes - past, present, and future of products available in Brazil: changes in the nutritional profile

Paula Albuquerque Penna Franca[a], Patrícia Duque-Estrada[a], Breno Fraga da Fonseca e Sá[a], Atze Jan van der Goot[b], Anna Paola Trindade Rocha Pierucci[a,*]

[a] *Laboratório de Desenvolvimento de Alimentos para Fins Especiais e Educacionais (DAFEE), Instituto de Nutrição Josué de Castro, Universidade Federal do Rio de Janeiro, Avenida Carlos Chagas Filho, 373, Centro de Ciências da Saúde, 21941 090, Rio de Janeiro, RJ, Brazil*

[b] *Food Process Engineering, Wageningen University & Research, PO Box 17, 6700 AA Wageningen, The Netherlands*

A R T I C L E I N F O

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A B S T R A C T

Plant-based meat substitutes are products used to replace meat in the human diet. These products have developed from traditional whole-grain meat substitutes to products based on an advanced technology called 2nd generation meat substitutes. Increased market visibility of 2nd generation products raised questions about the products´ healthiness once they are classified by NOVA as ultra-processed, are allegedly high in salt and saturated fat, and might not be nutritionally equivalent to meat. To answer those queries, we evaluated the nutritional profile of the 3 generations of products available in the Brazilian market. Products were classified into one of three stages of technology as traditional meat substitutes, 1st generation meat substitutes, or 2nd generation meat substitutes. Their nutritional values, ingredient composition, and nutrient profile were analyzed and compared. Most of the products analyzed (169 in total) were classified as 1st generation meat substitutes (55.6%), while 2nd generation ones represented 16% of products. The 2nd generation of meat substitutes presented a higher amount of protein, sodium, saturated fat, and a greater number of additives than previous generation products. The future generation of meat substitutes should focus on reducing saturated fat content and the use of fewer additives.

1. Introduction

Plant-based meat substitutes are products used to replace meat in the human diet and mimic the texture, taste, and appearance of meat products (Tziva et al., 2020). The meat substitutes marketplace is expanding rapidly around the globe, going beyond the vegetarian market to include meat-loving consumers who want to reduce their meat consumption because of health, ethical, cost and sustainability concerns (Dagevos and Voordouw, 2013). Meat substitutes are also options for convenience-oriented consumers that want to reduce meat intake but not at the expense of flavor and convenience (Wild, 2016).

Much has been said about meat substitutes: healthy, unhealthy (Kyriakopoulou et al., 2018), ultra-processed, the protein promise of the future (Ismail et al., 2020). Some people say it is fake food (Ancestral Nutrition, 2017), others promise salvation of the planet (Van der Weele et al., 2019) or burger absolution as healthy food (Lichstein, 2020). Despite the recent furor around it, meat substitutes are not a new food category as such (Bohrer, 2019). In western countries, foods from ancient production such as tofu and tempeh became available by the 1960s (Wild, 2016) when the hippie movement incorporated oriental influences in western food culture (Rödl, 2019). In Brazil, the hippie movement disseminated vegetarianism and a natural lifestyle. Food practices promoted by them included vegetarian meat substitutes such as burgers and patties made with lentils, beans, mushrooms, and fresh ingredients (Lifschitz, 1997; Sigolo, 2020). These early products, made by whole ingredients, can be called traditional meat substitutes (Lichstein, 2020), despite having a proposal to replace meat, their consumption remained restricted to the vegetarian public. Due to the long-lasting effect of natural lifestyle on Brazilian food culture, these traditional meat substitutes are still commercialized (Lifschitz, 1997; Sigolo, 2020).

Advancement in the production of meat substitutes happened with the launching of dry textured vegetable protein (TVP), which emerged by the mid to late 20th century (Ismail et al., 2020). Initially perceived as meat extenders, TVP gradually started being used as a meat substitute (He et al., 2020), giving rise to 1st generation meat substitutes (Tziva et al., 2020). Manufactured by low moisture cooking extrusion of defatted soy meal, soy protein concentrate, or gluten, the products obtained had a fibrous and spongy texture. However, the market share remained very small and restricted to vegetarians for a long time (Tziva et al., 2020).

* Corresponding author:
E-mail addresses: Franca_paula@yahoo.com.br (P.A. Penna Franca), atzejan.vandergoot@wur.nl (A.J. van der Goot), pierucci@nutricao.ufrj.br (A.P.T.R. Pierucci).

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As the demand for meat-free products increased, due to the rising concern of the environmental impact of meat production (He et al., 2020), and the expansion of the market by flexitarian consumers seeking a varied and healthy diet (Curtain and Grafenauer, 2019), producers developed meat substitutes more similar to meat. Based on technologies such as high moisture cooking extrusion, the 2nd generation meat substitutes aim to imitate the taste and experience of eating meat (Dekkers et al., 2018), delivering products of appearance, nutritional facts, aroma, and taste very similar to authentic meat products (He et al., 2020), such as whole cut meat and chicken strips with visible structured protein fibers. Also called the new generation of meat analogues (He et al, 2020) or novel meat analogues (Ismail et al, 2020), the 2nd generation of meat substitutes are marketed to a broader consumer base such as flexitarians and omnivorous (Lichstein, 2020). To achieve this, novel ingredients or innovative processes were developed (Ismail et al., 2020). In Brazil, 2nd generation meat substitutes started being commercialized in 2019 by a foodtech startup, soon other five companies followed, upgrading their portfolio or initiating a new business (GFI, 2020).

Increased visibility of meat substitutes was followed by media and academic repercussions (Boukid, 2021). The ultra-processed nature of 2nd generation meat substitutes, made with refined ingredients, generates a lot of debate whether they can be considered as a healthy choice or not (Santo et al., 2020). Some health professionals have been concerned whether these products can fully replace meat and at what cost for people´s health (Hu et al., 2019), once they are allegedly rich in saturated fat and sodium (Bohrer, 2019). At the same time, there is a healthy halo around plant-based products, with consumers associating plant-based to healthy eating, independent of the nutritional composition (Besson et al., 2020). As a result of such conjecture, it is relevant to evaluate, compare and make a critical note regarding the nutritional composition and the processing nature of the ingredients in these products.

Method

Search for meat substitutes products

To determine the composition of meat substitutes available on the Brazilian market, we searched for products on the company's websites, and at local stores (supermarkets and health food stores in the city of Rio de Janeiro). We analyzed information obtained from the product's labels or the ones included on the company's website. This search was conducted from September to November of 2020.

To search for meat substitutes we considered the following criteria: the products must be plant-based, precooked, and resemble meat, chicken, fish, or processed meat. Products, such as tofu, tempeh, and legumes, consumed traditionally as part of a vegetarian diet, not primarily designed to replace meat (He et al., 2020), were excluded in the search. Besides, products without available nutrition facts label were not included in our research.

Classification of products: stage of technology development

Products were classified into one of three stages of technology development as follows: Traditional meat substitutes- made exclusively with fresh or minimally processed ingredients and whole grain legumes, such as lentils burgers and chickpea sausages, 1st generation meat substitutes- produced mainly with TVP (by low moisture cooking extrusion, and/or gluten), are targeted to the vegetarian market, and have been in the market since 1990´s (Tziva et al., 2020), such as soy chunks and burguers made of TVP; 2nd generation meat substitutes - Based on high moisture cooking extrusion to produce new products of which the appearance, protein content, aroma, and taste are very similar to authentic meat products, such as chicken strips, salmon filet and bacon. Commonly, these products have a nationwide distribution (He et al., 2020), and

Table 1
Classification criteria for meat substitutes products.

	Technology	Ingredients	Public
Traditionalmeat substitutes	Homemade style	Fresh or minimally processed ingredients, like pulses and vegetables	Vegetarian public
1st Generation meat substitutes	Low moisture cooking extrusion	Meal, soy protein concentrate or wheat gluten	Vegetarian public
2nd Generation meat substitutes	High moisture cooking extrusionfermentation	Novel protein sourcesPlant protein isolate and plant protein concentrate	Flexitarians and general public

have been in the Brazilian market since 2019 and being produced by six manufacturers (GFI, 2020); Additionally, products were divided into six categories such as meat products, chicken products, fish products, burgers, ground beef, and processed meat. The criteria for classification of the products can be seen on **Table 1**.

Nutrient composition and ingredient analysis

The information contained in the nutrition facts labels were transcribed and analyzed. The amounts of all nutrients (carbohydrate, protein, total fat, saturated fat, fibers, iron, vitamin B_{12}, zinc, and sodium) and total energy (kcal) presented in each product were calculated for 100 g to allow comparison between products. The list of ingredients for each product was transcribed and each ingredient was allocated according to the main nutrient it provides (protein, carbohydrate, fat), natural seasonings, and additives.

Nutrient Profile

To analyze how the products perform according to their nutritional quality, Brazilian Regulations RDC nº 429 (Brasil 2020a) and IN nº 75 (Brasil 2020b) were applied. These legislations define criteria for front of package labeling of nutrients that should be avoided and nutritional claims for nutrients whose consumption should be encouraged. The summary of the criteria applied is shown in **Table 2**. Additionally, we evaluated if the serving size stated on the nutrition facts label was adequate according to RDC nº 360 (Brasil, 2003). The calorie density of the products was calculated according to the RDC nº 360 (Brasil, 2003), dividing 150 kcal per 80 g of serving size. Products within an interval of minimum (-20% of calorie density) and maximum (+20% calorie density) were classified as containing adequate calorie density.

Statistical analysis

Results of nutritional composition were expressed as median, minimum, and maximum. Products grouped by stage of technology development were compared by non-parametric Kruskal Wallis test, followed by Dunn post hoc test with Bonferroni adjustment. The level of statistical significance was set at $p < 0.05$. Analysis was made at RStudio Desktop version 1.4.1106.

Results

Product description

We found 180 meat substitute products in the Brazilian market produced by 27 different manufacturers. However, we only obtained data of 169 products due to a lack of available label information online. Products divided by the stage of technology development and product type can be seen in **Table 3**. Most of the products analyzed were considered 1st generation meat substitutes (55.6%), while 2nd generation ones represented the lowest share of products available on the market (16%), produced by only 6 manufacturers. The most common products among the 2nd generation were burgers and chicken (37% each).

Nutritional composition

The median value of total energy was 181 kcal/100 g product, with minimum and maximum values of 34 kcal and 343 kcal/100 g product, respectively (**Table 4**). The 1st generation products had the highest median value of 192 kcal/100g product. A great range from minimum to maximum energy values was seen in the three product categories (58.6 to 343 kcal for traditional; 34 to 325 for 1st generation and 108 to 326 for 2nd generation). Serving size was significantly different between traditional products to 1st generation and 2nd generation products, however a greater variability was noticed within groups than between the different groups.

Table 2
Nutrition claims and cutoff points used to classify meat substitutes products according to the Brazilian food legislation (RDC n° 429 and IN n° 75).

Nutrients	Specificity of nutritional claims
Protein	(Also needs to attend to minimum amino acids composition stated at IN n° 75). Source: 5g per serving size (6.25 g per 100 g). High Content: minimum of 10 g protein per serving size (12.5 g per 100 g).
Total fat	**Zero Content:** Maximum of 0.5g per serving size (0.62 g of fat per 100 g) and all fat fractions must be equal to zero on the nutrition facts label. Additionally, no fat source ingredients must be present in the ingredients list. **Low:** Maximum 3g of fat per serving size (3.75 g per 100g).
Saturated fat	**High:** Above 6 g per 100g
Fiber	**Source:** must contain at least 2.5 g of fiber per serving size (3.13 g per 100 g) **Rich:** must contain at least 5 g of fiber per serving size (6.25 g per 100 g)
Sodium	**Zero Content:** Maximum of 5 mg per serving size (6.25 mg per 100 g) **Very Low:** Maximum of 40 mg per serving size (50 mg per 100 g). **Low:** Maximum of 80 mg per serving size (100 mg per 100 g). **No claims allowed:** Above 100 mg. **High:** Above 600 mg per 100g
Iron, vitamin B_{12}, zinc	**Source** of vitamins or minerals: at least 15% of the daily recommended dietary intake must be provided by serving size. **Rich** in vitamins or minerals: at least 30% of the daily recommended dietary intake must be provided by serving size.

Table 3
Product type categorized by stages of technology development.

	Traditional (N=48; 28.4%)	1st Generation (N=94; 55.6%)	2nd Generation (N=27; 16.0%)
Burger	29 (60.4%)	18 (19.1%)	10 (37.0%)
Chicken	1 (2.1%)	9 (9.6%)	10 (37%)
Fish	0 (0%)	7 (7.4%)	2 (7.4%)
Ground beef dishes	13 (27.1%)	14 (14.9%)	2 (7.4%)
Meat	2 (4.2%)	17 (18.1%)	1 (3.7%)
Processed Meat	3 (6.2%)	29 (30.9%)	2 (7.4%)

For detailed explanation of categories check details on Table 1.

Table 4
Nutritional composition of meat substitutes per 100g of the product, categorized according to the stage of technology development.

	Traditional N=48 (28.4%)	1st Generation N=94 (55.6%)	2nd Generation N=27 (16.0%)
Serving Size (g)			
Median[min and max]	100[20, 270] ^{a,}	50[20, 150] ^{b}	80[30, 130] ^{b}
Energy (Kcal)			
Median[min and max]	159[58.6, 343] ^{a}	192[34, 325] ^{b}	175[108, 326] $^{a, b}$
Carbohydrate(g)			
Median[min and max]	23.5[8.49, 66.3] ^{a}	14.8[0, 51.7] ^{b}	9.67[2.40, 23.9] ^{b}, ^{c}
Protein (g)			
Median[min and max]	5.09[1, 60.3] ^{a}	13.6[1.83, 32.4] ^{b}	13.8[7, 23] ^{b}
Total fat (g)			
Median[min and max]	2.66[0, 9.25] ^{a}	6.17[0, 40.0] ^{b}	9.23[0, 21.5] ^{b}
Saturated fat (g)			
Median[min and max]	0.4[0, 3.58] ^{a}	0.95[0, 5.32] ^{b}	3.75[0, 12.3] ^{c}
Fiber (g)			
Median[min and max]	4.4[0, 9.36] ^{a}	4.57[0, 20] ^{a}	4.3[0.4, 6.25] ^{a}
Sodium (mg)			
Median[min and max]	343[15, 1540] ^{a}	575[18.0, 1580] ^{b}	478[326, 700] ^{b}
Iron (mg)			
Median[min and max]	2.7[2.7, 2.7] ^{a}	1.34[0.42, 5] ^{a}	3.5[1.62, 11.7] ^{a}
Zero content	47 (97.9%)	88 (93.6%)	8 (29.6%)
Vitamin B_{12} (μg)			
Median[min and max]	NA[NA, NA] ^{a}	0.86[0.06, 1.67] ^{a}	0.90[0.30, 2] ^{a}
Zero content	48 (100%)	92 (97.9%)	10 (37.0%)
Zinc (mg)			
Median[min and max]	NA[NA, NA] ^{a}	2[2, 2] ^{a}	1.75[1.38, 2.10] ^{a}
Zero content	48 (100%)	93 (98.9%)	22 (81.5%)

Results are shown as median [minimum and maximum]. Different letters in the same row show significant difference among the groups at $p < 0.05$. For detailed explanation of categories check details on Table 1.

The 1st and 2nd generation meat substitutes had similar protein content (13.6 g/100 g and 13.8 g/100 g respectively), while traditional meat substitutes had a median of 5.09 g/100 g. We noticed a variation in the protein content within the same product category. The minimum and maximum protein content of all products were 1 g protein/100 g product and 60.3 g protein/100 g dry product, respectively.

We also noticed the variation in the carbohydrate content within the same level of technology ranging from 8.49 g/100 g to 66.3 g/100 g for traditional meat substitutes and from 2.40 g/100 g to 23.9 g/100 g for 2nd generation meat substitutes. The median value of dietary fiber ranged from 3.9 to 5.5 g/100 g in all categories and didn´t vary significantly among categories. However, the three categories had products with zero fiber content.

Among the micronutrients, none of the traditional meat substitutes had any amount of iron, vitamin B_{12}, and zinc reported on the nutrition facts label, except for one product that reported 2.7 mg/100 g of iron, as can be seen in Table 4**.** The 1st generation meat substitutes had 6 products (12%) containing iron, 2 products (2.1%) containing vitamin B_{12}, and one product (1.1%) containing zinc. The 2nd generation meat substitutes had 19 products (70.4%) containing iron, 17 products (63%) with vitamin B_{12}, and 5 products (18.5%) with zinc. The sodium content varied greatly among products. The highest median (575 mg/100 g product) and intra-variation within category (18 mg/100 g product to 1580 mg/100 g product) was found for 1st generation meat substitutes.

Nutrient profile

In Table 5 we showed product´s adequacy to Brazilian food legislation according to serving size and calorie density RDC nº 360 (Brasil, 2003) and nutrient profile according to RDC nº 429 (Brasil 2020a) and IN nº 75 (Brasil 2020b). Overall, 61.5% (n = 104) of the products were adequate in calorie density and 11.8% (n = 20) were below. High-calorie density was noticed in 4.2% (n=2) of traditional products, 16% (n=15) of 1st generation meat substitutes, and 11.1% (n=3) of 2nd generation meat substitutes. Across all products, 45.5% (n=77) were considered as high content of protein and 31.9% (n=54) as source of protein. All 2nd generation meat substitutes could claim that the products were either source (n=7, 25.9%) or rich (n=20, 74.1%) in protein. Regarding total fat, 11.8% (20) of the products could claim zero content of fat. Low-fat claims were eligible by 18.3% (31) of the overall products, from that 70.9% (22) were traditional products. Overall, we found that products made in traditional style had a lower amount of fat than 2nd generation products. From our results, 77.8% of the 2nd generation products were eligible to make dietary fiber claims as source (74.1%) or as rich in fiber (3.7%). Sodium content was considered high for 6 products of the 1st generation and one traditional product, 2nd generation products amount of sodium was considered adequate. Saturated fat was high in 77.8% of the 2nd generation products, but not on the previous generation products. (Table 5).

Table 5
Adequacy of nutrients per 100g of the product in each stage of technology development according to the Brazilian food legislation (RDC n° 429 and IN n° 75).

	Traditional N=48 (28.4%)	1st Generation N=94 (55.6%)	2nd Generation N=27 (16.0%)
Serving Size			
Low	11 (22.9%)	53 (56.4%)	3 (11.1%)
Adequate	23 (47.9%)	37 (39.4%)	17 (63.0%)
High	14 (29.2%)	4 (4.3%)	7 (25.9%)
Calorie Density			
Low	16 (33.3%)	22 (23.4%)	7 (25.9%)
Adequate	30 (62.5%)	57 (60.6%)	17 (63.0%)
High	2 (4.2%)	15 (16.0%)	3 (11.1%)
Protein			
High Content	5 (10.4%)	52 (55.3%)	20 (74.1%)
Source	15 (31.1%)	32 (34%)	7 (25.9%)
No claims allowed	28 (58.3%)	10 (10.6%)	0
Total fat			
Low	22 (45.8%)	9 (9.6%)	0 (0%)
Zero Content	5 (10.4%)	13 (13.8%)	2 (7.4%)
No claims allowed	21 (43.8%)	72 (76.6%)	25 (92.6%)
Saturated Fat			
Adequate	48 (100%)	94 (100%)	6 (22.2%)
High	0	0	21 (77.8%)
Fiber			
Source	24 (50%)	46 (48.9%)	20 (74.1%)
Rich	11 (22.9%)	26 (27.7%)	1 (3.7%)
No claims allowed	13 (27.1%)	22 (23.4%)	6 (22.2%)
Sodium			
Low	5 (10.4%)	0 (0%)	0 (0%)
Very Low	2 (4.2%)	3 (3.2%)	0 (0%)
No claims allowedHigh	40 (83.3%)1 (2.1%)	85 (90.4%)6 (6.4%)	27 (100%)0
Iron			
Source	1 (2.1%)	1 (1.1%)	11 (40.7%)
Rich	0 (0%)	1 (1.1%)	6 (22.2%)
No claims allowed	0 (0%)	4 (4.3%)	2 (7.4%)
Zero content	47 (97.9%)	88 (93.6%)	8 (29.6%)
B12			
Source	0 (0%)	0 (0%)	4 (14.8%)
Rich	0 (0%)	1 (1.1%)	12 (44.4%)
No claims allowed	0 (0%)	1 (1.1%)	1 (3.7%)
Zero content	48 (100%)	92 (97.9%)	10 (37.0%)
Zinc			
Source	0 (0%)	1 (1.1%)	4 (14.8%)
Rich	0 (0%)	0 (0%)	1 (3.7%)
Zero content	48 (100%)	93 (98.9%)	22 (81.5%)

For detailed explanation of categories check details on Table 1 Nutrition claims and cutoff points used to classify meat substitutes products according to the Brazilian food legislation (RDC n° 429 and IN n° 75) are show on Table 2.

Source for proteinaceous ingredients

Fig. 1 shows that soy protein was the most common protein ingredient (41%) in a variety of forms, such as soy extract, concentrated soy protein, hydrolyzed soy protein, and isolated soy protein. Gluten was the second most common protein ingredient (19%). Pulses (whole grain and flour) such as chickpeas, lentils, black-eyed beans, black beans, and white beans were present in 13% of the products. Ingredients derived from peas amounted to 7% of the protein ingredients. Unspecified vegetable protein responded for 8% of protein ingredients as vegetable protein, micronized protein, or hydrolyzed protein.

Wheat flour or bulgur was the most common carbohydrate source. Vegetables (carrots, pumpkin, zucchini, aubergine, kale, beetroot, corn, and green jackfruit) were present in 19% of the products. Products containing some sort of sugar (sugar, crystallized sugar, brown sugar, muscovado sugar, glucose syrup, xylose, maltodextrin, dextrose) amounted to 12%. Few products used vegetable fiber (8%). Among those, it was noteworthy the use of cashew fiber, from a typical Brazilian fruit.

