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Original article

Using Twitter® as source of information for dietary market research: a study on veganism and plant-based diets

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Summary Social media has experienced rapid growth in recent years and has been subjected of discussions on a wide range of topics including new lifestyles and eating habits, providing a great opportunity to obtain spontaneous consumer information. In this sense, the present work aimed to understand the perception of Twitter® users about themes of veganism and plant-based diets. The social networking data mining methodology was applied to measure the relationship between both terms. The significant differences found were analysed using the global chi-square (χ^2) test, and their sources of variation were investigated by the chi-square per cell. The results indicate that the vegan group's posts are more related to the categories of recipes, trends, criticism and negative comments about veganism, being more often citing sources when compared to the other group. The results of the plant-based diet group are more significantly related to the impacts of nutrition, physical activity and consumer health. In conclusion, Twitter® has proved to be an interesting tool for obtaining data on (re) produced food publications on social media and their results can guide the market and the academic environment in creating new products, services and marketing strategies to answer the needs of specific consumers.

Keywords Consumer research, plant-based diet, social media, Twitter®, vegan.

Introduction

Socio-economic, cultural and environmental factors determine the consumption of products, being decisive in the behaviour of contemporary consumers (Schinaider, 2018). In recent years, new market trends have emerged to answer the emerging needs of an increasingly demanding audience, which seeks a more ethical, healthy and sustainable lifestyle (Willet *et al.*, 2019). In this context, there is an increase in veganism and plant-based diets in the worldwide (Melina *et al.*, 2016).

Currently, there is a variety of diets that recommend the intake of vegetables, being generally classified according to the inclusion or exclusion of animal products (Aps; Craddock *et al.*, 2016). This work will focus only on the vegan lifestyle and plant-based diets. Often, both themes are used in a similar way, despite having different classifications (Mann, 2017). Thus, it is worth mentioning that plant-based diets consist of a dietary pattern that prioritises the consumption of vegetable foods and whole grains, while the vegan lifestyle, being more comprehensive to different areas of life, is not just the issue food, as it seeks to exclude, as far as possible, all forms of exploitation and animal cruelty (Nezlek & Forestell, 2020).

At the food level, the greatest differentiation between both groups is based on the fact that vegans may consume processed foods (Appleby & Key, 2016). As a result, these diets do not always have positive impacts on health, given that being vegan or vegetarian does not necessarily mean having good eating habits (Melina *et al.*, 2016). Several products, such as fried foods, sweets and cookies, classified as ultra-

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processed, have nothing of APs in their composition and can be consumed by this audience (Ludwig *et al.*, 2019). Plant-based diets, on the other hand, are premised on being healthy given that individuals consume whole foods in their most natural form, prioritising the consumption of fruits, vegetables and whole grains, little or no APs, no food preservatives and no processed products (Mariotti, 2017). Thus, there are no strict guidelines or definitions for adopting a plant-based diet, in addition to the intake of many fresh products and minimally processed foods; therefore, some individuals may not eat animal products, while others eat restricted quantities; being thus, it is flexible in this sense, but strict in its focus on eating whole foods (Markowski & Roxburgh, 2019).

The vegan movement found on social networks is a new way of disseminating information, where there is the purpose of connecting people, provoking dialogues, expanding interactions and allowing the sharing of opinions and experiences that arise through actions and events of engagement, organisation and dissemination of ideologies (Wills, 2016). The industry has seen trends in veganism and plant-based diets as extremely attractive economic opportunities (Ginsberg, 2017). This can be proven by the fact that the main world food-producing brands are trying to create products that attend this profile of new consumers and the expansion of foodtech companies focused on this market (Carfi *et al.*, 2018). In this context, identifying the consumer's profile and understanding their behaviour are essential for the economic and sustainable growth of the food industries (Schinaider, 2018).

The expansion of social networks allows users to create and disseminate content and information, enabling exchanges between social groups established on online platforms, significantly contributing to the globalisation of new life practices and eating habits (Cavalheiro *et al.*, 2018). Social networks have become strong tools for organising human activity, featuring interrelated groups, organisations and systems, which are linked to common visions, values and ideas (Freeman, 2017). In order to understand the desires of the growing public that uses social media, industries and the scientific community have been using research tools based on the content expressed by these users (Cássia, 2016). The analysis of the narrative of these populations has amplified the capacity of organisations to react to the changes imposed by the consumer market, enabling the creation and reformulation of new products, the development of new marketing strategies and the emergence of new services that come to serve, with quality and quantity, these emerging demands (Mylan *et al.*, 2019). Thus, the analysis of social media