Considering fat sources, soybean oil (18%), and other vegetable oils (vegetable oil- 22%; sunflower oil-10%, olive oil- 9%) were the most common sources. Saturated fat sources such as coconut oil and palm oil were found in 8% of the products. Nuts of native Brazilian plants such as Brazil nuts and cashew nuts were also used. Other seeds and nuts found were sesame seeds, sunflower seeds and almonds.

Concerning food additives, 55 of 169 products (32.5%) did not have any food additives. Flavorings were the most frequently used food additives in 41% of products, followed by thickeners and vegetable gums (26%). The flavor enhancer monosodium glutamate was found in 4 products. Other ingredients found were natural seasonings, salt, soy sauce, and minerals and vitamins. Coloring agents were found in 13% of the products. Antioxidants as citric acid and ascorbic acid were found in 6% of products. The sweetener referred to in the ingredients list was sorbitol (6% of products).

Discussion

Practically all plant proteins could be used in the preparation of meat substitutes. However, due to availability, cost, and processing functionality, soy protein, pea protein, and wheat gluten are usually used as the basis for structuring meat substitutes (Schreuders et al., 2019). The vast use of the same protein source might be implicated with some issues, like allergenicity of vegetable proteins and rejection of one or more ingredients (Rubio et al., 2020). Gluten triggers adverse reactions in those with gluten intolerance, wheat allergy, and celiac disease Curtain and Grafe-

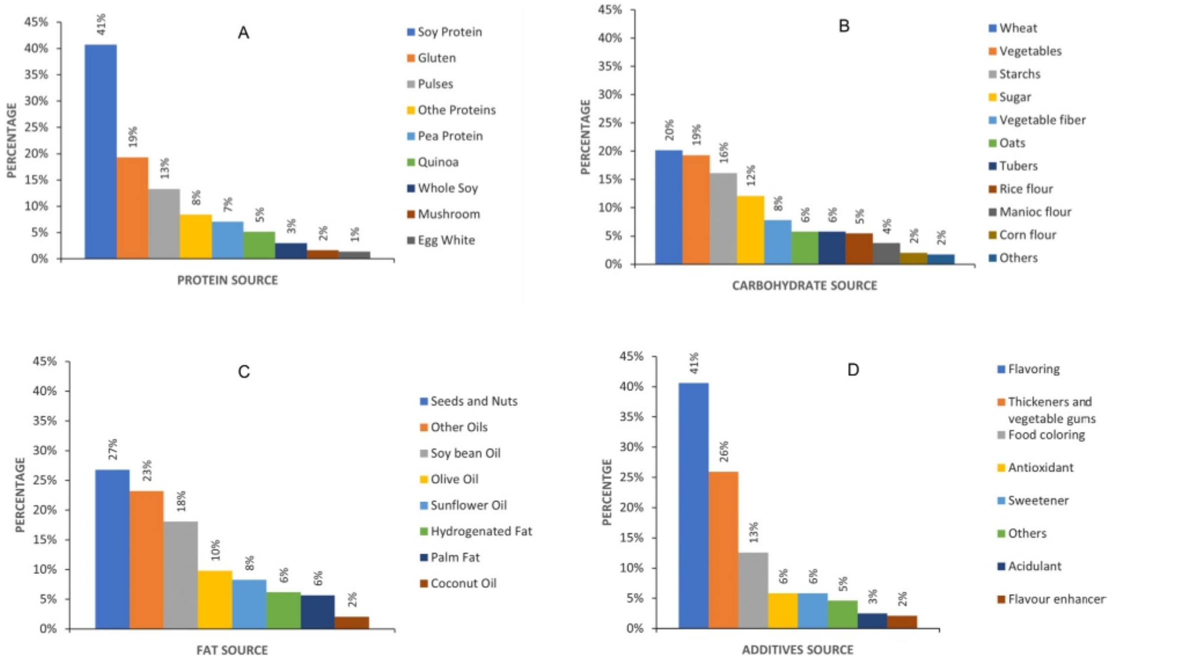

Figure 1. Percentage of ingredients used in the formulation of meat substitutes divided by source of proteins (A), carbohydrates (B), fat (C), and additives (D). Fig. 1 should be printed in color

nauer (2019). found a more diverse protein profile among the products they analyzed with more than two-thirds of the products containing some sort of legume ingredients such as adzuki beans, black beans, chickpeas, and lentils.

The variation of protein content could raise concerns if meat substitutes can be claimed as a meat replacement. While meat mainly consists of protein, fat, and water, plant materials have a much richer and diverse nutrient composition. Clearly, the presence of other components leads to lower protein content (Fasolin et al., 2019). Processing can be used to remove the other components (e.g., to produce protein isolates), but conventional processes require large amounts of energy and water thereby compromising the environmental potential of meat substitutes (Van Der Goot et al., 2016). In addition, the use of highly refined protein ingredients results in a final product without the benefit of health promotion nutrients such as vitamins, minerals, fibers, antioxidants, and anti-inflammatory agents, that otherwise could have a positive effect on consumers' health (Fasolin et al., 2019).

Besides, the origin for the apprehension about a too low protein intake in plant-based diets is difficult to identify given that vegetarian populations in western countries are not known for protein deficiencies (Mariotti and Gardner, 2019). According to the Academy of Nutrition and Dietetics (Melina et al., 2016), plant-based diets supply all necessary nutrients for growth and maintenance in all stages of life. Cohort studies demonstrate that protein intake among vegans, vegetarians and semi-vegetarians in the western population is sufficient to meet individual daily requirements, provided energy intake needs are being met (Mariotti and Gardner, 2019). Protein-rich foods, such as legumes, nuts, and seeds, are sufficient to achieve protein adequacy in adults consuming vegetarian/vegan diets (Mariotti and Gardner, 2019). Indeed, the Vegetarian Lifestyle Index (Le et al., 2018) based on the Loma Linda University-Vegetarian Food Guide Pyramid Recommendations (Haddad et al., 1999) considered in the same index component legumes, soy, and meat substitutes. Therefore, meat substitute's protein content are expected to be equivalent to the legume´s protein content that originated them, and not similar to meat protein content. Nevertheless, it seems that 2nd generation producers are finding a route to offer meat substitutes that contain higher levels of protein, seeking similarity to the quantities found in meat.

The median amount of carbohydrates became lower with the advanced stages of technology, from traditional products towards 2nd generation products. Teri Lichstein (2020) observed that traditional meat alternatives (18.8 g/100 g) had higher average carbohydrate content than plant-based meat (10.2 g/100 g). Most of the carbohydrates source ingredients are used as thickening agents, contribute to texture and consistency, reduces syneresis, emulsifies oils, binds water, immobilizes fat, and improves rheology. They can also be present as a result of the use of less processed ingredients, such as protein concentrates (Kyriakopoulou, Keppler, and Van Der Goot, 2021).

The 2nd generation meat substitutes had a higher amount of total fat and saturated fat than the other products. Fat is an essential component of palatability as it contributes to the juiciness and tenderness of the products (Kyriakopoulou, Keppler, and Van Der Goot, 2021). Also, 2nd generation products that aim to mimic the marbled effect of meat, exhibit visible semi-solid vegetable fats like coconut oil and cocoa butter which are rich in saturated fat (Rubio et al., 2020). However, the high saturated fat amount is one of the biggest criticisms that these products have been facing (Bohrer, 2019). Enhanced intake of saturated fat has been associated with increased risk of cardiovascular disease mortality and incidence of type 2 diabetes (Rocha et al., 2019).

Fibers are non-digestible carbohydrates (Makki et al., 2018), which are present at low levels in meat-based diets (Curtain and Grafenauer, 2019). They interact directly with gut microbiota leading to the production of short-chain fatty acids and regulating gut microbial ecology that impacts host physiology (Makki et al., 2018). As dietary fibers are found exclusively in plants and are not present in meat, the inclusion of meat substitutes in the diet might be considered as an opportunity for consumers to increase their dietary fiber intake (Lichstein, 2020). The median value of dietary fiber did not vary significantly among categories Curtain and Grafenauer (2019). described similar dietary fiber content in meat substitutes available in the Australian market

Fresán et al (2019). found a significant difference between products made of wheat (1.35 g/100 g), soy (6.35 g/100 g), or nuts (3.01 g/100 g). However, it should be noted that processing may reduce the dietary fiber content in protein ingredients from soy and pulse sources (Boukid, 2021). In other words, the ratio protein-fibers in the final product can be controlled by choosing the degree of refined ingredients in the product. The optimal ratio will depend on the actual consumer. Consumers that still eat meat might benefit from meat substitutes high in fibers, while vegan consumers might need a higher protein content. For the latter group, also some micronutrients might be a concern, such as omega-3 fatty acids, vitamin D, vitamin B_{12}, iron, calcium, and zinc (Rocha et al., 2019).

Meat is a good source of vitamin B_{12} whose source is restricted to animal food origin (Bohrer, 2019) Pawlak et al. (2014). studied the prevalence of vitamin B_{12} deficiency among individuals adhering to vegetarian diets and demonstrated that deficiency ranged from 0% to 86.5% among adults and elderly, up to 45% in infants, from 0% to 33.3% in children and adolescents, and from 17% to 39% among pregnant women. Those results demonstrate the urgency vegetarians have of Vitamin B_{12} food sources. Fortifying meat substitutes with vitamin B_{12} might help vegetarian consumers reach their recommended daily intake (Lichstein, 2020). However, the addition of micronutrients poses manufacturers with a dilemma. It is likely that vegan consumers will have limited meat substitutes in their diets anyhow. For flexitarian consumers that replace only part of their meat consumption with meat substitutes, food fortification is less critical. Fortification leads to additional ingredient costs and longer ingredient lists, which are both not appreciated by consumers (Kyriakopoulou, Keppler, and Van Der Goot, 2021). Besides, those products will be mostly used by consumers that still use animal-based product, which might explain why manufacturers are reluctant to fortify their products.

According to the World Health Organization (World Health Organization. 2012), sodium intake should be limited to 2 g per day. The products investigated provided a median value of 23.9% of the recommendation of sodium intake per day. If we consider that in a day, consumers will eat other foods containing sodium, most probably their sodium intake will be higher than recommendation. It was estimated that Brazilian adults consume an average of 3.7 g of sodium per day and that 97.6% of adults consume over the WHO recommendation (Mill et al., 2021). In Brazil, salt added to foods and industrialized products are considered the main dietary sources of sodium, according to the national food acquisition surveys (Sarno et al., 2013). Besides its role as a flavor enhancer and preservative, salt is created during the fractionation process of plant proteins and sometimes added before the structuring process, which leads to the solubilization and unfolding of the protein affecting its structuring potential (Kyriakopoulou, Keppler, and Van Der Goot, 2021). This multi-purpose properties of salt explain the difficulties of lowering it in those food products and all foods (e.g., bread) in general. Nevertheless, excessive sodium intake is associated with increased blood pressure and risk of cardiovascular diseases (Mill et al., 2021), and the industry has long been called to reduce sodium content from its products (World Health Organization, 2014). In Brazil, many voluntary agreements have already been made in this way (Sarno et al., 2013). Regarding the nutrient profile of the products, 2nd generation meat substitutes presented a high percentage of products above the limit for saturated fat (77.8%), while1st generation products and traditional products were adequate. As for sodium, 6.4% of 1st generation products were above maximum limit while 2nd generation products and all but one traditional product were within the acceptable range for sodium. Other studies had similar findings, as Curtain et al (2019) found that only 4% of the products could claim to be low in sodium.

A point that may raise concern among consumers is genetically modified organisms (GMO) crops (Boukid, 2021). Research on consumers preference among Brazilians identified that 22% expect meat substitutes to be non-GMO and 6% not to have soy (GFI, 2020). Soy production in Brazil is associated with deforestation, indiscriminate use of pesticides, contamination of watercourses, and loss of biodiversity (De Castro Lima et al., 2020; Zu Ermgassen et al., 2020). Future demands may result in products based on protein sources that do not require excessive processing (Boukid, 2021), and make use of locally produced native crops, encouraging local development and diminishing the environmental impact of food production (Rubio et al., 2020).

Another point that may raise concern to consumers is the use of food additives. Indeed, recent research associates the consumption of different classes of food additives with negative health impacts such as dysbiosis, thyroid damage, hyperactivity, and even carcinogenic activity (N Kumar et al., 2019.). Much of the recognized flavor of dishes in western diets derive from animal fat (Sha and Xiong, 2020). Hence, artificial meaty flavor has been developed to meet consumer‘s expectations about the taste of meat substitutes. Artificial flavor is also used to mask aftertaste, and the beany and bitter flavors commonly found in TVP and pea protein (P Kumar et al., 2017.). Another commonly used additive, monosodium glutamate, is known to give the umami flavor (Yamaguchi and Ninomiya, 2000). However, its use as a food additive is controversial. Many producers avoid the use of it or replace it with ingredients that naturally contain glutamates (Lichstein, 2020) such as mushrooms and soy sauce, a rich source of umami flavor (Yamaguchi and Ninomiya, 2000). Coloring agents are used to mimic the meat red color or chicken color (Boukid, 2021). Some companies used artificial colorings such as yellow tartrazine and ponceau 4R, which are positively associated with allergic reactions and carcinogenic activity, while other companies used natural coloring agents such as beet juice extract and tomato extract (N Kumar et al., 2019.). An alternative to improve the flavor in meat substitutes without food additives is the employment of different herbs and spices, including those also used in meat processing (Sha and Xiong, 2020).

Health considerations

Many criticisms considering 2nd generation meat substitutes are in relation to the use of highly processed ingredients (Lichstein, 2020). “Ultra-processed foods (UFP) are defined by the NOVA classification of food as

“……industrial formulations typically with five or more and usually many ingredients… Substances only found in ultra-processed products include some directly extracted from foods, such as casein, lactose, whey, and gluten, and some derived from further processing of food constituents, such as hydrogenated or interesterified oils, hydrolyzed proteins, soy protein isolate, maltodextrin, inverted sugar and high fructose corn syrup. Classes of additive only found in ultra-processed products include dyes and other colors, color stabilizers, flavors, flavor enhancers, non-sugar sweeteners, and processing aids such as carbonating, firming, bulking and anti-bulking, de-foaming, anti-caking and glazing agents, emulsifiers, sequestrants and humectants. Several industrial processes with no domestic equivalents are used in the manufacture of ultra-processed products, such as extrusion and moulding, and pre-processing for frying. (Monteiro et al, 2018; Monteiro et al, 2019).

The consumption of UPF has been associated with higher energy intake, adiposity, and at a population level, higher prevalence of obesity in recent observational data (Lawrence and Baker, 2019). The mechanisms proposed for these health associations are that UPF are energy-dense, high in unhealthy types of fat, refined starches, free sugars and salt, and poor sources of protein, dietary fiber, and micronutrients (Monteiro et al., 2018, 2019).

NOVA considers textured and isolated proteins, and gluten as industrial formulations. Therefore, all meat substitutes of the 1st and 2nd generation are ranked as UPF. Still, they do not present many of the negative characteristics of UPF. As seen by our results, calorie density was adequate or below the recommended for 90% of the products. Adequate calorie density is crucial in moderating daily energy intake (Forde et al., 2020) Rolls (2009). demonstrated through a series of designed test meals that energy-dense foods and diets promote greater energy intake and in-

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APÊNDICE 2 MANUSCRITO ANALYSIS OF INGREDIENT LIST AND NUTRIENT COMPOSITION OF PLANT-BASED BURGERS AVAILABLE IN THE GLOBAL MARKET

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RESEARCH ARTICLE

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Analysis of ingredient list and nutrient composition of plant-based burgers available in the global market

Paula Franca[a], Anna Paola Pierucci[a] and Fatma Boukid[b]

[a]Instituto de Nutrição Josué de Castro, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil; [b]ClonBio Group Ltd, Dublin, Ireland

ABSTRACT

The nutrient composition of plant-based burgers is a key factor when making their purchase/consumption decision to maintain a balanced diet. For this reason, ingredient list and nutritional information of burgers launched in the global market were retrieved from their labels. Products were classified based on the technology development, market position and region of the manufacturer. From the ingredient analysis, we observed a high heterogeneity in the ingredients used, a predominance of soy and wheat as main sources of proteins, and the increasing use of new protein sources (e.g. peas, other types of beans and pseudo-cereals). Oil was the most cited ingredient followed by salt. Nutritional composition varied mainly depending on the region with no clear pattern among countries. To less extent, technology development resulted in traditional products with lower amounts of protein and higher amounts of carbohydrates. Vegan and vegetarian products showed limited differences due to the high intra-heterogenicity.

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Introduction

The first historical reports of meat substitutes date back to 2,000 years ago with the discovery of tofu. Since then, tofu and fermented soy have been used in Asian countries to guarantee protein intake for the population with low access to animal proteins (Rödl 2019; Nolden and Forde 2023). Recently, due to the urgency of global warming, meat substitutes emerged as an important option to ensure sufficient protein intake (Dagevos and Voordouw 2013) at a low environmental cost, as demonstrated by life cycle studies of plant-based meat chicken (Rubio et al. 2020; Mejia et al. 2020). Meat substitutes are gradually moving from niche to mainstream products (Birke Rune et al. 2022) and promise a revolution in the way protein is ingested (van der Weele et al. 2019) to keep food consumption within environmental boundaries (Willett et al. 2019).

Meat substitutes are available in different formats such as sausages, meatballs, and burgers (Boukid 2021). Among these, hamburger-style products are a popular category responsible for a large part of this market. The plant-based burger market is projected to witness exponential growth from a valuation of US$5.1 billion in 2023 to US$23.2 billion by 2033. Beyond Meat, Impossible Foods, Kellogg Co., and Conagra Brands are among the leading producers of plant-based burgers (Plant-Based Burger Market Size, Share, Trend by 2023 | FMI). The plant-based burger market can be divided into two main categories namely vegan and vegetarian.

Vegan burgers are made using a large array of plant-based ingredients having different nutritional, molecular and physicochemical properties compared to animal-based ingredients (Curtain and Grafenauer 2019). Fat component is usually replaced by vegetable oils/fats or blends of fibres-based emulsions. With focus on protein ingredients, animal protein has unique functional, sensory, and nutritional characteristics and the replacement of animal protein by vegetable protein often requires the combination of various ingredients and different processing techniques to achieve the taste, flavour, and mouthfeel of foods from animal origin (Tziva et al. 2020). Plant proteins can be added in different forms, i.e. isolates, concentrates and/or textured. Textured proteins come in two main types. Low moisture textured proteins are obtained from extruding plant proteins to shift their texture from a globular to a fibrous structure. These dry extrudates have a long history of use to mimic

CONTACT Anna Paola Pierucci pierucci@nutricao.ufrj.br Instituto de Nutrição Josué de Castro, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil

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the texture of ground meat. High moisture textured proteins, however, are mostly used to create a meat-like cut (Baune et al. 2022). Even though soy protein and wheat gluten remain the dominant ingredients in the production of meat analogues, emerging protein sources such as peas, mung bean, chickpeas and fungi are also being used (Boukid 2021).

On the other hand, the formulation of vegetarian burgers contains ingredients derived from milk or eggs. These products might have an improved texture and/or protein quality compared to vegan products. However, products made of eggs and dairy ingredients have a more significant environmental impact than 100% plant-based products (Fresán et al. 2019). Until now, few studies compared the environmental impact of vegan versus vegetarian meat substitutes. A study (Fresán et al. 2019) found that greenhouse gas emissions of products containing eggs were significantly higher than strict plant-based products. In a review (Nijdam et al. 2012) focused on the life cycle assessments of 52 animal and vegetal protein sources, carbon emissions per kilogram product and per kilogram of protein were approximately twice as high for products containing egg or milk when compared to plant-based products.

Nutritionally, to the authors' knowledge, most studies compared plant-based products to animal-based products, and less focus was attributed to comparing vegan to vegetarian. A recent study investigated the nutritional profile of commercial vegan and vegetarian burgers (Boukid et al. 2021). They found that vegan burgers had higher levels of energy, fat, saturated fatty acids (SFA) and protein compared to vegetarian burgers. Nevertheless, this study was geographically focused on the European market. Considering the expansion of vegan and vegetarian burgers in the global market and its increasing consumption among the flexitarian population, it is important to know how these products behave in terms of nutritional characteristics, ingredients, and market positioning, to better understand their role in human nutrition.

In this light, this work aimed to evaluate if vegan burgers can be considered more nutritionally equilibrated than vegetarian products. For this reason, a market search of plant-based burgers sold in the global market was conducted to retrieve and analyse the ingredients list and nutritional facts. The retrieved products were classified using three criteria, stage of technology development (i.e. generations), region and market position (vegan or vegetarian). Overall, this article offers a descriptive overview of the market landscape, emphasising the nutritional differences within these categories over time. This information provides readers with a comprehensive understanding of the market dynamics and emerging trends, contributing to a broader perspective on the evolving consumer preferences and industry developments within the plant-based food sector.

Material and methods

Data collection

Data on the nutrient content and ingredients list of burger meat substitutes available globally were obtained from Mintel Global New Products Database (Mintel GNPD, London, UK, (https://portal.mintel.com/portal/). Mintel is a global market intelligence agency expert in consumer research and marketing solutions. Mintel GNPD database provides detailed information on products launched every year globally in various product categories. The Mintel GNPD tracks packaged food and beverage launches in 86 markets worldwide. The search was conducted on May 13th, 2022, using these search parameters:

- Date: January 1st, 1998 – May 13th, 2022
- Category: Food
- Sub-Category: Meat Substitutes
- Nutrition: energy, carbohydrates, sugar, protein, fat, SFA, fibre, sodium
- Region: global

The search retrieved 3218 products, after applying the keywords burger, hamburger, patty or patties and discarding products with missing ingredient list and/or nutritional information, the final sample was composed of 807 products. The selected products were organised by year of launches from September 1998 to May 2022.

Information related to the products including nutritional composition, list of ingredients, and country were retrieved. The results of the search were exported to Microsoft Excel (Microsoft Office, Washington, WA, USA).

Stage of technology development

Products were classified according to the stage of technology development as proposed by Penna Franca et al. (2022), with some modifications. Briefly, in this classification, products are stratified into Traditional, First-generation meat substitutes or Second-generation meat substitutes, according to the technology applied by the manufacturer, the ingredients applied and the market share. Traditional products are those that first appeared on the market, intended for the general public and produced in a homemade style like homemade lentils or beans patties (Lichstein 2020; Tziva et al. 2020). The First-generation meat substitutes employ low moisture cooking extrusion, use texturised proteins and wheat gluten, and are oriented to the vegetarian/vegan market, examples of First-generation products are burgers made with low moisture textured soy protein. Second-generation products, caused a revolution in the market by proposing products similar in taste, texture and flavour to animal-based meat (He et al. 2020), like vegetable burgers that have a similar mouthfeel and bleed as meat burgers (Penna Franca et al. 2022). Applying other technologies such as high moisture cooking extrusion and fermentation, employing novel protein sources and protein isolates and concentrates. Second generation products are not restricted to the vegetarian market, aiming at flexitarians and anyone who intends to minimise their meat consumption (GFI 2020; He et al. 2020; Penna Franca et al. 2022).

To classify the products as the First and Second-generation meat substitutes it would be necessary to contact the manufacturers to define which technology was used in the elaboration of their products. Therefore, a simplified classification was applied, differentiating only the traditional products from the latter (First-Generation meat-substitutes and Second-generation meat-substitutes) which were classified in this study together as Generation Products.

Market position

Based on the list of the ingredients, the collected products were classified into vegan and vegetarian products (containing animal derivates, Table S1).

Region

Based on the information on the label, the collected products were affiliated to the location of the manufacturer.

Ingredient stratification and analysis

Considering the wide variety of ingredients used in the formulations of the studied products, grouping criteria were defined for naming them to allow an analysis of the frequency of words. The complete classification can be seen in Table S2.

The ingredients were grouped according to their chemical composition, botanical composition, or according to their main food matrix and level of processing, following the criteria below.

1. Varieties of the same ingredient were replaced by a single culinary ingredient. Example: basmati rice, long grain white rice, black rice, brown rice, wild rice, were replaced by rice.
2. The parts of a given ingredient were replaced by the original ingredient independently of extension of technological processing: example: egg white, egg yolk and whole egg were replaced by egg; lemon juice, lemon zest, lemon extract were replaced by lemon.
3. Methods of preparation, cooking or manufacturing were classified as the food of origin. Example: onions appeared in a wide variety of forms; onion powder, sautéed onion, onion flakes, roasted onion, cooked onion, dried onion. All replaced with onion.
4. Each legume species was grouped according to its main food matrix. Culinary ingredients (wholegrain legumes or flour) were classified separately than processed ingredients (extruded, isolated or purified protein ingredients). Example: texturised soy protein was classified as soy protein. Soybean (wholegrain culinary ingredient) was classified as soybean; isolated fava bean protein was classified as fava bean protein and cooked fava bean as fava bean (wholegrain culinary ingredient).
5. All varieties of vegetable oils were classified as oil except for olive oil (olive oil, extra virgin olive oil, virgin olive oil) due to the unique nutritional characteristics of this food.
6. Foods that have a nutritional composition very similar were grouped according to their chemical composition:

a. butter (ghee, butter, no salt butter, organic butter).
b. vegetable fat (hydrogenated fat, vegetable fat, palm fat, cocoa butter).
c. nuts (almonds, walnuts, pecan nuts, pine nuts, cashew nuts, chestnut, macadamia nuts, Brazil nuts, pistachio nuts).
d. seeds (sunflower seeds, sesame seeds hemp seeds, nigella, organic ground raw seeds, whole sesame, pumpkin seeds, chia seeds, poppy seeds, tahini).
e. sugar (coconut sugar, brown sugar, washed raw sugar, agave syrup powder).

6. Ingredients commonly used as spices were grouped together as spices (cinnamon, cumin, vanilla, mace, cardamon, nutmeg, cloves, allspice, caraway, fennel), except for the different types of pepper (black, white, chilli, ground, powder, etc.) which were classified as pepper. Salt, curry, and turmeric remained by themselves since they appeared frequently (FAO 2005).
7. Greens, vegetables, and fruits that appeared repeatedly kept their names separately (example: onion, garlic, pumpkin, carrot, zucchini). Those that appeared less than 5 times were grouped according to the botanical group: greens, herbs, fruits and vegetables.
8. Ingredients composed of several ingredients (cheese, soy sauce, breadcrumbs, ketchup, mustard sauce, vegan cheese, nuts milk, vegetable stock, tamari sauce) were replaced by the ready ingredient.
9. Additives: Additives were grouped according to their Functional Classes stated at the Codex Alimentarius (FAO, 2021): yeasts, emulsifiers, flavouring, colour, sweetener, acidity regulator; except for nutritional yeast, potassium chloride which remained by itself as it was used in many of the products. Additives that have a different function from the above ones were classified as additives.
10. Industrial ingredients: plant fibres from different sources (ex: bamboo fibre, wheat fibre, citrus fibre) and starches from different sources (ex: rice starch, tapioca starch, cornstarch, etc.) were replaced for plant fibre and starch.

Data extraction

Nutritional facts related to energy (kcal/100 g), total fat (g/100 g), saturated fatty acids-SFA (g/100 g), carbohydrates (g/100 g), sugars (g/100 g), protein (g/100 g), fibre (g/100 g), and sodium (mg/100 g) were retrieved.

Statistical analysis

The statistical analysis was carried out using the Statistical Package for Social Sciences software (IBM SPSS Statistics, Version 25.0, IBM corp., Chicago, IL, USA). Multivariate analysis of variance (MANOVA) was used to determine the effects of technology development stage, region, and market position of the retrieved burgers on the nutritional composition of burgers. MANOVA was performed based on fixed factors using Pillai's trace test. The percentages of total variations were computed to determine the contribution of the factors and their interactions in the variance of each parameter. The percentage of total variation was computed to explain the variance of each parameter as a function of the sum squares of the main factors and their interaction. Significant differences among the mean values were analysed using Mann–Whitney non-parametric test ($p < 0.05$) for two independent samples. A principal component analysis (PCA) was performed based on the correlation matrix. For visual representation of the ingredients, WordClouds® 2022 was used.

Results

Market trend

From 2012 the number of launches increased, with 11.69% of all plant-based burger products launched, this number is due to the large number of vegan burgers launched that year (80 in total). As illustrated in Figure 1(a), traditional products peaked in 2013 (37 products launched), and then the number of launches per year decreased. Despite all the technological development for ingredients and formulations to deliver products that taste and have a similar mouthfeel to meat, traditional products continue to be launched every year. Vegan and vegetarian product launches (Figure 1(b)) followed similar trend with two main peaks in 2013 and 2020. Vegan products were predominant in term of number of launches compared to those vegetarians.

Ingredient analysis

Word extraction yielded 1472 words that were assembled according to previously explained classification (2.3) which resulted in 205 ingredients.

Graphic representation of the most used ingredients can be seen in Figure 2. Oil was the most cited ingredient (975), followed by salt (841). Salt is universally used as a seasoning and as a food additive (Taladrid et al. 2020). Natural seasoning and bioactive compounds are also common ingredients in making plant-based burgers. The third most used ingredient was onion, and garlic ranked 6th among the ingredients. Whole grains and fibres such as bamboo fibre, wheat fibre, chicory root fibre were also used for functional (i.e. thickening and emulsifying agents) and nutritional features (boost fibre content) (Kyriakopoulou et al. 2021). Additives such as emulsifiers and yeast extract were frequently

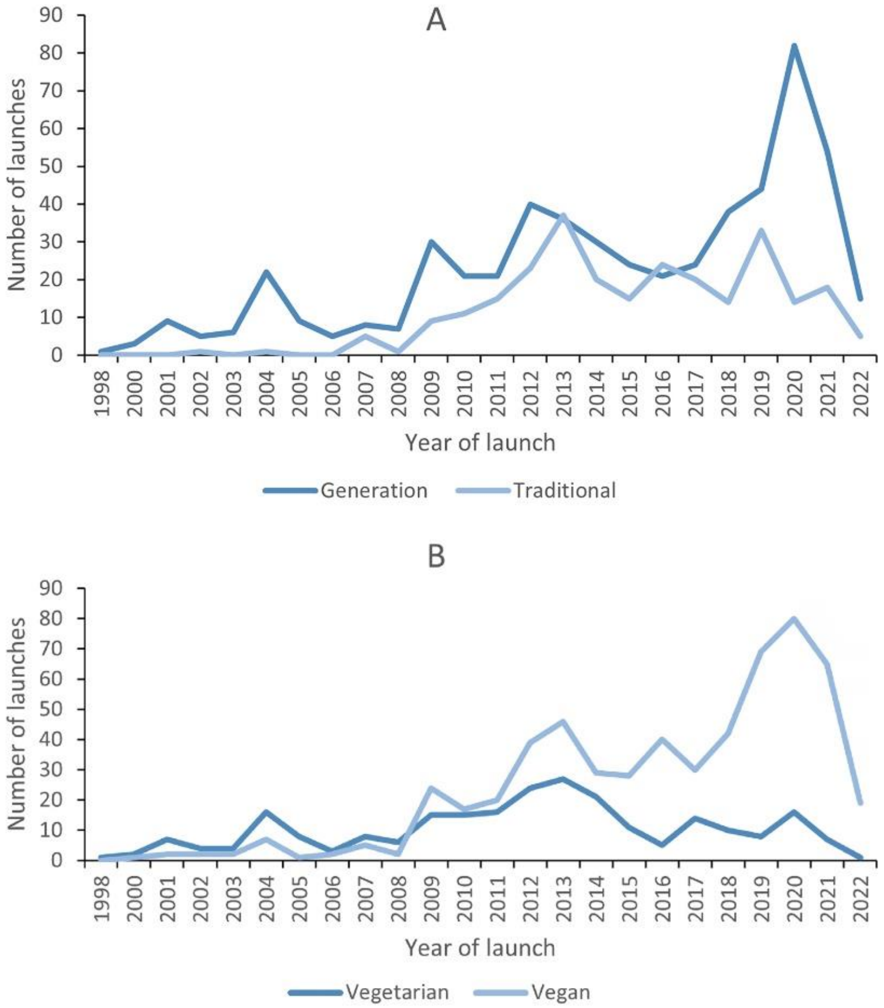

Figure 1. Number of launches per year for (a) generation and traditional products; (b) vegetarian and vegan products.

found on the labels of the retrieved burger products. Milk or dairy products (milk, cheese, cream, buttercream, butter, whey protein) were present in 15% of the products. The word cheese appeared 121 times as some of the products contained as many as four different types of cheese. Vegan cheese was used in six products.

The different protein sources can be seen in Table 1. Protein sources were divided in processed ingredients and culinary ingredients, as explained in 2.3. Processed ingredients refer to isolated, extruded, or purified proteins mainly used by the industry to formulate meat substitutes. Culinary ingredients are part of people's normal diet (Monteiro et al. 2019) and might be used in meat substitutes as a source of plant-based protein. Legumes were the most frequent protein sources. Among the processed ingredients, soy protein was reported on the label of 489 products (41.2%) and pea protein on 116 products (9.77%). Wheat as wheat protein or gluten had a high frequency of use (28.31% out of total products). In the culinary ingredients, there was a greater variability, soy was responsible for 14.75% of the frequency in the group while a diversity of legumes, beans, broad beans, lentils and chickpeas was observed. Wheat as wheat protein or gluten had a high frequency of use (14.83% out of total products). Gluten has a long history of formulating meat alternatives such as seitan. It is currently used as a functional ingredient due to its functionality, such as oil/water binding capacities, viscosity, and swelling (Kyriakopoulou et al. 2021). Additionally, another 5% of the products had wheat flour.

Nutrient composition

The effects of region, technology development and market position on the nutritional composition of meat substitutes are summarised in Table 2. Region is the main factor influencing all the parameters, while technology development stage affected all parameters except energy, fibre, and sugars. Notably, no differences were found in term of market position. Significant interaction between region and technology development was also evidenced, followed by the interaction between region and market position. However, the interaction between technology development stage and market position did not show any effect on the nutritional properties.

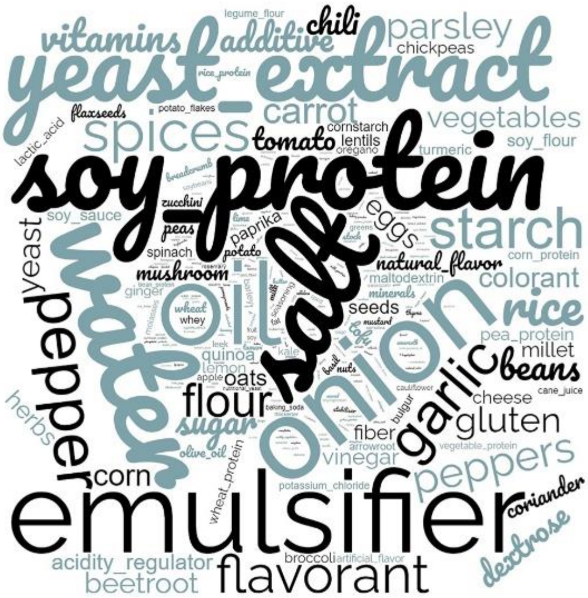

Figure 2. World cloud of the ingredients used in the formulations of the plant-based burgers.

In term of region, Table 3 shows that the retrieved plant-based burgers are sold in 45 countries. USA holds the largest of marketed plant-based burgers followed by Canada. Based on a recent market report, USA holds the largest share of the plant-base burger market followed by Canada (Plant-Based Burger Market Size, Share, Trend by 2023 | FMI). For a better understanding of the impact of region on the nutritional composition, principal components analysis was used for data reduction. The first three principal components explained a total of variability of 69% (Figure 3). Component 1 accounted for 29%, and it is explained by fat, energy, and saturated fat, whereas component 2 accounted for 24% and is explained as a function of carbohydrates, fibre, and sugar. Component 3 accounted for 16% as a function of protein and sodium. The loading plot showed that no clustering was possible as a function of countries.

Table 1. Frequency of protein ingredients used in the formulations of the plant-based burgers, according to the process level.

Food group/protein ingredient	Frequency	%	Food group/protein ingredient	Frequency	%
Processed ingredients			Culinary ingredients		
Animal based protein	**49**	**4%**	**Animal based protein**	**311**	**28.85%**
Milk	49	4%	Cheese	121	11.22%
			Eggs	190	17.63%
Cereal	**417**	**35%**	**Cereal**	**90**	**8.35%**
Corn	44	3.71%	Wheat	90	8.35%
Rice	37	3.12%			
Wheat	336	28.31%			
Legume	**629**	**52.99%**	**Legume**	**493**	**45.72%**
Soy	489	41.2%	Soy	159	14.75%
Pea	116	9.77%	Beans**	123	11.4%
Mung bean	17	1.43%	Chickpeas	78	7.24%
Fava bean*	7	0.59%	Pea	70	6.49%
			Lentils	53	4.92%
			Legume flour***	10	0.92%
Mycoprotein	**14**	**1.18%**	**Nuts**	**38**	**3.53%**
Mycoprotein	14	1.18%	Nuts	38	3.53%
Vegetable protein	**63**	**5.31%**	**Vegetable protein**	**6**	**0.56%**
Vegetable protein	63	5.31%	Vegan cheese	6	0.56%
Pseudo-cereals	**4**	**0.34%**	**Pseudo-cereals**	**140**	**12.99%**
Quinoa	2	0.17%	Amaranth	18	1.67%
Chia	2	0.17%	Quinoa	122	11.32%
Seeds	**5**	**0.42%**			
Hemp	4	0.34%			
Sunflower	1	0.08%			
Tubers	**6**	**0.51%**			
Potato	6	0.51%			
Total	**1187**	**100%**	**Total**	**1078**	**100%**

*Fava bean: fava bean and broad bean; **Beans: Adzuki beans, Beans, Black beans, Black eyed bean, Cranberry bean, Kidney beans, Lima bean, Pinto beans, Red beans, Split moong beans, white beans; ***Legume flour: Black bean flour, Fava flour, Mesquite powder, Navy bean flour.

Table 2. Multivariate analysis of the nutritional composition.

	Region		Technology development stage		Market position		Region × Technology development stage		Region × Market position		Technology development stage × Market position		Region × Technology development stage × Market position	
	%SS	Sig.	%SS	Sig.	%SS	Sig.	%SS	Sig.	%SS	Sig.	%SS	Sig.	%SS	Sig.
Energy (kcal/100 g)	49.07	***	1.29	ns	0.75	ns	29.19	***	8.02	ns	0.20	ns	11.49	*
Fat (g/100 g)	49.00	**	6.45	***	0.83	ns	25.47	*	10.53	ns	0.72	ns	7.00	ns
Saturated Fat (g/100 g)	58.21	***	2.46	ns	0.20	ns	15.72	ns	17.74	ns	0.19	ns	5.48	ns
Sodium (mg/100 g)	40.69	***	9.33	***	0.40	ns	18.39	***	13.20	***	0.68	ns	17.32	***
Carbohydrates (g/100 g)	49.03	***	12.75	***	0.85	ns	16.38	*	14.81	ns	0.02	ns	6.15	ns
Fibre (g/100 g)	33.84	***	0.14	ns	1.19	ns	35.18	***	15.93	***	0.25	ns	13.48	***
Sugars (g/100 g)	46.49	***	0.51	ns	0.25	ns	17.30	***	28.11	***	0.39	ns	6.95	ns
Protein (g/100 g)	29.88	**	35.86	***	0.81	ns	12.60	***	11.12	ns	0.21	ns	9.52	*

ns: not significant; *$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$; SS: sum of squares: Sig.: significance.

Table 3. Regions selling plant-based burgers.

Countries	N	%	Countries	N	%	Countries	N	%
USA	324	40.1%	Peru	9	1.1%	South Africa	3	0.4%
Canada	119	14.7%	Belgium	8	1.0%	Costa Rica	3	0.4%
UK	34	4.2%	Sweden	7	0.9%	Czech Republic	2	0.2%
France	28	3.5%	Finland	6	0.7%	Denmark	2	0.2%
Italy	26	3.2%	Malaysia	6	0.7%	Ecuador	2	0.2%
Colombia	22	2.7%	New Zealand	6	0.7%	India	2	0.2%
Germany	22	2.7%	Thailand	6	0.7%	Taiwan, China	2	0.2%
Mexico	22	2.7%	Hong Kong, China	5	0.6%	UAE	2	0.2%
Australia	21	2.6%	Philippines	4	0.5%	Cambodia	1	0.1%
Israel	17	2.1%	Puerto Rico	4	0.5%	Greece	1	0.1%
Chile	16	2.0%	South Korea	4	0.5%	Kenya	1	0.1%
Netherlands	16	2.0%	Indonesia	3	0.4%	Laos	1	0.1%
Spain	16	2.0%	Ireland	3	0.4%	Morocco	1	0.1%
Austria	12	1.5%	Portugal	3	0.4%	Qatar	1	0.1%
Argentina	10	1.2%	Singapore	3	0.4%	Switzerland	1	0.1%

N: number of products, %: percentage of products out of total.

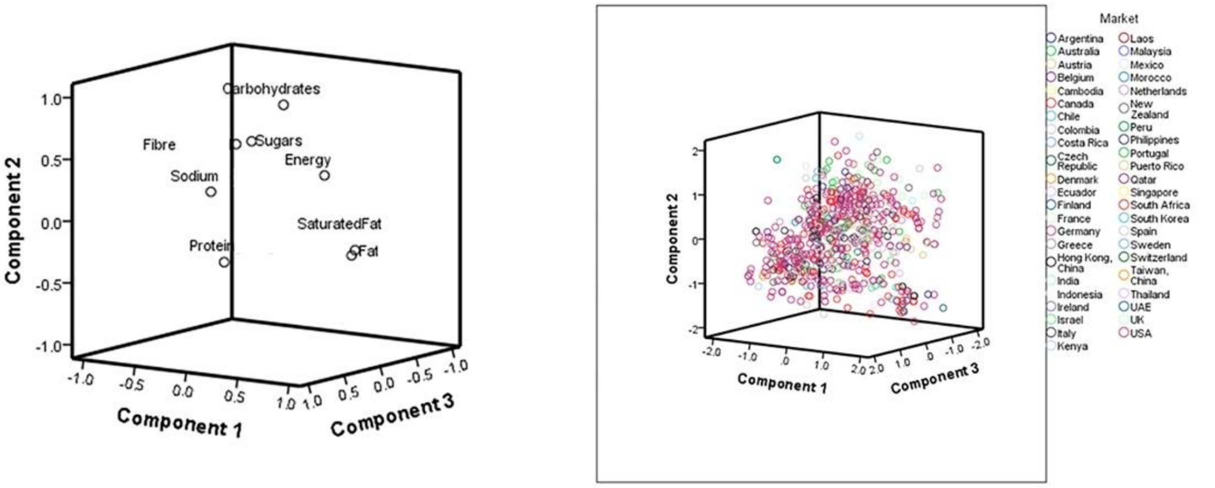

Figure 3. Principal components analysis of the nutritional composition of the retrieved plant-based burgers sold in the global market. (a) Loading plot of the first three components (component 1, 2 and 3); (b) score plots of countries projected on the factorial space.

Out of the total ($n=807$), most of the products (68%, $n=544$) belong to generation products while the traditional products represent almost one third of the market share (32%, $n=262$). A high intra-variability was noticed between traditional and generation products (Figure 4). No significant differences were found between traditional and generation products in terms of energy, SFA, and sugar. The traditional products showed the lowest fat content. Although, statistically, SFA resulted similar between them. The generation products showed high range of variability, where the maximum values reached (12 g/100g) compared to the maximum of traditional products (8 g/100g).

Sodium was found higher in the generation products compared to the traditional products. The traditional products showed higher total carbohydrates and lower fibre than the generation products. Sugar was found statistically the same in both groups. The generation products of plant-based burgers showed higher protein content than the traditional products.

Out of the total ($n=807$), vegetarian products represent 30% ($n=241$) while vegan represents 70% ($n=566$). Figure 5 shows the nutritional facts of vegan and vegetarian burgers. Statistical analysis revealed that there are no significant differences among both types in terms of fat, SFA, fibre, sugar, and proteins. Vegan products showed higher energy and carbohydrates, and lower sodium than vegetarians. Sodium did not vary significantly between both groups.

Discussion

The dynamic shift in the plant-based burger market reflects an ever-evolving landscape, showcasing a diverse spectrum of ingredients and innovative technological methodologies aimed at catering to the escalating consumer demand for sustainable and nourishing plant-based alternatives. In light of the increasing surge in the introduction of new plant-based products on a global scale, this study was conducted to assess the evolution of plant-based burgers in the international market over 24 years since 1998. Based on the findings, two notable spikes in product launches occurred in 2013 and 2020, indicating a significant upsurge in consumer demand for plant-based burger options during these periods. Despite the relatively lower prevalence of traditional products compared to newer, innovative alternatives, the consistent increase in launches since 2013 highlights the sustained growth and market interest in plant-based burger offerings. Additionally, the declared nutritional composition of the products appeared to be influenced more by technological advancements and regional preferences than by the specific market positioning of the products.

Generation products focused on reducing carbohydrates (starchy ingredients) using purified ingredients such as proteins and fibres. In the past, starches and flours played pivotal roles in the texture and consistency of meat substitutes. Currently, advanced structuring technology such as extrusion and shear structuring enabled an improved texture through the production of high moisture and low moisture textured proteins with fibrous texture (Lichstein 2020; Baune et al. 2022). Generation products showed the highest fibre content owing to the increased use of fibres to improve the texture and the bite. Fibres have been increasingly used for their functional properties such water/oil binding and thickening properties (Nolden and Forde 2023). However, previous studies focused on Australian and Brazilian market showed similar fibre amounts among both generations (Curtain and Grafenauer 2019; Penna Franca et al. 2022). The traditional products had low fat content in consistence with a previous study focused on the Brazilian market (Penna Franca et al. 2022). The increase of fat in the generation products of meat substitutes can be attributed to the relevance of fat in improving the palatability, the juiciness and tenderness of the products (Penna Franca et al. 2022). As underlined in Table S1, these commercial products are made using fats/oils (e.g. coconut oil/butter, sunflower oil, canola oil, sesame oil, and sunflower oil). Generation products had the highest protein content which can be attributed to increased use of protein isolate, protein concentrate and textured proteins from different plant sources (Ma et al. 2022). This result aligns with previous findings focused on the Brazilian market (Penna Franca et al. 2022).

Traditional meat substitutes are composed of culinary ingredients which explains their low amounts of sodium, protein and high amounts of carbohydrates (Lichstein 2020; Penna Franca et al. 2022). These products are made with less processed ingredients that can meet the demand of those who are interested in following a more natural health style (Claudia et al. 2011; Petersen et al. 2021). However, the nutritional profile of traditional products deviates from the nutritional composition of meat products they are intended to replace, which can be misleading for consumers seeking plant-based burgers as the meal's protein main source. The lack of regulation of these products also complicates the situation due to the absence of standard nutritional quality and thus commercial products are very diverse in term of nutritional quality (Boukid

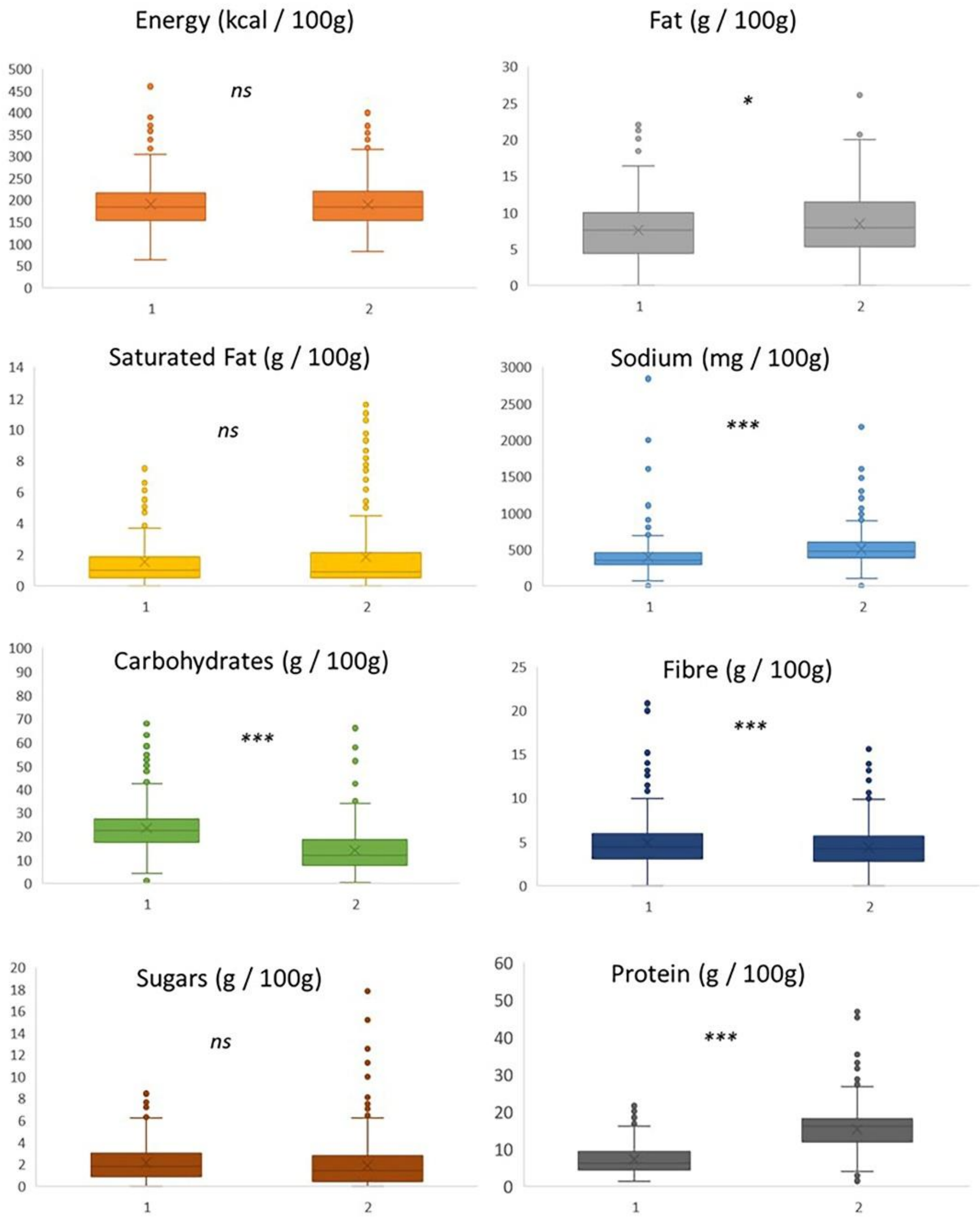

Figure 4. Nutritional profile of commercial burger patties sold in the global market. Statistical significance based on Kolmogorov–Smirnov test [$^*p < 0.05$, $^{**}p < 0.01$, ns non-significant ($p > 0.05$)]; the box-plot legend: the box is limited by the lower (Q1 = 25th) and upper (Q3 = 75th) quartile; the median is the horizontal line dividing the box; Whiskers above and below the box indicate the 10th and 90th percentiles; outliers: are the points outside the quartile 10–90th percentiles. 1: Traditional products; 2: Generation products. $^*p < 0.05$, $^{***}p < 0.001$, ns non-significant ($p > 0.05$).

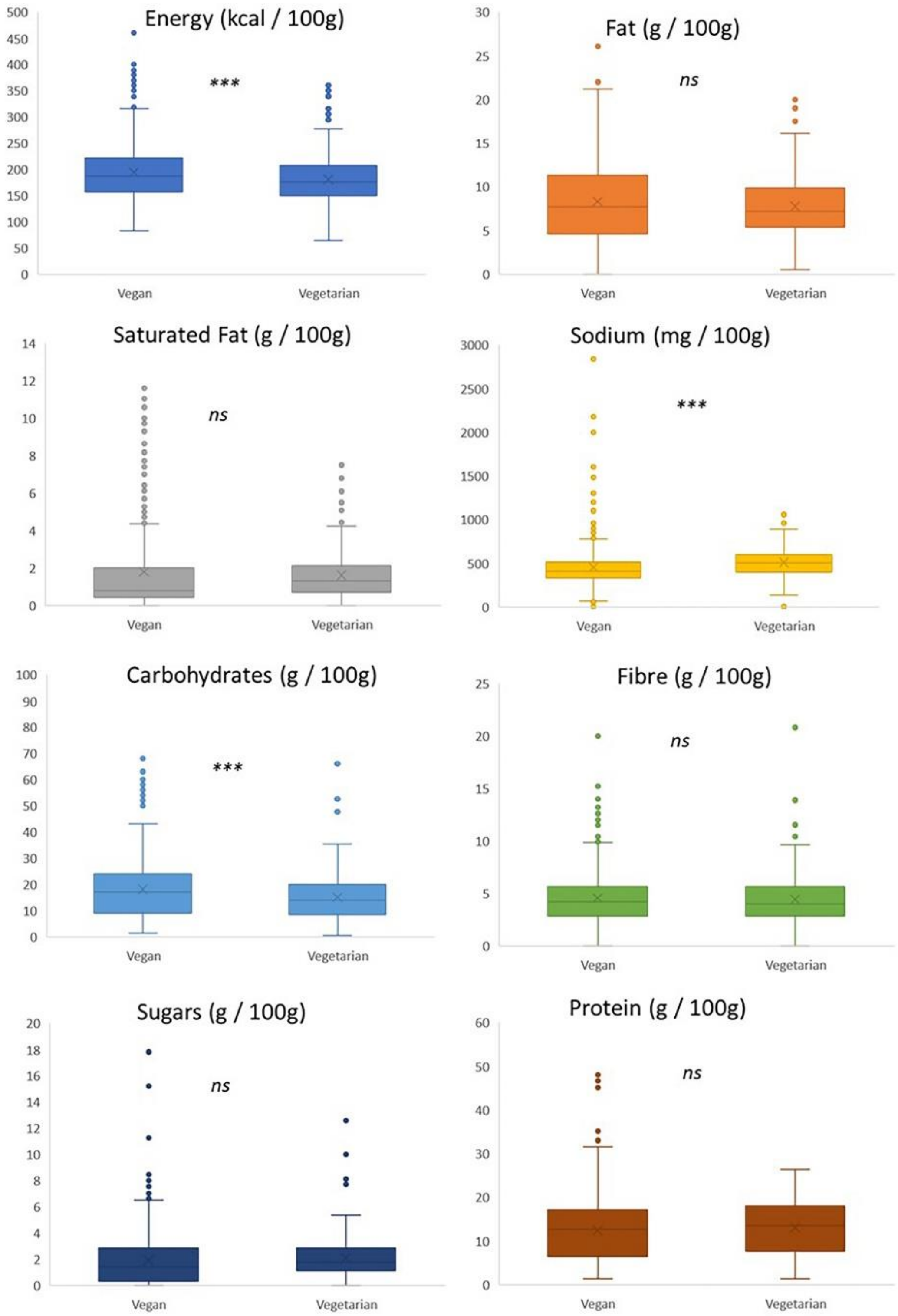

Figure 5. Nutritional profile of vegetarian and vegan burgers sold in the global market. Statistical significance based on Kolmogorov–Smirnov test [*$p < 0.05$, **$p < 0.01$, ns non-significant ($p > 0.05$)]; the box-plot legend: the box is limited by the lower (Q1 = 25th) and upper (Q3 = 75th) quartile; the median is the horizontal line dividing the box; Whiskers above and below the box indicate the 10th and 90th percentiles; outliers: are the points outside the quartile 10–90th percentiles. *$p < 0.05$, ***$p < 0.001$, ns non-significant ($p > 0.05$).

2021). Therefore, it would be interesting to regulate these products with the adoption of a distinct nomenclature that distinguishes between traditional products, based on culinary ingredients, from meat substitutes that aim to replace meat nutritionally and aesthetically.

Even though region chiefly impacted the nutritional composition of plant-based burgers, the high heterogeneity in the nutritional profile of commercial products did not show a clear clustering unlike focused studies on specific region such Europe (Boukid and Castellari 2021). The anticipated variation in trends among countries can be attributed to several key factors. Firstly, discrepancies in the quality and availability of ingredients utilised in the production of plant-based burgers are closely related to their country of origin (Fresán et al. 2020). Diverse standards for fortification and enrichment of vegan food products may contribute to significant variations in the nutritional quality of these burgers across different regions (Grasso et al. 2023). Furthermore, disparities in labelling regulations, including nutrient content claims and health claims, may differ between countries, can significantly influence how manufacturers present the nutritional information and claims, consequently shaping consumer perceptions of the overall nutritional value of vegan burgers (Van Wezemael et al. 2014). Additionally, cultural dietary habits and local culinary traditions, preferences, and tastes often influence the incorporation of specific ingredients and the adaptation of preparation techniques, thus contributing to the notable divergence in the nutritional profiles of vegan burgers across various geographical locations (Alalwan et al. 2017; Figueroa et al. 2021; Marrero Bsph et al. 2022).

Regarding ingredient composition, soy protein was the most used protein ingredient, which was also observed in a previous study with plant-based products extracted by Mintel GNPD (Andreani et al. 2023). Texturing processes of proteins isolates and concentrates not only improve the texture of the product but increase the bioavailability of nutrients by neutralising the anti-nutritional factors that are present in legumes and cereals (Gilani et al. 2012; Pasqualone et al. 2020). Also, the type of raw material used influences the amino acid and fatty acid compositions of textured proteins produced by different protein sources (Cotacallapa-Sucapuca et al. 2021). De Angelis et al. (2022) observed that the amino acid composition differed between the 3 analysed products, with the dry fractionated pea plus oat combination differing to isolated pea plus oat and isolated soy plus oat for leucine, sulphur amino acids (methionine + cystine) and aromatic amino acids (phenylalanine + tyrosine). Although only sulphur amino acids were below FAO/WHO protein standards (FAO 2011). These data demonstrate that the vegetable source and the type of processing will influence the protein quality of the final product.

Despite the observed predominance of soy and wheat other protein sources were also explored, such as chia protein, potato protein, hemp protein and fava bean protein. In fact, the development of novel protein sources, with unique functional properties, high biological value and phytochemical activity has been gaining attention (López et al. 2019; Boukid and Castellari 2022). Furthermore, peas, gluten and soy are among the most common food allergens (FAO 2022). Therefore, research has sought to develop hypoallergenic plant-based protein sources such as chia protein (Kotecka-Majchrzak et al. 2020) and potato protein (Hussain et al. 2021), or rarely allergenic such as hemp protein (Mamone et al. 2019).

Besides its use as flavour enhancer and preservative, salt can be added during plant protein extraction and/or during vegetable proteins texturization (Penna Franca et al. 2022). It was also reported that many modern formulated plant-based products contain higher amounts of salt to mask the unattractive taste or texture qualities inherent to plant proteins (Nolden and Forde 2023). International health organisation promotes salt reduction due to its association with serious health issues including blood pressure and cardiovascular diseases (Salt reduction 2023).

A variety of plant-based ingredients are good sources of bioactive compounds, such as herbs and spices, which are used for their aroma, flavour and colour (Embuscado 2019). Onion and garlic are common natural flavourings and important sources of organosulfur compounds. Annatto and beetroot are natural colourants and may exhort functional properties, beetroot juice increases levels of nitric oxide which ameliorate mitochondrial biogenesis and efficiency (Domínguez et al. 2017). Mushrooms are important sources of vitamin D in diets with restrictions on foods of animal origin. (Kris-Etherton et al. 2002; Biesalski et al. 2009; Aydar et al. 2020). Seeds, nuts and legumes are the main sources of protein in diets restricted in animal foods (de Oliveira Silva and Perrone 2015; Mariotti and Gardner 2019). In addition, they are a good source of fibre, and phytochemicals such as phytosterols, phytoestrogens and antioxidants (Aydar et al. 2020).

Some concerns exist about the use of additives in meat substitutes (Hu et al. 2019; Rubio et al. 2020).

To be approved, additives need to be generally recognised as safe (Joint FAO/WHO 1995). However, research has shown health consequences for different classes of additives (Petersen et al. 2021). Emulsifiers have been associated with dysbiosis; food colourants might be associated with allergies development (Kumar et al. 2019); monosodium glutamate has been linked to cancer development (Naimi et al. 2021; FAO 2022), which may justify the perception of consumers that additives are unnatural and unhealthy (Petersen et al. 2021). Current research demonstrated the direct impact of emulsifiers on gut microbiota (Naimi et al. 2021). However, research on the effect of plant-based meat substitutes on the microbiota obtained positive results (Crimarco et al. 2020) including an increase in butyrate production and metabolisation in the treatment group, as well as a decrease in the *Tenericutes phylum* (Toribio-Mateas et al. 2021).

The major strength of the present study is attributable to the large number of the considered products in terms of time and region. This comprehensive approach facilitated the retrieval of comprehensive and authentic data, enabling a holistic and accurate representation of the nutritional information presented on food packaging labels. However, this study has some limitations. One notable limitation pertains to the absence of comparative analysis regarding supplementary components such as minerals, vitamins, and amino acid profiles. Information about the digestibility and bioavailability of nutrients of plant-based burgers are also of high relevance but not included in products labelling. Furthermore, the study was unable to factor in additional product attributes, including the quality of base ingredients, which might contain abundant elements not explicitly outlined in the nutritional labels. Lastly, the study did not incorporate pricing, which is a primary aspect as it directly influences consumer accessibility, market competitiveness, and overall product sustainability (Li et al. 2023). Understanding the price dynamics associated with plant-based alternatives is crucial for comprehending their market positioning, consumer adoption rates, and long-term viability within the food industry (Safdar et al. 2022).

Conclusion

Overall, the present work is one of the few studies comparing the nutritional quality of vegans versus vegetarian burger products. It also details the protein sources used in a large set of commercial plant-based burgers. Results showed the versatility of protein sources with the predominance of soy. Going further into classifying the products based on their region, technology development stage and market position enabled a better understanding of the main factors impacting the nutritional composition. Results showed that region predominantly impacted the nutritional composition, while no clustering was found due to the versatility of products composition. Comparing vegan to vegetarian burgers did no show differences and thus the use of animal derived ingredients cannot be automatically associated with improved nutritional quality. Therefore, it is essential to understand the product's nutritional quality and ingredient formulation to aid consumers in deciding which products are most suitable as part of a healthy and sustainable diet.

Disclosure statement

The authors declare that the research was carried out in the absence of any commercial or financial relationships that could be interpreted as potential conflicts of interest.

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Data availability statement

Data is contained within the article or Supplementary Material (Tables S1 and S2).

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APÊNDICE 3: TABELA SUPLEMENTAR 1 (MANUSCRITO 2)

Supplementary Table 1: Country of origin, market position, stage of technology development and nutrients per 100g of plant-based burgers

Market	Generation	Vegan/ vegetarian	Energy (kcal/ 100g)	Fat (g /100g)	Saturated Fat (g/ 100g)	Sodium (mg / 100g)	Carbo hydrates (g / 100g)	Fibre (g / 100g)	Sugars (g / 100g)	Protein (g / 100g)
USA	2	1	141,09	1,76	0,00	540,86	12,93	4,70	3,53	17,64
USA	2	1	166,67	2,78	0,00	402,78	16,67	13,89	1,39	19,44
USA	2	2	141,18	3,53	0,00	458,82	7,06	3,53	1,18	20,00
USA	2	1	179,10	5,97	0,75	746,27	13,43	4,48	1,49	17,91
USA	2	2	126,76	1,41	0,00	492,96	8,45	5,63	0,00	18,31
USA	2	1	211,27	8,45	0,70	661,97	16,90	2,82	1,41	18,31
Finland	2	2	405,00	17,00	7,00	2200,00	37,00	9,50	7,70	26,00
USA	2	1	149,25	5,22	0,75	567,16	10,45	4,48	1,49	14,93
USA	2	1	194,03	8,96	2,24	477,61	10,45	4,48	2,99	16,42
USA	2	1	239,44	12,68	1,41	549,30	7,04	2,82	0,00	22,54
USA	2	1	211,27	8,45	0,70	661,97	16,90	2,82	1,41	18,31
UK	2	1	164,00	8,00	0,90	700,00	7,00	2,50	2,60	16,00
USA	2	1	239,44	12,68	1,41	549,30	7,04	2,82	0,00	22,54
USA	2	1	169,01	5,63	0,00	591,55	11,27	5,63	0,00	19,72
USA	2	2	122,81	0,88	0,00	385,97	12,28	7,02	0,00	19,30
USA	2	1	183,10	8,45	2,82	591,55	8,45	5,63	1,41	18,31
UK	1	1	200,00	8,80	1,30	600,00	25,50	2,00	1,80	4,70
USA	2	1	194,03	8,96	2,24	477,61	10,45	4,48	2,99	16,42
USA	2	2	133,33	5,33	0,00	626,67	9,33	4,00	2,67	16,00
USA	2	1	239,44	9,86	1,41	957,75	23,94	2,82	1,41	14,08
USA	2	1	157,90	9,21	3,95	710,53	7,89	5,26	2,63	15,79
USA	2	1	203,13	9,38	1,56	453,13	10,94	6,25	4,69	18,75
UK	2	2	210,00	9,20	2,50	600,00	36,10	2,80	2,50	18,80
USA	2	2	133,80	0,00	0,00	402,82	11,27	5,63	0,00	19,72
USA	2	2	140,85	2,82	0,00	436,62	8,45	4,23	1,41	18,31
USA	2	2	155,56	4,44	1,67	433,33	8,89	5,56	1,11	20,00
USA	2	1	140,85	6,34	0,00	422,54	7,04	5,63	0,00	15,49
USA	2	1	211,27	8,45	1,41	760,56	22,54	2,82	1,41	12,68
USA	2	1	239,44	12,68	1,41	549,30	7,04	2,82	0,00	22,54
USA	2	1	192,31	5,77	0,64	602,56	20,51	6,41	2,56	14,10
USA	2	1	210,53	7,89	1,32	710,53	7,89	5,26	2,63	26,32
USA	2	1	203,13	10,94	3,13	453,13	10,94	4,69	1,56	12,50
USA	2	2	140,85	3,52	0,00	507,04	7,04	4,23	0,00	18,31
Netherlands	2	1	220,00	11,00	2,50	680,00	19,00	2,50	2,00	11,00
New Zealand	2	2	177,00	4,30	0,60	590,00	7,90	2,80	1,60	25,10
USA	2	1	192,31	9,62	0,00	1057,69	3,85	0,00	1,92	21,15
UK	2	1	164,00	8,00	1,00	800,00	6,00	2,50	2,50	17,00
USA	2	1	260,87	13,04	3,26	869,57	13,04	6,52	4,35	21,74
UK	1	1	195,00	10,10	2,20	590,00	21,60	3,00	2,40	4,30

Canada	2	1	200,00	8,00	2,00	466,67	24,00	5,33	4,00	8,00
Canada	2	1	190,14	9,86	4,23	514,09	12,68	3,52	0,70	13,38
USA	2	2	146,67	5,33	0,00	626,67	9,33	4,00	1,33	16,00
USA	2	2	140,85	2,82	0,00	647,89	11,27	7,04	2,82	18,31
USA	2	1	194,03	8,96	2,24	417,91	10,45	4,48	2,99	16,42
USA	2	1	126,76	4,93	1,41	549,30	7,04	5,63	0,00	18,31
Mexico	2	2	216,67	6,67	0,00	50,00	25,00	1,67	0,00	16,67
Sweden	2	1	184,00	8,10	2,70	700,00	10,40	4,30	4,10	17,10
Belgium	2	1	164,00	6,00	0,70	700,00	8,80	3,80	2,00	18,60
USA	2	1	126,76	4,93	1,41	549,30	7,04	5,63	0,00	18,31
USA	2	2	225,35	8,45	1,41	605,63	21,13	2,82	1,41	15,49
USA	2	1	234,38	10,94	3,13	750,00	15,63	4,69	1,56	20,31
Canada	2	1	218,31	12,68	3,52	669,01	9,86	6,34	2,11	16,90
USA	2	1	225,35	7,04	2,11	549,30	28,17	4,23	2,82	14,08
USA	2	1	154,93	4,23	2,11	788,73	22,54	4,23	1,41	8,45
USA	2	1	183,10	4,23	0,70	661,97	12,68	5,63	1,41	22,54
Spain	2	1	250,00	11,91	2,88	520,00	21,65	2,22	0,25	14,60
Canada	2	2	152,94	0,00	0,00	529,41	16,47	5,88	1,18	20,00
USA	2	1	171,88	9,38	1,56	343,75	12,50	1,56	1,56	10,94
USA	2	1	126,76	3,52	1,41	507,04	21,13	7,04	1,41	7,04
Sweden	2	1	190,00	8,30	0,90	800,00	20,50	3,00	3,00	8,30
USA	2	2	169,01	3,52	0,70	549,30	14,08	5,63	2,82	16,90
USA	2	1	200,00	8,00	0,67	533,33	22,67	2,67	5,33	12,00
USA	1	2	169,01	11,27	1,41	507,04	16,90	1,41	1,41	2,82
USA	2	1	140,85	7,04	2,11	507,04	7,04	4,23	1,41	16,90
USA	2	2	105,26	0,88	0,00	473,68	10,53	5,26	0,00	22,81
Canada	2	1	250,00	13,64	1,14	545,46	15,91	3,41	1,14	14,77
Argentina	2	1	196,57	0,46	0,00	252,57	35,43	4,57	12,57	12,57
Singapore	2	2	98,59	2,11	0,00	521,13	8,45	5,63	0,00	16,90
USA	2	2	126,76	0,00	0,00	436,62	15,49	5,63	1,41	16,90
UK	1	1	170,00	7,30	3,20	370,00	16,40	3,90	4,00	9,80
Greece	1	1	294,20	19,00	7,50	800,00	22,00	3,00	2,00	8,80
France	1	1	259,00	14,10	6,10	420,00	24,70	6,00	0,35	8,30
France	2	2	145,00	4,30	0,70	500,00	10,60	1,20	3,40	16,00
Canada	1	1	180,00	7,00	0,50	340,00	25,00	3,00	4,00	5,00
USA	2	1	98,59	2,11	0,70	408,45	12,68	4,93	0,00	14,08
USA	1	1	179,49	8,97	3,85	461,54	17,31	4,49	1,92	6,41
USA	2	2	239,44	7,04	0,70	676,06	30,99	2,82	1,41	14,08
USA	2	1	175,00	5,83	0,83	583,33	20,00	5,83	1,67	14,17
USA	2	2	126,76	3,52	0,00	478,87	18,31	2,82	1,41	7,04
USA	2	1	149,25	5,97	0,75	731,34	14,93	2,99	4,48	10,45
Netherlands	2	1	185,00	10,00	1,00	600,00	14,00	3,00	1,50	10,00
Netherlands	2	1	175,00	8,10	1,30	690,00	9,00	3,60	2,70	16,50
France	1	1	212,00	7,20	0,30	500,00	29,20	4,20	2,80	7,60
Belgium	2	1	117,00	5,00	0,50	400,00	7,00	5,00	1,00	11,00
Netherlands	2	2	108,00	2,10	0,60	390,00	17,40	6,30	3,30	3,90
USA	1	2	197,53	7,05	1,41	592,59	26,81	7,05	1,41	5,64
USA	2	2	115,39	1,28	0,00	576,92	12,82	5,13	3,85	11,54

Belgium	1	2	231,00	14,00	3,00	500,00	16,60	1,10	2,30	9,60
Malaysia	2	2	226,67	4,33	0,00	57,00	28,67	4,67	0,00	18,67
Austria	2	1	164,00	6,00	0,70	700,00	9,50	2,00	0,60	18,00
Spain	2	2	147,90	7,50	1,10	500,00	6,80	4,80	2,20	13,30
Indonesia	2	1	197,18	7,04	0,70	830,99	22,54	2,82	1,41	11,27
Australia	2	1	174,67	9,07	2,53	534,67	10,67	4,67	4,67	10,27
USA	2	2	126,76	3,52	0,00	521,13	22,54	7,04	2,82	5,63
USA	2	2	154,93	2,11	0,70	464,79	14,08	5,63	2,82	22,54
USA	1	2	280,00	12,00	1,33	400,00	34,67	6,67	1,33	10,67
Portugal	1	2	186,00	9,00	1,00	630,00	19,00	3,50	2,00	6,50
Hong Kong, China	2	2	112,68	4,93	0,00	535,21	12,68	7,04	0,00	12,68
UK	2	2	174,00	7,10	5,40	700,00	18,10	2,40	4,00	11,50
France	2	2	169,00	10,00	1,40	460,00	6,50	4,80	1,90	13,30
UK	1	1	235,00	14,60	2,80	280,00	25,70	6,20	2,10	4,60
USA	2	1	210,53	7,89	1,32	684,21	7,89	2,63	2,63	26,32
UK	2	1	143,00	6,30	0,80	600,00	16,10	2,60	2,30	5,50
Sweden	1	2	200,00	6,70	0,70	400,00	26,00	8,10	2,50	7,60
Netherlands	2	2	182,00	13,50	1,50	700,00	1,50	6,30	1,30	14,50
USA	2	1	128,57	5,71	0,71	285,71	8,57	2,86	0,00	14,29
USA	2	2	225,35	7,04	1,41	676,06	18,31	4,23	1,41	21,13
Belgium	2	2	143,00	6,00	0,65	700,00	5,20	8,80	4,00	17,00
Germany	2	1	164,00	6,00	0,70	700,00	9,50	2,00	0,60	18,00
Belgium	2	2	182,00	13,50	1,50	700,00	1,50	6,30	1,30	14,50
Finland	1	2	190,00	10,00	4,00	520,00	22,00	4,00	2,50	4,00
France	2	2	223,00	11,00	4,20	480,00	25,00	5,60	3,00	5,90
Netherlands	2	2	201,00	10,80	1,40	300,00	15,00	4,80	1,30	10,90
Canada	2	1	160,00	3,50	1,50	460,00	20,00	4,00	2,00	10,00
Italy	2	2	145,00	4,30	0,70	500,00	10,60	1,20	3,40	16,00
UK	2	1	124,00	2,90	1,00	300,00	10,70	5,80	2,30	15,80
Netherlands	2	2	136,00	3,70	1,50	500,00	20,80	0,80	3,30	10,30
Netherlands	2	1	181,00	9,50	1,00	563,00	8,00	7,00	1,00	16,00
India	1	2	268,00	6,90	0,10	600,00	42,30	4,50	5,10	9,30
France	1	2	101,00	0,40	0,30	400,00	21,10	4,40	0,10	3,40
Finland	2	1	134,00	6,00	0,70	600,00	11,00	3,00	4,00	9,00
Australia	2	2	175,20	3,84	0,40	490,40	25,84	4,72	7,52	6,80
USA	2	1	140,85	2,11	0,00	549,30	14,08	4,23	4,23	19,72
USA	2	1	140,85	4,23	1,41	295,78	12,68	2,82	1,41	11,27
Australia	2	2	154,40	0,72	0,08	270,40	27,20	4,64	6,48	7,04
Mexico	1	2	185,51	9,88	1,10	482,99	19,76	2,20	3,29	4,39
Portugal	1	2	161,33	4,27	0,67	400,00	20,67	6,13	1,07	10,13
USA	2	1	140,63	7,81	0,78	609,38	10,94	7,81	1,56	14,06
USA	1	2	200,00	14,12	1,76	352,94	8,24	1,18	1,18	12,94
Germany	1	2	183,67	3,88	0,41	612,25	27,76	6,94	3,06	6,12
Italy	2	2	116,00	2,90	0,50	700,00	6,40	6,70	5,20	16,00
Netherlands	2	1	147,00	5,10	0,80	890,00	11,70	6,60	3,20	10,40
USA	2	1	175,00	5,83	0,83	583,33	20,00	5,83	1,67	14,17
UK	2	1	126,00	3,50	0,50	400,00	8,00	3,00	2,00	14,00

UK	2	1	252,29	13,58	1,10	366,97	14,86	3,21	0,83	16,88
USA	2	1	203,13	9,38	1,56	406,25	7,81	3,13	1,56	23,44
USA	2	1	140,85	2,11	0,00	549,30	14,08	4,23	4,23	19,72
France	1	2	178,00	5,70	1,30	340,00	26,80	6,00	4,80	4,90
USA	2	2	186,81	8,79	1,10	417,58	23,08	3,30	3,30	4,40
Belgium	1	2	304,00	21,20	2,10	900,00	14,60	0,40	1,60	10,00
France	1	2	169,00	9,00	0,80	220,00	13,50	6,50	2,40	5,30
USA	2	1	150,00	5,00	0,83	483,33	11,67	5,00	1,67	18,33
France	1	2	90,00	5,20	0,60	320,00	8,50	3,50	2,90	2,30
Portugal	1	1	213,87	6,09	2,60	493,33	27,87	2,31	0,51	11,89
UK	2	1	205,00	13,60	1,90	350,00	7,70	3,30	0,70	16,50
Netherlands	2	1	210,00	12,00	3,50	500,00	16,00	2,00	1,00	8,00
Netherlands	2	1	305,00	19,50	3,90	600,00	14,50	4,80	5,10	19,00
Hong Kong, China	2	2	140,85	3,52	0,00	535,21	23,94	7,04	1,41	4,23
USA	2	1	184,21	11,84	1,32	526,32	5,26	2,63	0,00	15,79
UK	2	1	139,00	5,60	1,00	500,00	5,20	4,50	1,30	16,80
USA	1	2	161,97	1,41	0,00	119,72	33,80	5,63	6,34	6,34
UK	1	2	188,00	7,10	0,90	190,00	28,90	2,50	3,60	3,40
UK	2	2	172,00	4,90	0,00	1300,00	16,00	5,60	2,80	17,00
France	2	2	200,00	8,10	3,10	450,00	18,50	3,10	2,50	11,70
France	1	1	64,00	2,53	0,53	173,33	5,87	4,00	2,13	2,40
USA	2	2	101,01	1,01	0,00	525,25	8,08	6,06	1,01	19,19
USA	1	2	153,92	7,70	0,64	230,88	16,67	5,13	3,85	6,41
USA	2	2	400,00	16,67	10,00	1200,00	26,67	13,33	3,33	46,67
Sweden	1	1	134,00	6,00	0,70	600,00	11,00	3,00	4,00	9,00
Ireland	1	1	125,00	3,50	1,50	330,00	11,40	9,60	0,80	7,60
UK	1	1	125,00	3,50	1,50	330,00	11,40	9,60	0,80	7,60
Belgium	2	1	220,00	10,60	2,20	560,00	5,70	4,00	4,00	24,10
USA	2	2	153,85	5,38	0,77	238,46	16,92	3,08	3,85	10,00
Germany	1	2	344,00	4,10	0,40	600,00	60,10	9,00	0,80	12,10
Germany	2	2	203,33	8,89	1,89	777,78	13,33	5,78	6,89	17,33
Canada	1	2	360,00	6,67	1,33	333,33	68,00	9,33	0,00	16,00
Canada	2	2	131,87	3,30	0,00	384,62	12,09	5,49	0,00	14,29
USA	1	2	186,81	8,79	1,10	417,58	23,08	3,30	3,30	4,40
USA	2	1	171,43	7,14	0,71	500,00	22,86	7,14	2,86	7,14
USA	1	2	200,00	14,12	1,76	352,94	8,24	1,18	1,18	12,94
Germany	2	2	292,57	16,80	2,63	788,57	11,43	3,54	4,00	22,29
USA	2	2	140,85	3,52	0,00	394,37	9,86	5,63	1,41	16,90
Finland	1	1	154,00	2,90	0,50	700,00	23,30	1,30	0,20	6,70
Austria	1	1	244,00	16,00	7,60	470,00	17,00	2,10	2,50	8,30
UK	1	1	175,00	10,80	1,20	300,00	15,30	3,70	2,80	3,60
Canada	2	2	126,76	2,11	0,28	408,45	15,49	4,23	0,00	11,27
Austria	1	1	186,00	8,40	1,73	13,33	21,40	1,73	1,13	5,33
Czech Republic	2	1	143,50	6,30	0,80	583,00	5,50	5,70	2,80	13,50
Spain	2	2	228,00	10,00	0,96	500,00	22,89	8,90	2,55	7,11
USA	2	2	101,01	1,01	0,00	383,84	9,09	6,06	0,00	19,19

Canada	2	2	185,84	7,96	0,44	292,04	11,50	4,42	0,88	16,81
USA	2	2	169,01	5,63	0,00	521,13	15,49	4,23	0,00	16,90
Ireland	1	1	250,00	15,20	3,50	200,00	15,70	3,20	1,70	9,90
France	1	1	110,67	6,27	1,60	333,33	6,40	3,47	2,27	5,47
India	1	2	207,00	9,60	4,70	421,20	26,60	4,10	2,90	3,50
USA	2	2	145,46	3,64	0,00	436,36	5,45	3,64	0,00	23,64
Germany	2	2	114,00	5,20	0,60	500,00	13,20	2,60	2,10	2,30
UK	2	1	160,00	6,40	1,00	500,00	6,10	4,20	1,20	17,30
Austria	2	2	158,00	3,10	0,40	510,00	23,90	5,40	0,80	5,90
Austria	1	1	154,00	2,80	2,10	700,00	24,10	1,40	0,60	7,40
Spain	1	1	80,00	5,00	1,50	300,00	5,00	2,50	2,00	2,00
Belgium	2	2	197,00	10,00	1,40	420,00	6,50	4,80	1,90	13,30
Australia	2	2	141,00	7,20	5,70	117,00	14,00	6,70	2,60	4,90
Italy	1	1	148,00	10,20	1,60	400,00	1,30	3,00	1,10	11,20
Australia	2	2	177,33	8,00	0,80	353,33	12,27	4,27	1,73	12,13
Austria	2	2	114,00	5,20	0,60	500,00	13,20	2,60	2,10	2,30
Canada	2	2	186,67	5,33	0,67	560,00	30,67	2,67	2,67	4,00
USA	2	1	211,77	8,24	0,59	435,29	16,47	7,06	1,18	16,47
Ireland	2	1	205,00	13,60	1,90	350,00	7,70	3,30	0,70	16,50
Austria	1	1	183,33	9,93	2,40	633,33	17,20	2,20	2,13	5,20
USA	2	2	126,76	4,23	0,00	591,55	14,08	4,23	2,82	12,68
USA	1	2	119,72	2,11	0,00	161,97	21,13	4,93	4,23	5,63
Italy	2	1	154,00	6,50	0,70	650,00	5,00	3,50	1,30	17,00
Netherlands	2	1	160,00	6,50	1,00	700,00	7,00	5,50	4,00	15,00
Canada	2	2	152,94	5,88	0,00	388,24	8,24	2,35	1,18	17,65
Spain	2	2	161,62	7,10	1,12	500,00	8,37	9,10	1,20	11,51
Germany	2	2	212,00	11,10	1,60	700,00	5,90	4,40	2,90	19,90
USA	2	2	157,90	5,26	0,00	684,21	7,89	5,26	2,63	18,42
Italy	2	2	180,00	1,80	0,40	530,00	14,10	0,20	3,40	26,70
USA	2	2	190,14	7,04	0,70	619,72	16,90	2,82	0,00	14,08
Germany	1	1	111,33	1,00	0,20	433,33	19,00	3,00	4,33	5,00
Canada	2	2	320,00	4,00	0,00	1480,00	32,00	12,00	4,00	48,00
Ar2tina	2	2	237,58	5,45	0,85	329,70	33,94	1,45	17,82	13,33
France	1	2	201,00	13,40	1,20	350,00	12,30	6,50	0,70	4,60
Canada	2	1	156,25	4,69	0,63	500,00	12,50	3,13	1,56	17,19
Finland	2	2	339,00	5,80	1,10	2180,00	30,00	13,20	15,20	35,20
USA	1	2	208,79	6,59	3,85	417,58	32,97	5,49	0,00	5,49
USA	2	2	197,18	6,34	0,70	605,63	19,72	4,23	1,41	16,90
USA	1	2	150,94	7,55	0,94	386,79	17,92	4,72	3,77	4,72
UK	2	2	174,00	10,60	5,50	520,00	9,70	5,10	2,40	15,00
UK	2	2	236,00	13,50	3,30	380,00	14,30	3,60	2,00	14,30
USA	2	1	179,10	5,97	0,75	522,39	19,40	5,97	2,99	16,42
France	1	2	222,00	8,50	0,80	410,00	26,80	7,30	1,60	6,00
USA	2	2	141,18	5,29	0,59	329,41	11,76	3,53	2,35	14,12
Netherlands	2	1	240,00	11,33	2,40	546,67	17,07	1,60	3,33	16,93
Germany	1	2	339,00	4,50	0,90	1100,00	55,00	13,20	4,60	13,10
Germany	2	2	354,00	7,00	1,50	1600,00	58,00	7,30	2,50	11,20
USA	2	2	226,67	9,33	0,67	466,67	26,67	2,67	0,00	12,00

France	1	1	252,00	11,60	1,90	390,00	28,00	6,00	3,00	6,00
France	1	1	191,00	9,20	1,60	390,00	12,60	3,70	1,00	12,50
France	1	2	153,00	8,70	1,30	380,00	2,00	4,70	0,60	14,40
UK	2	1	163,00	7,00	3,30	500,00	6,50	3,00	2,20	17,00
UK	1	1	250,00	15,20	3,50	200,00	15,70	3,20	1,70	9,90
Germany	2	2	232,00	10,40	1,50	800,00	8,10	3,80	4,30	24,60
USA	2	1	223,53	10,59	0,59	411,77	8,24	1,18	1,18	23,53
Spain	1	2	171,00	5,80	1,05	600,00	17,70	3,00	1,40	10,48
USA	2	1	156,25	4,69	0,00	500,00	12,50	3,13	1,56	17,19
Spain	1	1	195,00	7,50	2,50	600,00	20,10	2,50	1,30	10,50
France	1	1	93,33	5,47	0,67	266,67	4,80	5,87	2,40	3,20
Italy	1	2	186,00	11,10	1,50	455,00	11,90	4,40	1,30	7,30
Italy	2	2	161,00	6,50	0,70	650,00	6,00	7,10	4,60	16,00
Germany	1	2	111,00	2,70	0,40	500,00	17,00	2,40	0,30	3,40
France	1	1	98,00	6,30	1,60	300,00	7,30	2,10	2,40	2,00
Italy	1	1	82,67	4,27	0,67	346,67	6,00	2,53	1,47	4,00
Mexico	2	2	182,22	8,89	1,11	466,67	20,00	3,33	0,00	4,56
USA	2	1	164,18	6,72	0,75	358,21	19,40	10,45	1,49	14,93
South Africa	2	2	148,75	4,40	0,55	813,75	12,20	0,60	5,30	15,80
Australia	1	2	212,00	7,68	0,56	340,00	26,80	5,28	3,68	6,24
USA	2	2	197,18	6,34	0,70	661,97	26,76	5,63	2,82	9,86
Italy	2	2	231,00	8,00	3,40	600,00	24,00	3,50	3,00	14,00
France	1	1	146,00	10,40	3,40	230,00	9,80	3,10	2,70	1,80
Germany	1	2	212,00	5,70	1,10	710,00	31,60	4,90	2,10	6,20
USA	1	1	89,43	1,63	0,00	455,29	14,63	4,07	0,81	6,50
USA	2	2	150,00	5,00	0,00	380,00	9,00	3,00	1,00	18,00
USA	2	2	180,00	9,00	0,50	350,00	14,00	3,00	1,00	15,00
USA	2	2	175,44	8,77	0,00	631,58	7,02	3,51	1,75	17,54
USA	2	1	171,43	8,57	0,71	500,00	21,43	7,14	2,86	7,14
USA	2	2	131,58	1,97	0,00	513,16	11,84	6,58	0,00	14,47
Finland	1	2	111,00	2,70	0,40	0,50	17,00	2,40	0,30	3,40
France	2	2	230,00	10,00	1,10	400,00	25,60	6,70	2,80	6,00
UK	2	1	165,00	10,00	0,70	370,00	4,40	4,20	0,50	14,40
USA	2	2	115,39	2,31	0,00	315,39	20,00	3,85	1,54	6,15
USA	1	1	276,92	4,62	0,38	423,08	47,69	11,54	7,69	13,85
USA	1	2	186,81	8,79	2,75	351,65	24,18	3,30	0,00	4,40
France	2	1	211,00	11,40	6,80	700,00	0,50	9,30	0,10	21,90
Germany	2	1	211,00	11,40	6,80	700,00	0,50	9,30	0,10	21,90
Spain	2	1	211,00	11,40	6,80	700,00	0,50	9,30	0,10	21,90
UK	2	1	211,00	11,40	6,80	700,00	0,50	9,30	0,10	21,90
Italy	2	1	211,00	11,40	6,80	700,00	0,50	9,30	0,10	21,90
Germany	1	2	153,00	2,10	0,30	600,00	26,30	4,30	3,70	5,10
Italy	2	2	191,00	4,70	0,74	473,00	11,30	1,30	2,40	25,30
Canada	2	2	169,01	7,04	0,35	359,16	9,15	4,23	0,00	17,61
USA	1	2	169,01	5,63	0,00	394,37	25,35	2,82	8,45	4,23
Canada	2	1	147,89	8,45	2,11	373,24	5,63	2,82	0,00	12,68
Denmark	2	2	230,00	8,40	0,70	410,00	24,00	4,40	6,60	13,00
Austria	1	1	208,00	12,00	5,50	500,00	17,00	2,00	1,70	7,50

USA	1	2	318,58	18,58	1,77	265,49	28,32			
UK	2	1	182,00	8,20	3,20	600,00	9,80	3,90	1,90	18,00
UK	2	2	168,75	7,80	0,99	1100,00	14,00	4,00	0,10	11,70
France	2	2	230,00	10,00	1,10	400,00	25,60	6,70	2,80	6,00
Netherlands	1	1	111,00	1,00	0,20	430,00	19,00	3,00	4,30	5,00
Canada	2	2	157,14	5,71	0,57	385,71	20,00	7,14	2,86	7,14
Germany	2	2	82,00	3,00	0,30	320,00	5,30	1,50	0,80	7,50
USA	2	1	175,00	5,83	0,83	583,33	20,00	5,83	1,67	14,17
USA	2	1	228,57	12,86	0,00	657,14	8,57	2,86	0,00	20,00
USA	1	2	126,76	3,52	0,00	535,21	23,94	7,04	1,41	4,23
USA	1	1	154,93	4,23	2,11	690,14	22,54	5,63	0,00	7,04
UK	1	2	181,00	7,90	0,80	200,00	19,50	5,50	2,90	5,20
France	1	1	98,67	5,07	0,80	373,33	8,80	3,73	3,73	2,93
Italy	2	2	116,00	2,90	0,50	700,00	6,40	6,70	5,20	16,00
Germany	2	1	315,56	20,00	1,56	777,78	9,56	4,00	2,78	22,56
USA	2	2	187,39	8,82	1,10	672,40	23,15	4,41	2,20	5,51
USA	1	2	173,33	3,33	0,00	133,33	28,00	6,67	1,33	8,00
USA	1	2	173,33	2,00	0,00	20,00	32,00	5,33	2,67	5,33
USA	1	2	160,00	3,33	0,00	66,67	25,33	4,00	4,00	6,67
USA	1	2	173,33	2,67	0,00	120,00	30,67	5,33	2,67	8,00
USA	1	2	208,79	12,09	3,85	164,84	21,98	2,20	0,00	4,40
France	1	1	82,67	4,27	0,67	346,67	6,00	2,53	1,47	4,00
USA	1	2	219,78	10,99	2,75	219,78	27,47	4,40	0,00	5,49
USA	1	2	208,79	12,09	3,85	164,84	21,98	2,20	0,00	4,40
USA	1	2	219,78	10,99	2,75	219,78	27,47	3,30	0,00	4,40
Spain	1	2	225,00	10,10	1,20	500,00	28,90	3,30	1,30	4,60
Spain	1	2	200,00	9,00	1,80	400,00	19,60	2,00	0,50	9,30
Spain	1	2	200,00	9,10	1,80	500,00	17,60	2,60	0,90	10,80
Spain	1	1	243,00	13,00	4,10	500,00	17,10	2,30	1,30	13,30
USA	2	2	253,52	12,68	2,11	760,56	25,35	5,63	2,82	12,68
Italy	1	2	108,00	2,70	0,40	500,00	17,00	2,40	0,30	3,40
Italy	1	2	93,00	0,40	0,10	300,00	16,20	7,10	1,00	2,60
Australia	2	1	194,67	7,47	0,67	585,33	11,07	3,87	0,27	18,93
USA	1	1	140,85	3,52	1,41	633,80	22,54	7,04	1,41	5,63
Australia	2	2	141,60	1,60	0,72	130,40	20,72	6,48	6,00	7,52
Spain	2	2	293,00	16,80	2,60	790,00	11,40	3,50	4,00	22,30
USA	2	2	194,03	11,94	1,49	522,39	17,91	10,45	1,49	10,45
Austria	2	2	219,00	10,60	1,60	550,00	15,90	3,10	4,30	13,40
Austria	2	2	234,00	12,30	1,80	510,00	14,50	5,40	4,90	13,70
Austria	2	2	203,00	10,20	1,60	550,00	13,90	3,30	4,60	12,20
Italy	2	2	209,00	12,00	7,40	290,00	5,70	5,40	0,40	16,80
South Korea	2	2	195,00	0,00	0,00	460,00	35,00	1,00	6,00	14,00
Spain	2	2	219,00	14,80	1,60	500,00	14,90	5,10	1,10	3,90
Spain	2	1	236,00	15,40	4,20	600,00	14,10	4,40	0,90	8,10
Spain	2	2	167,00	7,00	0,40	400,00	4,60	1,30	0,10	20,80
Sweden	2	2	160,00	9,00	0,70	400,00	3,00	4,00	0,40	15,00
USA	1	2	141,09	6,41	0,00	320,67	16,67	5,13	1,28	6,41
USA	1	2	183,42	8,47	0,71	352,73	19,75	5,64	4,23	4,23

Austria	1	1	237,33	14,67	5,07	506,67	17,33	1,47	0,93	8,67
Italy	2	1	262,00	17,50	1,50	600,00	4,40	6,50	4,30	18,60
Italy	2	1	257,00	16,10	1,40	1000,00	5,10	6,90	4,50	19,60
Sweden	1	2	200,00	7,00	0,50	500,00	25,00	4,00	5,00	10,00
Italy	1	2	217,00	11,70	2,60	440,00	17,40	1,20	3,40	9,90
Italy	1	2	185,00	10,60	1,70	340,00	15,90	1,80	3,70	5,60
Italy	2	2	164,00	5,80	1,00	450,00	16,00	0,50	0,70	13,30
USA	1	2	165,34	4,41	2,76	286,60	28,66	4,41	0,00	5,51
USA	1	2	209,44	7,72	5,51	319,67	30,86	5,51	0,00	5,51
USA	1	2	231,48	9,92	6,61	374,78	33,07	4,41	0,00	5,51
Italy	1	2	222,00	10,80	1,30	410,00	18,50	6,50	2,30	9,50
UK	2	1	149,33	5,07	0,53	666,67	6,00	4,00	0,67	18,00
USA	2	1	194,03	10,45	1,49	537,31	10,45	5,97	2,99	13,43
USA	1	1	232,32	11,11	2,02	474,75	28,28	5,05	2,02	5,05
USA	2	1	158,33	5,83	0,83	450,00	18,33	6,67	1,67	14,17
UK	1	1	267,00	11,10	0,90	600,00	31,70	4,80	4,90	7,70
Mexico	2	2	152,94	5,29	0,00	376,47	8,24	2,35	1,18	18,82
Italy	2	1	202,50	10,50	3,60	600,00	11,00	6,00	3,40	16,00
USA	2	2	176,99	3,54	0,00	495,58	23,01	3,54	1,77	15,04
Italy	1	1	111,00	1,00	0,20	430,00	19,00	3,00	4,30	5,00
USA	2	1	203,13	9,38	1,56	406,25	7,81	3,13	1,56	23,44
Italy	2	2	209,00	12,00	7,40	290,00	5,70	5,40	0,40	16,80
USA	2	1	171,43	8,57	0,71	500,00	21,43	7,14	2,86	7,14
USA	2	1	210,53	7,89	1,32	684,21	7,89	2,63	2,63	26,32
Germany	1	1	216,67	6,83	0,83	400,00	33,17	1,67	5,17	4,67
Czech Republic	1	1	111,33	1,00	0,20	433,33	19,00	3,00	4,33	5,00
UK	2	2	109,00	3,70	0,80	290,00	8,40	4,70	1,00	8,00
Italy	1	2	165,00	10,40	1,40	310,00	1,20	12,60	0,60	10,50
France	1	1	216,00	7,70	3,70	400,00	26,00	4,20	2,50	8,60
France	1	2	227,00	8,00	1,00	330,00	29,00	5,20	1,80	7,20
Canada	1	1	112,50	2,50	0,00	415,00	20,00	6,25	1,25	2,50
Canada	2	2	112,68	0,70	0,14	394,37	8,45	5,63	0,00	18,31
Canada	2	1	169,01	6,34	2,11	492,96	7,04	5,63	0,00	21,13
Italy	2	1	154,00	6,50	0,70	650,00	5,00	3,50	1,30	17,00
France	1	1	104,00	6,60	1,60	400,00	7,30	2,30	2,00	2,60
Switzerland	2	2	218,00	9,00	0,60	520,00	12,00	7,00	2,00	19,00
Canada	2	2	160,00	4,67	0,40	453,33	10,67	4,00	1,33	17,33
Canada	2	2	133,33	3,33	0,40	506,67	9,33	4,00	1,33	17,33
Canada	2	1	146,67	5,33	0,53	426,67	12,00	5,33	2,67	12,00
Denmark	2	1	168,00	6,00	0,67	706,67	9,33	2,00	0,60	18,00
Germany	1	2	342,00	3,00	0,70	500,00	63,00	12,00	2,60	9,80
USA	2	2	164,71	7,06	0,00	494,12	21,18	8,24	2,35	7,06
UK	2	1	222,00	8,60	0,60	500,00	14,70	4,10	1,40	20,80
Germany	1	2	350,00	6,50	0,80	1600,00	54,70	9,40	6,20	13,50
Canada	2	2	157,14	4,29	0,43	414,29	22,86	5,71	2,86	7,14
USA	2	1	169,01	5,63	2,11	450,70	16,90	2,82	1,41	11,27
USA	2	1	197,18	9,86	2,11	422,54	11,27	4,23	0,00	14,08

USA	2	2	229,28	14,11	2,20	423,28	6,17	3,53	0,00	20,28
USA	1	2	141,09	6,41	6,41	320,67	16,67	5,13	1,28	6,41
USA	1	2	183,42	9,88	0,71	352,73	21,16	5,64	2,82	2,82
USA	2	2	183,42	8,47	0,71	395,06	16,93	4,23	2,82	9,88
USA	2	2	126,98	2,82	0,00	409,17	22,58	4,23	4,23	7,05
USA	1	2	113,21	2,83	0,00	254,72	18,87	3,77	2,83	2,83
Colombia	2	2	150,00	1,43	0,00	514,29	15,71	4,29	0,00	17,14
USA	2	2	194,03	11,94	1,49	552,24	16,42	7,46	1,49	8,96
USA	1	2	103,77	2,83	0,00	254,72	17,92	2,83	3,77	2,83
USA	1	2	219,78	10,99	2,75	219,78	27,47	4,40	0,00	5,49
Israel	2	2	186,00	10,00	1,00	375,00	17,00	8,00	1,50	11,00
Mexico	1	2	182,40	5,60	0,80	504,00	25,40	4,10	2,80	7,60
USA	1	2	186,81	6,59	1,10	384,62	26,37	3,30	1,10	4,40
USA	1	1	186,81	7,69	3,30	362,64	24,18	3,30	2,20	7,69
USA	1	1	197,80	8,79	2,75	461,54	26,37	3,30	4,40	5,49
USA	1	1	186,81	7,69	1,65	329,67	25,27	3,30	2,20	6,59
USA	2	1	211,27	9,86	2,11	577,47	18,31	2,82	1,41	12,68
Canada	2	2	150,44	2,65	0,27	238,94	17,70	1,77	4,42	14,16
USA	2	2	229,28	14,11	1,76	423,28	6,17	3,53	0,00	20,28
Canada	2	2	120,00	2,00	0,00	520,00	13,33	4,00	2,67	12,00
Canada	2	2	140,35	3,51	0,35	631,58	8,77	3,51	1,75	17,54
Canada	2	1	159,09	5,68	0,57	443,18	12,50	3,41	3,41	13,64
USA	1	2	160,00	2,00	0,00	120,00	29,33	2,67	1,33	5,33
Canada	2	1	166,67	5,83	0,83	450,00	18,33	6,67	1,67	14,17
USA	2	2	369,57	26,09	8,70	554,35	9,78	2,17	1,09	23,91
USA	2	2	142,86	3,57	0,00	428,57	14,29	4,29	2,86	14,29
Canada	2	2	141,59	5,31	0,88	424,78	18,58	3,54	7,08	4,42
Puerto Rico	1	2	141,09	2,94	0,00	352,73	23,52	4,70	1,18	4,70
Colombia	1	2	339,00	4,50	0,90	2840,00	56,00	13,00	4,40	12,00
Colombia	2	2	350,00	2,68	0,49	978,05	36,34	1,71	0,00	45,12
USA	1	2	93,46	3,27	0,00	205,61	14,95	2,80	1,87	2,80
USA	1	2	199,88	9,41	1,18	282,19	22,34	3,53	2,35	4,70
USA	1	2	141,09	7,05	0,71	352,73	15,52	2,82	1,41	2,82
USA	1	2	171,33	7,05	0,50	312,42	23,18	3,02	1,01	4,03
USA	1	1	154,93	4,23	2,11	690,14	22,54	5,63	0,00	7,04
USA	2	2	220,46	7,94	0,88	352,73	24,69	4,41	4,41	14,99
USA	2	2	211,27	8,45	0,00	380,28	23,94	4,23	7,04	11,27
USA	1	2	141,09	2,94	0,00	352,73	23,52	4,70	1,18	4,70
Ar2tina	2	2	134,67	6,13	0,53	28,00	2,93	6,93	0,40	17,33
USA	2	2	211,64	10,58	1,32	343,92	16,75	5,29	1,76	16,75
USA	1	2	255,10	18,37	5,10	285,71	17,35	8,16	4,08	8,16
USA	1	2	202,82	10,58	1,32	343,92	26,46	4,41	0,88	8,82
USA	1	2	244,90	16,33	6,12	316,33	19,39	9,18	4,08	9,18
USA	1	2	218,36	11,76	1,68	352,73	28,55	5,04	1,68	8,40
Canada	1	2	242,86	15,71	1,43	414,29	20,00	5,71	1,43	5,71
Canada	1	2	175,00	4,00	0,25	67,50	26,50	11,50	4,50	9,50
USA	1	2	198,41	9,92	7,72	385,80	24,25	4,41	2,20	3,31
USA	1	2	183,10	8,45	0,70	408,45	23,94	5,63	1,41	4,23

USA	2	2	211,27	11,27	1,41	267,61	23,94	4,23	1,41	2,82
USA	2	2	183,10	9,86	0,70	408,45	21,13	8,45	1,41	4,23
Canada	1	2	169,01	5,63	0,56	394,37	25,35	2,82	8,45	4,23
Canada	2	2	190,00	7,00	0,50	300,00	22,00	8,00	3,00	15,00
Canada	2	2	150,44	2,65	0,27	238,94	17,70	1,77	4,42	14,16
USA	2	2	126,76	4,23	0,00	549,30	22,54	5,63	4,23	7,04
Canada	2	1	183,10	8,45	1,41	450,70	9,15	5,63	2,11	20,42
Canada	1	2	370,97	6,45	0,32	419,36	69,35	6,45	0,00	12,90
Colombia	1	2	374,00	8,80	1,30	2000,00	54,00	9,30	3,50	15,00
UK	1	2	196,92	7,69	1,23	270,77	19,85	8,77	0,92	7,85
Canada	2	2	180,00	7,00	0,50	330,00	19,00	9,00	2,00	14,00
Canada	2	2	190,00	8,00	0,50	340,00	20,00	7,00	4,00	13,00
Ar2tina	2	2	220,00	3,06	0,35	660,00	36,47	5,41	0,35	11,06
Morocco	2	1	180,00	7,00	0,50	600,00	12,00	7,00	4,00	17,00
USA	2	1	184,21	7,89	0,00	684,21	7,89	2,63	0,00	23,68
USA	1	2	209,44	8,82	6,61	264,55	27,56	4,41	0,00	4,41
USA	1	2	198,41	7,72	5,51	297,62	27,56	4,41	0,00	4,41
USA	1	2	176,37	7,72	6,61	231,48	24,25	3,31	0,00	4,41
USA	1	2	209,44	7,72	5,51	385,80	29,76	4,41	0,00	4,41
Argetina	2	2	138,67	6,27	0,67	610,67	5,87	6,27	0,40	14,67
Colombia	1	2	222,22	0,00	0,00	644,44	42,22	4,44	0,00	10,00
Mexico	2	2	169,01	5,63	0,00	521,13	21,13	7,04	1,41	8,45
Mexico	2	2	140,85	5,63	0,70	422,54	18,31	4,23	7,04	4,23
Canada	2	1	91,55	3,17	2,11	401,41	4,93	2,82	0,00	11,97
Canada	2	2	170,73	7,32	0,61	536,59	9,76	3,66	2,44	15,85
Sweden	2	2	207,50	10,25	1,50	550,00	16,25	4,75	0,13	10,13
USA	1	2	176,37	7,94	0,44	352,73	9,70	7,94	0,88	16,75
USA	2	2	255,73	19,40	4,41	396,83	5,29	2,65	0,00	17,64
USA	1	2	171,72	7,07	0,51	313,13	23,23	3,03	1,01	4,04
Israel	2	2	141,00	3,40	0,00	320,00	17,60	7,40	2,80	8,00
Israel	2	2	179,00	6,10	0,70	336,00	24,30	4,50	2,70	6,90
UK	2	2	210,00	13,63	2,25	681,75	8,25	5,50	1,88	8,25
Australia	1	2	148,80	1,68	0,32	300,00	23,60	6,48	5,92	6,40
Mexico	2	2	126,06	2,11	0,00	408,45	15,49	4,23	0,00	11,27
Peru	1	2	103,33	1,58	0,00	251,50	18,42	1,83	0,00	3,75
Argentina	2	2	207,06	4,59	0,71	429,41	32,94	5,65	0,35	11,76
USA	1	1	197,80	8,79	1,10	307,69	24,18	6,59	2,20	5,49
USA	2	2	154,93	7,04	0,70	176,06	18,31	5,63	2,82	2,82
USA	2	2	169,01	8,45	0,70	295,78	19,72	1,41	1,41	2,82
Peru	1	2	126,67	1,00	0,00	301,08	23,58	5,33	0,00	5,83
New Zealand	2	2	221,00	2,30	0,00	665,00	21,00	3,50	2,90	31,50
Netherlands	1	2	184,00	7,80	0,90	300,00	17,50	5,50	3,40	8,30
Mexico	1	2	149,33	10,67	0,67	373,33	16,00	4,00	2,67	1,33
Peru	1	2	125,00	1,33	0,00	315,42	20,92	4,75	0,00	7,42
Peru	1	2	134,17	1,42	0,00	303,75	23,58	4,75	0,00	6,92
USA	2	2	183,42	7,05	0,00	423,28	21,16	5,64	2,82	8,47
Canada	2	1	159,29	7,96	1,33	407,08	18,58	5,31	4,42	5,31
Canada	2	1	141,59	7,08	1,33	336,28	17,70	5,31	2,65	5,31

USA	2	2	265,63	14,06	2,34	562,50	12,50	7,81	4,69	21,88
USA	1	2	200,00	14,12	1,76	352,94	8,24	1,18	1,18	12,94
USA	2	2	315,22	17,39	5,43	478,26	10,87	3,26	2,17	27,17
Mexico	1	2	149,33	10,67	0,67	386,67	16,00	4,00	4,00	1,33
Mexico	1	1	166,67	12,00	1,33	360,00	16,00	4,00	2,67	2,67
Mexico	1	1	167,14	12,86	1,43	442,86	15,71	4,29	2,86	1,43
Canada	1	1	176,99	5,31	1,77	345,13	29,20	7,08	2,65	7,08
Puerto Rico	2	2	191,92	8,08	1,01	353,54	21,21	2,02	1,01	7,07
USA	1	1	161,62	6,06	1,01	292,93	22,22	3,03	2,02	5,05
South Africa	2	2	148,75	5,63	0,75	772,50	7,38	6,25	0,25	14,00
USA	1	2	181,82	5,19	3,25	311,69	28,57	5,19	1,30	5,19
USA	1	1	188,24	9,41	1,18	376,47	22,35	3,53	3,53	4,71
Canada	2	1	160,00	4,00	0,40	280,00	24,00	4,00	5,33	9,33
USA	1	2	198,41	7,72	5,51	319,67	27,56	3,31	0,00	4,41
USA	2	1	168,14	5,31	0,88	407,08	23,01	3,54	2,65	8,85
Canada	2	1	173,33	5,33	0,53	586,67	20,00	4,00	2,67	12,00
Canada	1	1	146,67	4,67	0,40	226,67	18,67	4,00	4,00	9,33
USA	2	2	140,85	7,04	0,70	352,11	15,49	2,82	1,41	2,82
USA	2	2	197,18	9,86	0,70	394,37	22,54	9,86	1,41	7,04
USA	1	2	155,84	4,55	2,60	181,82	19,48	3,90	0,00	3,90
USA	2	1	120,00	4,00	0,00	520,00	16,00	4,00	4,00	4,00
USA	2	1	100,00	4,00	0,00	500,00	12,00	1,00	2,00	4,00
USA	2	2	194,03	11,94	1,49	522,39	17,91	10,45	1,49	10,45
USA	2	2	181,82	7,07	0,51	545,46	14,14	4,04	3,03	14,14
USA	2	2	181,82	7,07	0,51	494,95	16,16	4,04	3,03	15,15
USA	1	2	184,85	4,95	0,00	176,77	22,22	4,04	3,03	7,07
USA	2	2	199,88	5,29	0,59	305,70	28,22	5,88	3,53	12,93
USA	2	2	211,27	7,04	0,70	591,55	23,94	4,23	11,27	9,86
USA	2	1	169,01	6,34	2,11	492,96	7,04	5,63	0,00	21,13
USA	2	2	169,01	7,04	0,70	422,54	18,31	4,23	1,41	16,90
USA	2	2	141,18	5,88	0,00	376,47	9,41	3,53	1,18	16,47
USA	1	2	126,98	2,82	0,00	409,17	22,58	4,23	4,23	7,05
USA	1	2	169,31	8,47	0,71	296,30	19,75	1,41	1,41	2,82
USA	1	2	199,88	10,58	0,59	293,95	23,52	5,88	2,35	4,70
USA	2	2	183,42	8,47	0,71	395,06	16,93	4,23	2,82	9,88
Canada	2	1	159,29	6,19	3,54	371,68	16,81	2,65	0,88	8,85
USA	1	2	183,42	8,47	0,71	409,17	23,99	5,64	1,41	4,23
USA	1	2	183,42	9,88	0,71	409,17	21,16	8,47	1,41	4,23
Colombia	1	2	222,22	1,11	0,00	644,44	42,22	4,44	0,00	10,00
USA	2	2	264,55	17,64	4,41	379,19	6,17	3,53	0,00	20,28
USA	2	1	164,18	5,97	0,75	492,54	19,40	5,97	1,49	14,93
USA	2	2	225,35	8,45	1,41	450,70	26,76	4,23	2,82	12,68
USA	2	2	239,44	11,27	2,11	633,80	25,35	5,63	2,82	12,68
USA	2	2	123,89	5,31	0,44	495,58	17,70	3,54	1,77	5,31
USA	2	2	159,29	6,19	0,88	380,53	21,24	5,31	2,65	7,08
USA	2	2	159,29	9,73	0,88	415,93	15,93	3,54	2,65	5,31
Hong Kong, China	2	2	141,18	5,88	0,00	376,47	9,41	3,53	1,18	16,47

Hong Kong, China	2	2	256,64	19,47	4,42	398,23	5,31	2,65	0,00	17,70
Chile	2	2	140,83	2,12	0,25	393,33	16,92	2,72	0,37	14,42
Chile	2	2	135,00	2,38	0,18	363,33	14,42	2,13	1,28	16,58
Chile	1	2	156,36	3,00	0,21	392,73	23,27	3,27	3,11	9,17
Canada	1	1	237,50	8,75	5,63	487,50	28,75	2,50	2,50	10,00
Chile	1	2	145,46	5,83	0,61	390,00	19,36	2,79	1,78	7,24
Canada	2	2	159,09	10,23	1,14	386,36	13,64	1,14	0,00	7,95
USA	2	2	199,88	5,88	0,59	376,25	24,69	3,53	4,70	12,93
Israel	2	2	164,00	0,90	0,50	360,00	16,00	4,50	2,00	7,00
Canada	2	2	321,43	16,07	2,68	482,14	23,21	5,36	1,79	19,64
Canada	1	2	209,68	3,23	0,32	217,74	38,71	4,84	0,00	8,06
Philippines	2	1	142,86	4,76	0,00	666,67	11,90	4,76	0,00	14,29
USA	1	2	167,55	7,05	0,44	343,92	9,70	7,05	0,88	16,75
Canada	2	2	164,71	7,06	0,59	494,12	21,18	4,71	3,53	7,06
Thailand	2	1	190,48	7,14	0,00	380,95	20,63	4,76	3,17	11,11
Thailand	2	1	142,86	4,76	0,00	666,67	11,90	4,76	0,00	14,29
USA	2	2	183,10	5,63	0,70	901,41	18,31	4,23	0,00	15,49
USA	2	2	183,10	5,63	0,70	830,99	18,31	4,23	1,41	16,90
USA	2	2	98,59	1,41	0,00	633,80	8,45	5,63	0,00	18,31
USA	2	1	140,85	5,63	1,41	492,96	8,45	5,63	1,41	18,31
USA	2	2	141,59	7,96	0,88	389,38	15,04	5,31	2,65	7,96
USA	2	2	239,44	9,86	1,41	450,70	28,17	4,23	2,82	12,68
Colombia	2	1	166,67	8,89	1,11	422,22	4,44	0,00	0,00	20,00
Chile	1	2	142,00	2,80	0,50	218,40	21,00	4,40	1,00	8,10
Philippines	2	1	190,48	7,14	0,00	380,95	20,63	4,76	3,17	11,11
USA	2	2	98,59	1,41	0,00	633,80	8,45	5,63	0,00	18,31
Colombia	1	2	188,89	0,00	0,00	633,33	37,78	5,56	1,11	10,00
Israel	2	2	211,00	8,80	1,70	428,00	20,50	2,50	1,10	11,70
USA	2	2	183,10	5,63	0,70	788,73	18,31	4,23	1,41	16,90
USA	2	2	183,10	5,63	0,70	845,07	18,31	4,23	0,00	16,90
USA	2	2	247,79	12,39	1,33	451,33	15,93	5,31	4,42	16,81
USA	1	2	202,53	7,59	1,27	481,01	29,11	5,06	2,53	6,33
Israel	2	2	192,00	11,00	1,20	630,00	14,40	6,40	1,70	12,10
USA	2	2	212,39	9,73	1,77	407,08	6,19	3,54	0,00	24,78
Taiwan, China	1	2	141,00	6,80	1,20	216,00	17,90	3,90	2,00	4,10
Taiwan, China	2	1	252,00	14,00	2,40	228,00	18,80	2,80	1,80	14,00
Mexico	1	2	152,02	10,61	0,81	295,96	12,12	4,04	3,03	2,02
USA	1	1	168,14	5,31	3,10	336,28	18,58	5,31	3,54	12,39
USA	1	2	162,50	6,25	0,00	312,50	18,75	5,00	3,75	6,25
New Zealand	1	2	229,60	7,60	0,80	320,00	31,52	5,92	5,52	5,60
Canada	1	2	180,00	6,00	0,50	280,00	21,00	9,00	2,00	8,00
Canada	2	2	126,76	2,11	0,28	408,45	15,49	4,23	0,00	11,27
Canada	2	2	141,18	5,29	0,47	388,24	22,35	3,53	2,35	4,71
Canada	1	2	160,00	10,00	1,43	452,86	4,29	0,00	1,43	15,71
Canada	1	2	266,67	18,67	2,00	293,33	6,67	1,33	1,33	20,00

Canada	2	2	238,94	15,93	4,42	345,13	5,31	1,77	0,00	17,70
Colombia	1	2	460,00	22,00	4,00	380,00	54,00	14,00	8,00	14,00
Canada	1	2	197,80	7,69	5,49	318,68	27,47	3,30	0,00	4,40
Canada	1	2	175,82	7,69	6,59	230,77	24,18	3,30	0,00	4,40
Canada	1	2	197,80	7,69	5,49	296,70	27,47	4,40	0,00	4,40
USA	1	2	175,82	7,69	0,55	285,71	21,98	3,30	0,00	3,30
Mexico	1	2	229,03	3,23	0,32	387,10	40,32	4,84	0,00	9,68
Canada	1	2	301,89	13,21	1,89	509,43	20,75	5,66	1,89	20,75
Ar2tina	2	2	138,67	6,27	0,67	494,67	5,87	6,27	0,53	14,67
Canada	2	2	133,33	3,33	0,27	520,00	8,00	4,00	1,33	17,33
Canada	2	2	221,24	12,39	4,42	318,58	4,42	1,77	0,00	23,89
Canada	2	2	230,09	15,04	2,21	477,88	8,85	3,54	0,88	17,70
USA	2	2	238,10	17,64	4,41	335,10	4,41	2,65	0,00	17,64
USA	2	1	184,21	7,89	0,00	684,21	7,89	2,63	0,00	23,68
USA	2	2	175,82	7,69	0,55	263,74	20,88	3,30	0,00	4,40
Australia	2	2	179,20	6,88	2,40	310,40	17,60	5,12	1,60	9,04
USA	1	2	139,45	2,05	0,00	262,50	24,61	6,56	0,82	8,20
New Zealand	1	2	264,44	12,00	2,44	327,78	29,56	5,56	2,33	8,56
Qatar	2	2	148,75	5,63	0,75	772,50	7,38	6,25	0,25	14,00
Canada	2	2	212,39	9,73	1,77	407,08	6,19	3,54	0,00	24,78
South Korea	2	2	238,94	17,70	4,42	336,28	4,42	2,65	0,00	17,70
USA	2	2	221,24	16,81	7,96	238,94	7,96	3,54	0,88	18,58
Singapore	2	2	221,24	15,93	5,31	345,13	2,65	1,77	0,00	17,70
USA	1	2	199,88	9,41	1,18	282,19	22,34	3,53	2,35	4,70
Canada	1	2	191,92	8,08	1,01	353,54	21,21	2,02	1,01	7,07
Canada	2	2	164,95	8,25	0,52	463,92	7,22	4,12	1,03	16,49
USA	2	2	243,59	8,97	1,28	358,97	28,21	8,97	1,28	10,26
USA	1	2	230,77	8,97	0,64	346,15	25,64	6,41	2,56	10,26
USA	1	2	185,19	7,94	1,32	432,10	10,58	3,53	0,88	16,75
USA	2	2	220,46	15,87	5,29	343,92	2,65	1,76	0,00	17,64
USA	2	2	211,64	12,35	7,05	326,28	7,94	2,65	0,88	16,75
USA	2	2	158,33	5,83	0,83	366,67	18,33	6,67	2,50	13,33
Canada	2	2	159,29	9,73	1,33	353,98	15,04	2,65	2,65	6,19
Costa Rica	2	2	140,00	2,00	1,00	510,00	31,00	7,00	4,00	7,00
USA	2	2	202,82	10,58	3,09	564,37	7,94	4,41	0,88	22,05
USA	1	2	202,82	5,29	0,88	246,91	28,22	6,17	2,65	13,23
USA	2	2	230,09	13,27	6,19	353,98	7,96	5,31	0,88	23,01
USA	2	2	164,18	6,72	0,75	477,61	19,40	5,97	1,49	13,43
USA	2	1	164,18	6,72	0,75	582,09	13,43	5,97	1,49	16,42
USA	2	2	184,21	9,21	0,00	789,47	7,89	2,63	2,63	15,79
Germany	2	2	241,00	16,40	2,00	960,00	7,10	5,30	1,70	13,70
Thailand	2	1	243,00	13,80	1,90	1,10	10,30	2,30	1,40	18,20
USA	2	2	238,94	15,04	2,21	477,88	8,85	1,77	0,88	17,70
Laos	2	2	183,10	5,63	0,00	605,63	18,31	5,63	2,82	15,49
USA	1	2	164,84	7,69	0,55	274,73	20,88	3,30	0,00	3,30
USA	1	2	175,82	7,69	0,55	252,75	23,08	3,30	0,00	4,40
Thailand	2	2	221,24	15,93	5,31	345,13	2,65	1,77	0,00	17,70
Canada	2	2	147,73	5,11	0,45	420,46	9,09	3,41	1,14	17,05

USA	2	2	183,10	5,63	0,00	605,63	18,31	5,63	2,82	15,49
USA	2	2	185,84	3,54	0,44	486,73	21,24	5,31	5,31	16,81
USA	1	2	211,27	7,04	0,70	380,28	29,58	5,63	1,41	8,45
USA	1	2	183,10	7,04	0,70	577,47	25,35	4,23	2,82	5,63
Canada	1	2	176,00	4,80	0,80	160,00	22,40	4,80	1,60	11,20
Canada	1	2	176,00	5,60	0,80	128,00	20,80	4,00	3,20	9,60
Canada	1	2	176,00	8,00	1,20	36,00	24,80	6,40	5,60	11,20
USA	1	1	154,93	6,34	1,41	295,78	22,54	2,82	1,41	4,23
USA	1	1	183,10	9,86	1,41	366,20	22,54	2,82	2,82	4,23
USA	1	2	183,10	7,04	0,70	450,70	25,35	4,23	1,41	5,63
USA	2	1	197,18	5,63	0,70	408,45	26,76	4,23	2,82	8,45
USA	2	2	214,29	16,67	10,71	428,57	7,14	2,38	2,38	11,90
UAE	2	2	158,24	11,82	10,59	282,35	3,12	2,47	0,47	8,65
UAE	2	2	221,24	15,93	5,31	345,13	2,65	1,77	0,00	17,70
USA	2	2	214,29	16,07	11,61	517,86	8,04	2,68	0,00	12,50
Colombia	1	2	250,00	4,00	0,00	360,00	43,00	7,00	0,00	11,00
Ecuador	2	2	220,00	12,00	2,00	585,00	10,00	1,00	0,00	18,00
USA	2	2	213,33	12,00	1,33	413,33	25,33	2,67	2,67	4,00
USA	1	2	293,33	14,67	1,33	386,67	38,67	2,67	2,67	4,00
USA	1	2	226,67	9,33	1,33	520,00	34,67	8,00	2,67	5,33
Canada	2	2	140,35	3,51	0,35	596,49	8,77	3,51	1,75	17,54
USA	2	2	247,79	15,93	2,21	513,27	7,08	3,54	0,88	23,89
USA	2	1	203,13	7,81	0,78	609,38	12,50	6,25	1,56	25,00
Mexico	2	2	216,93	15,87	5,29	343,92	2,65	1,76	0,00	17,64
USA	2	2	238,94	15,04	2,21	477,88	8,85	1,77	0,88	17,70
USA	2	2	183,42	8,47	0,71	395,06	16,93	4,23	2,82	9,88
Hong Kong, China	2	2	221,24	15,93	5,31	345,13	2,65	1,77	0,00	17,70
USA	2	2	225,35	8,45	1,41	450,70	26,76	4,23	2,82	12,68
USA	2	2	239,44	9,86	1,41	450,70	28,17	4,23	2,82	12,68
Canada	2	2	253,33	12,00	1,33	506,67	26,67	4,00	2,67	8,00
USA	2	2	203,54	11,50	0,88	424,78	9,73	4,42	0,00	14,16
Chile	2	1	276,00	6,80	2,30	879,00	28,10	10,60	8,10	25,80
Malaysia	2	2	221,24	15,93	5,31	345,13	2,65	1,77	0,00	17,70
USA	2	2	229,28	15,87	4,41	308,64	4,41	1,76	0,00	17,64
USA	2	1	184,21	7,89	0,00	684,21	7,89	2,63	0,00	23,68
Canada	2	2	154,93	3,52	0,42	380,28	14,08	2,82	1,41	5,63
Canada	2	2	211,27	7,04	0,70	774,65	29,58	5,63	1,41	8,45
Canada	2	1	173,33	5,33	0,53	586,67	20,00	4,00	2,67	12,00
Canada	2	1	146,67	4,67	0,40	226,67	18,67	4,00	4,00	9,33
USA	2	2	203,54	12,39	7,96	345,13	5,31	0,00	0,00	17,70
Canada	2	1	140,85	6,34	2,11	563,38	8,45	5,63	1,41	18,31
Ar2tina	2	2	220,00	4,71	0,71	460,00	35,29	5,76	0,47	10,00
Ar2tina	2	2	240,00	3,06	0,35	497,65	42,35	5,18	0,47	10,59
Canada	2	2	169,01	4,93	0,70	887,32	19,72	4,23	0,00	16,90
Canada	2	1	164,18	6,72	0,75	582,09	13,43	5,97	1,49	16,42
Canada	2	1	194,03	6,72	0,75	328,36	22,39	8,96	2,99	13,43
Canada	2	1	194,03	6,72	0,75	417,91	19,40	7,46	1,49	16,42

Germany	2	2	243,00	8,00	4,00	500,00	12,00	1,00	1,00	33,00
Mexico	1	2	168,68	0,00	0,00	349,40	32,53	10,84	1,20	9,64
Canada	2	2	176,99	8,85	0,44	300,89	10,62	5,31	1,77	16,81
Canada	2	2	133,33	2,67	0,27	426,67	9,33	2,67	1,33	17,33
USA	2	2	283,19	9,73	1,77	495,58	27,43	7,08	4,42	18,58
Colombia	1	2	175,00	3,75	0,00	175,00	27,50	10,00	3,75	12,50
Canada	2	2	230,09	15,04	2,21	477,88	8,85	3,54	0,88	17,70
USA	2	2	157,90	7,89	0,00	684,21	10,53	2,63	5,26	15,79
USA	2	2	184,21	9,21	0,00	710,53	10,53	2,63	2,63	15,79
Colombia	2	1	360,00	6,00	2,00	820,00	66,00	4,00	10,00	12,00
Thailand	2	2	221,24	15,04	8,85	300,89	7,96	2,65	0,00	13,27
Colombia	2	2	380,00	8,00	2,00	100,00	52,00	4,00	0,00	22,00
Canada	2	2	238,94	15,93	4,42	345,13	5,31	1,77	0,00	17,70
USA	2	2	203,54	11,50	1,77	336,28	7,08	3,54	0,00	17,70
Israel	1	1	141,00	7,50	0,70	400,00	11,80	3,30	4,30	4,80
Canada	2	2	158,54	7,32	0,61	524,39	7,32	3,66	1,22	15,85
USA	2	2	105,26	2,63	0,00	605,26	10,53	2,63	2,63	15,79
USA	2	2	221,24	15,04	4,42	345,13	5,31	0,88	0,88	17,70
Ecuador	2	2	220,64	6,35	1,59	388,89	12,70	0,00	3,17	28,57
Israel	2	2	211,00	10,80	1,10	490,00	16,30	7,10	2,00	15,80
Puerto Rico	2	2	229,28	15,87	4,41	308,64	4,41	1,76	0,00	17,64
Canada	2	2	221,24	14,16	4,42	433,63	7,08	0,88	0,88	17,70
Canada	1	2	175,82	7,69	0,55	285,71	21,98	3,30	0,00	3,30
Canada	1	2	175,82	7,69	0,55	263,74	20,88	3,30	0,00	4,40
USA	2	2	256,64	17,70	2,65	398,23	9,73	4,42	0,88	15,93
Canada	2	2	315,22	17,39	5,43	478,26	10,87	3,26	2,17	27,17
Canada	2	2	238,94	16,81	9,73	300,89	5,31	4,42	0,88	18,58
Canada	2	1	183,10	8,45	1,41	450,70	9,15	5,63	2,11	20,42
Canada	2	2	185,84	9,73	2,65	327,43	12,39	3,54	0,00	18,58
Philippines	2	1	202,50	7,50	3,75	743,75	18,75	6,25	2,50	13,75
Canada	2	2	238,94	16,81	5,31	300,89	4,42	2,65	0,00	17,70
Cambodia	2	2	230,09	15,93	4,42	309,74	4,42	1,77	0,00	17,70
South Korea	2	2	187,50	11,25	5,00	650,00	10,00	5,00	5,00	10,00
Israel	1	2	161,00	4,60	0,60	321,00	20,00	6,40	5,90	6,60
Canada	1	1	339,29	16,07	2,68	571,43	26,79	3,57	1,79	21,43
USA	2	2	255,73	19,40	6,17	299,82	3,53	0,88	0,00	15,87
South Korea	2	2	237,50	17,50	8,75	675,00	11,25	5,00	6,25	12,50
Canada	2	2	230,00	6,00	0,50	410,00	20,00	7,00	1,00	25,00
USA	2	2	208,33	15,00	4,17	308,33	10,00	6,67	0,83	17,50
Puerto Rico	2	2	239,44	9,86	1,41	450,70	28,17	4,23	2,82	12,68
Australia	1	2	210,40	10,40	0,88	440,00	18,64	8,80	4,48	6,48
Australia	1	2	228,00	10,72	1,04	390,40	20,00	7,20	2,64	9,36
Canada	2	1	98,59	3,52	2,11	394,37	4,93	2,82	0,00	12,68
USA	2	2	212,39	12,39	1,33	371,68	6,19	4,42	0,00	20,35
Canada	2	2	84,51	2,11	0,14	422,54	8,45	4,23	1,41	11,27
Canada	1	2	169,01	8,45	0,56	295,78	19,72	1,41	1,41	2,82
USA	2	2	212,39	12,39	7,08	327,43	7,96	2,65	0,88	16,81
Mexico	2	1	176,00	10,67	1,33	466,67	18,67	5,33	4,00	1,33

Mexico	2	2	182,67	12,00	0,67	440,00	17,33	4,00	5,33	1,33
Canada	2	2	157,14	4,29	0,43	414,29	22,86	4,29	2,86	7,14
Israel	2	2	198,00	13,30	3,80	310,00	3,20	3,90	1,10	14,40
USA	2	2	169,01	7,04	0,00	366,20	8,45	0,00	1,41	25,35
USA	2	2	197,18	12,68	1,41	563,38	12,68	2,82	1,41	16,90
Malaysia	2	2	310,35	20,69	7,76	465,52	10,34	3,45	0,00	18,97
Malaysia	2	2	310,35	20,69	7,76	465,52	10,34	3,45	0,00	18,97
Israel	2	2	203,00	10,60	1,30	415,00	9,70	5,30	0,00	17,70
Canada	2	2	197,18	4,23	0,35	492,96	27,46	7,75	2,82	16,20
USA	2	2	225,35	9,86	0,00	478,87	23,94	5,63	1,41	14,08
Chile	2	2	271,80	3,00	0,50	398,00	25,60	15,60	3,00	27,80
Chile	1	2	275,80	3,80	0,66	384,00	35,00	15,20	5,00	17,80
Chile	2	2	231,00	16,70	9,30	399,00	2,70	5,60	0,30	16,00
Mexico	2	2	195,02	9,60	0,75	190,52	15,00	0,30	0,00	13,50
Indonesia	1	1	131,43	4,14	2,00	134,29	19,00	3,29	2,71	5,86
Canada	2	2	210,00	12,00	7,00	330,00	8,00	2,00	1,00	17,00
Australia	2	2	143,75	4,02	0,63	708,93	8,04	3,13	3,66	17,68
Philippines	2	2	203,54	12,39	5,31	557,52	8,85	7,96	0,00	15,04
USA	2	2	238,94	15,04	6,19	407,08	3,54	1,77	0,88	17,70
Canada	2	2	238,94	16,81	5,31	300,89	4,42	2,65	0,00	17,70
Canada	1	2	242,86	15,71	1,43	414,29	20,00	5,71	1,43	5,71
Chile	2	2	221,24	15,93	5,31	345,13	2,65	1,77	0,00	17,70
Colombia	1	1	350,00	2,92	0,00	533,33	52,50	20,83	0,00	19,17
Colombia	1	2	325,00	1,25	0,00	483,33	50,00	20,00	0,00	18,33
Colombia	1	2	358,33	6,67	0,00	491,67	58,33	6,67	0,00	13,33
Australia	2	2	234,78	14,00	11,04	178,26	8,43	5,04	1,04	13,91
Australia	1	2	224,00	6,72	0,64	230,40	30,64	5,68	3,92	7,20
South Africa	2	2	223,00	15,70	2,30	4,38	12,20	9,94	2,20	8,70
Israel	2	2	212,00	11,30	4,40	400,00	14,00	3,40	0,70	12,00
USA	2	2	185,84	8,85	0,88	442,48	18,58	7,96	1,77	7,96
Canada	2	2	221,24	14,16	6,19	477,88	6,19	0,00	0,00	17,70
Indonesia	1	1	131,43	4,14	2,00	134,29	19,00	3,29	2,71	5,86
USA	2	2	235,29	12,94	2,35	411,77	8,24	2,35	1,18	22,35
USA	2	2	132,74	3,98	0,44	495,58	7,08	0,00	0,88	18,58
USA	1	2	239,44	9,86	0,70	577,47	35,21	7,04	1,41	5,63
Chile	2	2	235,00	17,40	1,90	313,00	6,20	1,60	0,60	15,10
Chile	2	2	242,00	15,60	1,70	395,00	6,30	1,70	0,90	18,00
Australia	2	2	162,40	4,72	0,40	460,00	19,68	3,60	3,04	8,32
Peru	1	2	127,00	1,00	0,00	301,10	23,60	5,30	0,00	5,80
Peru	2	2	125,83	1,08	0,00	367,33	25,00	4,17	0,00	4,17
Chile	2	2	148,33	4,13	0,42	385,83	11,17	5,23	0,23	17,08
Israel	1	2	193,00	6,30	0,70	277,00	27,00	3,70	7,20	5,30
USA	2	1	164,18	6,72	0,75	477,61	19,40	5,97	1,49	13,43
USA	2	2	225,35	9,86	1,41	394,37	23,94	4,23	2,82	12,68
USA	2	2	225,35	8,45	1,41	450,70	26,76	4,23	2,82	12,68
Israel	2	2	230,00	14,80	4,00	587,00	5,30	3,70	0,00	17,10
Peru	2	2	271,80	3,00	0,50	398,00	25,60	15,60	3,00	27,80
Canada	2	2	238,94	16,81	9,73	300,89	5,31	4,42	0,88	18,58

USA	2	2	176,47	7,06	0,59	435,29	9,41	3,53	1,18	18,82
Thailand	2	2	115,04	4,42	0,88	398,23	15,93	5,31	2,65	2,65
Colombia	2	2	230,10	16,70	9,30	399,00	2,70	5,60	0,30	16,00
Canada	2	2	212,39	12,39	7,08	327,43	7,96	2,65	0,88	16,81
USA	2	2	212,39	13,27	8,85	398,23	7,08	0,88	0,88	16,81
Peru	2	2	230,09	15,93	4,42	309,74	4,42	1,77	0,00	17,70
Kenya	2	2	125,00	4,50	0,50	811,25	1,88	4,50	0,50	16,88
Peru	2	2	193,18	9,09	0,57	352,27	15,91	2,27	1,14	14,77
Canada	2	2	164,95	8,25	0,52	453,61	7,22	4,12	1,03	16,49
USA	2	2	212,39	12,39	7,08	327,43	7,96	2,65	0,88	16,81
USA	1	2	225,35	11,27	0,70	295,78	25,35	4,23	1,41	4,23
USA	1	2	225,35	11,27	1,41	323,94	29,58	7,04	0,00	7,04
USA	1	2	197,18	11,27	1,41	295,78	26,76	4,23	1,41	5,63
Colombia	2	2	209,09	10,00	0,91	536,36	10,91	2,73	1,82	17,27
Australia	1	2	214,17	11,17	2,83	486,67	25,33	5,58	7,67	5,83
Mexico	1	2	105,91	4,87	0,65	187,39	11,64	2,64	0,79	3,88
Mexico	1	2	96,40	2,18	0,30	205,97	13,18	5,35	1,76	6,00
Canada	2	2	238,94	16,81	5,31	300,89	4,42	2,65	0,00	17,70
Chile	2	2	211,00	15,70	4,48	387,00	1,83	2,40	1,09	16,30
Chile	2	2	160,00	5,88	0,00	376,47	3,53	2,35	1,18	16,47
Canada	2	2	203,54	11,50	3,54	460,18	8,85	5,31	1,77	17,70
USA	2	2	184,21	9,21	0,00	710,53	10,53	2,63	2,63	15,79
Canada	2	2	236,84	14,04	5,26	368,42	11,40	5,26	0,00	19,30
Israel	2	2	347,00	4,40	0,60	408,00	57,70	8,90	2,40	17,30
USA	2	2	260,87	13,04	4,35	663,04	13,04	2,17	0,00	22,83
Chile	2	2	197,67	9,30	0,58	360,47	16,28	2,33	0,00	15,12
USA	2	2	203,54	12,39	4,42	345,13	6,19	1,77	0,00	17,70
Canada	2	2	185,84	9,73	1,77	318,58	7,08	0,00	0,00	19,47
Malaysia	2	2	250,00	15,82	8,64	415,46	11,18	0,73	0,00	16,00
USA	2	1	185,84	7,08	4,42	247,79	18,58	2,65	1,77	9,73
USA	2	2	266,67	20,00	1,67	800,00	6,67	3,33	1,67	20,00
Colombia	2	1	164,18	6,72	0,75	477,61	19,40	5,97	1,49	13,43
USA	2	1	132,74	3,54	0,00	407,08	8,85	5,31	0,88	19,47
Australia	1	2	304,00	20,08	1,84	280,00	19,76	6,88	3,12	8,08
Colombia	2	2	225,00	10,00	1,25	725,00	13,75	5,00	1,25	18,75
Malaysia	2	2	250,00	15,82	8,64	415,46	11,18	0,73	0,00	16,00
Israel	1	2	152,00	8,10	1,30	360,00	8,60	4,10	0,60	9,30
Israel	1	2	126,00	7,20	1,20	360,00	1,30	7,30	1,00	10,40
Australia	1	2	200,80	7,92	0,80	630,40	20,88	8,08	2,88	7,60
Netherlands	2	2	148,75	5,63	0,75	772,50	7,38	6,25	0,25	14,00
New Zealand	1	2	389,09	13,27	2,00	767,27	41,82	7,27	5,27	22,00
Colombia	2	2	98,59	0,70	0,00	394,37	8,45	5,63	0,00	18,31
Costa Rica	2	1	164,71	7,06	1,76	400,00	7,06	1,18	0,00	18,82
New Zealand	2	2	246,25	15,38	1,88	715,00	15,13	1,63	0,63	11,13
Colombia	2	2	193,18	9,09	0,57	352,27	15,91	2,27	1,14	14,77
Canada	2	2	185,84	9,73	7,96	371,68	7,96	0,00	0,88	17,70
USA	1	2	181,82	8,08	1,01	353,54	20,20	7,07	4,04	6,06
Mexico	2	2	196,82	11,90	4,27	343,00	4,53	1,77	0,30	17,90

USA	2	2	236,36	18,18	8,18	436,36	9,09	7,27	0,00	9,09
Ar2tina	2	2	225,00	15,00	8,75	637,50	10,00	1,25	0,00	12,50
Canada	2	2	212,39	13,27	5,31	327,43	7,96	1,77	0,00	17,70
Singapore	2	2	192,22	6,67	1,11	756,67	28,00	2,78	4,89	2,33
USA	2	2	221,24	15,04	6,19	407,08	3,54	1,77	0,88	17,70
USA	2	2	220,46	14,99	5,29	343,92	4,41	0,88	0,88	18,52
Australia	2	2	201,77	11,33	5,22	324,78	8,14	4,78	0,62	16,64
USA	2	2	112,68	1,41	0,00	619,72	9,86	5,63	0,00	19,72
Australia	1	2	156,00	4,00	0,80	840,00	21,20	5,04	2,40	5,60

APÊNDICE 4 TABELA SUPLEMENTAR 2 (MANUSCRITO 2)

Supplementary Table 2: Ingredient`s classification

Food group	Ingredient
acidity_regulator	calcium carbonate Citric acid phosphoric acid Succinic acid
additive	calcium propionate, E282, fumaric acid, sodium gluconate, calcium alginate, calcium caseinate, calcium chloride, calcium lactate, cellulose powder, E260, E450, E461, inulin, magnesium chloride, magnesium sulfate, potassium sorbate, sodium alignate, sodium caseinate, sodium citrate stabiliser, E461, triacetin, additive from chicory root, antioxidant ins 307b, calcium acetate, calcium sulfate, dipotassium phosphate, disodium 5' ribonucleotide, sodium 5'fumaric acid, silicon dioxide, silicon dioxide, sodium acetate, Sodium metabisulfite, sodium pyrosulfite, disodium metabisulfite, Tetrasodium pyrophosphate, sodium pyrophosphate, tetrasodium phosphate, TSPP, tricalcium phosphate, sodium tripolyphosphate, sodium hexametaphosphate
amaranth	amaranth flakes
apple	apple concentrate, apple extract
barley	malted barley, barley malt
baking_powder	raising agent (500)
baking_soda	fermenting agents
bean_protein	broad bean protein, faba bean protein, faba bean protein concentrate, mung bean protein
beans	butter beans, fava bean, great northern bean, black bean, black turtle bean, red bean, adzuki beans, azuki beans, black beans, cannellini beans, cranberry beans, great white northern beans, haricot beans, kidney beans, lima bean, navy beans, organic pinto beans, red kidney beans, split moong beans, white beans
beetroot	beet extract, beet juice powder, beet juice extract, beetroot colorant, extract beet powder
broccoli	broccoli extract, broccoli
butter	butter oil, butter fat, clarified butter, dehydrated butter, unsalted butter
cane_juice	cane juice, dried cane syrup, evaporated cane juice
carrot	carrot paste, carrot extract
cellulose	cellulose from bamboo
cheese	cheddar cheese powder, cheddar cheese, edam cheese, goats cheese, gorgonzola cheese, grated cheese, gruyère, mozzarella cheese, parmesan cheese, parmesan cheese, pasteurized processed cheese, provolone cheese, romano cheese
chili	chili, poblano, jalapeno, chili sauce, chili paste, chipotle pepper, jalapeno
chives	spring onions, scalions
cider	apple cider concentrate, organic apple cider
citrus	citrus fruit extract
citric_acid	ins 330

coconut	coconut cream
colorant	achiote paste, annatto achiote, urucum, annatto extract, caramel color, yellow 5, e150d, sulphite
corn_protein	hydrolyzed corn protein, hydrolyzed corn maize protein, corn meal
custard	custard powder
dextrin	tapioca dextrin
dextrose	cultured dextrose
eggs	egg_white, liquid eggs, albumin, albumin, liquid eggs, dry eggs, powdered egg whites
emulsifier	agar agar, emulsifier 460, emulsifier 466, gelling agent, carrageen, cellulose gum, cmc, guar seed flour, gum Arabic, konjac flour, locust bean gum, guar gum, methylcellulose, soy lecithin, sunflower lecithin, vegetable gum, xantham gum, arabic gum, carob gum, e32 firming agent, psyllium fiber, psyllium seed powder, sodium alginate, acacia gum, ins 461
fat	coconut fat, palm fat, vegetable shortening, fat powder, vegetable fat, Coconut butter, cocoa butter, cacao butter, cocoa fat
fiber	citrus fiberapple fiberchicory root fiberbamboo fibersoy fiber vegetable fibers wheat fiber wheat fibre
flakes	whole grain barley flake
flavorant	barley extract, barley flavorant, disodium guanylate, disodium inosinate flavour, kosher consommé, malt extract natural liquid smoke natural smoke flavor natural hickory smoke concentrateartificial flavor (contains cottonseed)
flaxseed	flax meal, linseed
flour	corn flour, potato flour, rice flour, spelt flour, wheat flour, wheatflour, yellow corn flour, malt flour, malted barley flour
fruit	black currant fruit powder, pear powder, apple powder, plum powder, Pineapple juice concentrate, dehydrated pineapple juice, pomegranate fruit powder, citrus fruit, fruit juice, sea buckthorn juice, acerola cherry extract, cherry powder, lucuma
garlic	dried garlic, garlic powder
gluten	gluten flour, wheat gluten
greens	lovage greens
glycerin	glycerin ester of fatty acid, vegetable glycerin
green_tea	green tea extract
greens	horsetail herb leaves, moringa leafs, vegetables leaves, collard greens, mustard leaves, swiss chard, turnip greens
herbs	aromatic plants, bay leaf, fine herbs, lime leaf, herb extract, coriander leaves, Laurel
Hemp_protein	hemp protein
hydrogenated_oil	hydrogenated oil,partially hydrogenated oil
ketchup	tomato ketchup
lactic_acid	sodium lactate
leavening	leavening (sodium acid pyrophosphate, sodium_bicarbonate)
legume_flour	bean flour, fava flour, garbanzo bean flour, gram flour, lentil flour, pea flour, chickpea flour, navy bean flour
leghemoglobin	soy leghemoglobin

lemon	concentrated lemon juice, lemon juice, lemon juice powder
l-methionine, l-tryptophan	amino acid blend
lentils	brown lentils, golden lentils
lime	lime juice
lycopene	lycopene extract from tomato
MCT	medium chain triglycerides
milk	dried milk, milk powder, milk solids, skim milk
minerals	reduced iron, zinc (zinc oxide)
MSG	glutamic acidglutamatesmonosodium glutamate
mushrooms	crimini mushrooms, reishi mushroom, cordyceps mushroom, chaga mushroom, mushroom extract, oyster mushroom, portabella, mushroom, crimini, porcini, reishi splitgill mushroom
miso	fermented soy
mustard	Dijon mustard
natural_flavor	natural flavor
nutritional_yeast	brewer's yeastin, activated yeast, nutritional yeast
nuts	pine nuts, cashew nuts, almonds, macadamia nuts, Brazil nuts, pistachio nuts, pecan nuts, chestnut, organic walnuts, walnuts
nuts milk	nuts milk (water, nuts, salt, emulsifier, emulsifier, gellan gum, natural_ flavor)
oats	oats bran, hydrolyzed oat flour, oat flour, oatmeal, Oat fiber
oil	clove oil, DHA oil, flaxseed oil, oil of lemon, palm oil, shea oil, shea oil, soybean oil, avocado oil, palm oil, rice bran oil, canola oil, coconut oil, colza oil, corn oil, expeller pressed oil, expeller pressed oil, high oleic oil, oleic oil, palm oil, peanut oil, pumpkin seed oil, rapeseed oil, sesame oil, soybean oil, sunflower oil, walnut oil
olives	green olives
orange	orange zest
Olive_oil	extra virgin olive oil
onion	onions flakes, yellow onion, dried onion, onion powder, chinese onions
orange	orange peel, orange pulp
peas	yellow peas, Black eyed peas
pepper	peppercorns, black pepper, white pepper, dry pepper, crushed pepper, cayenne pepper
peppers	red peppers, yellow peppers, green peppers, sweet peppers, capsicum, bell peppers, bell pepper, red bell peppers
pomegranate	pomegranate extract,
pumpkin	pumpkin paste, pumpkin seeds
pulses	mesquite
quinoa	red quinoa, white quinoa
red_pepper	oven roasted red bell peppers
rice	dark rice, black rice, brown rice, cooked brown rice, rice puree, wild rice
Rice_protein	rice protein
rosemary	rosemary extract, rosemary
salt	sea salt

seaweed	algae, seagrass
semolina	wheat semolina
soy_beans	Organic soy beans, soy seeds
soy_sauce	soy sauce
seeds	hemp seeds, hemp seeds, nigella organic ground raw seeds, pomegranate seed, pomegranate seed powder, sesame seeds, whole sesame pumpkin seeds, chia seeds, poppy seeds, sesame seeds, sunflour seeds
soy protein	processed soybean ingredient, soy granules, Hydrated textured soy, soy protein concentrate, soy protein isolate, soy protein concentrate, textured soy protein, texturized soy protein
spices	black caraway, fennel seeds, garam masala, spice preparation, cassia, coriader, cumin, mustard seed, nutmeg, organic coriander, powder jeera
spinach	spinach
spirits	cider, wine, wine solids, sake, alcohol
starch	acetylated distarch adipate, ins 1422, arrowroot, starch, modified manioc starch, corn starch, modified corn starch, rice starch, starch sodium octenylsuccinate cassava starch, modified starch, potato starch, tapioca starch, wheat amylum, wheat starch
sugar	coconut sugar, evaporated sugarcane syrup, glucose syrup, maple syrup, processed sweet ingredient, brown sugar, washed raw sugar
stock	Mushroom stock, Vegeyable stock
sunflower_protein	sunflower protein
tomato	tomato extract, roasted tomatoes, sundried tomatoes, tomato (dried), tomato coulis, tomato paste, tomato puree
thickeners	thickeners (1422, 1450), thickener (ins 461)
vegan cheese	nuts based cheese, vegan cheddar, vegan cheese
vegetable	hydrilla, French beans, green peas, lotus root, maca, string beans, vegetables paste, ashwagandha, bamboo shoots, bean sprouts, bok choy, celery, green beans, kohlrabi, sweet potatoes, vegetables extract, water chestnuts, radish
vegetable fat	hydrogenated vegetable fat
vegetable_protein	textured vegetable_protein
vinegar	white vinegar, fermented vinegar, rice vinegar
vitamins	potassium_chloride, magnesium oxide, ferric orthophosphate, niacinamide, zinc oxide, cyanocobalamin, D-calcium pantothenate, copper gluconate, pyridoxine hydrochloride, thiamine mononitrate, riboflavin, tocopherols, vitamin B12 (cyanocobalamin), pantothenic acid (calcium pantothenate), (vitamin B1 (thiamine hydrochloride), vitamin B2 (riboflavin), vitamin B3 (niacinamide), vitamin B6 (pyridoxine)
wheat	wheat flakes, wheat grit
wheat_germ	defatted wheat germ
Wheat_protein	textured wheat protein, wheat protein
whey	cultured whey whey powder
yeast	Dried yeast, torula yeast, inactivated yeast
yeast_extract	autolyzed yeast extract

APÊNDICE 5 TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO

TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO

Você está sendo convidado (a) para participar, como voluntário, em uma pesquisa que tem como objetivo investigar a percepção sobre a campanha segunda sem carne de clientes de um restaurante no Rio de Janeiro. Para possibilitar a sua participação será necessário que confirme seu consentimento assinando o presente documento, o qual esclarece os procedimentos que serão desenvolvidos durante a coleta de dados da pesquisa e detalha os aspectos éticos requeridos pela Resolução MS/CNS 466/2012

A sua participação na pesquisa consiste em responder uma entrevista que será realizada pelo próprio pesquisador, sem qualquer prejuízo ou constrangimento para a participante. Sua participação nesta pesquisa é totalmente voluntária e não está condicionada a qualquer tipo de remuneração ou qualquer outro tipo vantagem financeiro. Você poderá desistir de participar do estudo, a qualquer momento, sem nenhum tipo de prejuízo.

As informações obtidas nesta investigação serão tratadas de forma sigilosa e sob nenhuma circunstância informações pessoais serão divulgadas ou disponibilizadas a terceiros, sendo acessíveis somente à equipe de pesquisadores. Os dados agrupados serão tratados de forma a compor publicações científicas, as quais poderão ser apresentadas em eventos científicos e publicadas em revistas científicas, sem que a sua identidade seja revelada.

Se você tiver alguma consideração ou dúvida sobre a ética da pesquisa, entre em contato com o Comitê de Ética em Pesquisa (CEP) do Hospital Universitário Clementino Fraga Filho/HUCFF/UFRJ, R. Prof. Rodolpho Paulo Rocco, n.°255, Cidade Universitária/Ilha do Fundão - Sala 01D-46/1° andar - pelo telefone 3938-2480, de segunda a sexta feira, das 8 às 16 horas, ou por meio do e-mail:cep@hucff.ufrj.br.O CEP é o órgão que tem como objetivo defender os interesses dos participantes da pesquisa no Brasil, além de contribuir no desenvolvimento da pesquisa dentro de padrões ético

CONSENTIMENTO DA PARTICIPAÇÃO DA PESSOA COMO SUJEITO

Eu, ________________________________, abaixo assinado, concordo em participar do estudo como sujeito. Fui devidamente informado e esclarecido pela pesquisadora Paula Albuquerque Penna Franca sobre a pesquisa e os procedimentos nela envolvidos, bem como os benefícios decorrentes da minha participação. Foi me garantido que posso retirar meu consentimento a qualquer momento e que não estou sendo obrigado(a) a participar da pesquisa.

Local:	Data / / .
____________________________	____________________________
Assinatura do participante Nome:	Assinatura do Pesquisador Nome: Paula Albuquerque Penna Franca

Pesquisadora: ProfªDrª Anna Paola Rocha Trindade Pierucci

Professora Adjunta do Instituto Josué de Castro, Universidade Federal do Rio de Janeiro, UFRJ. E-mail: appierucci@gmail.com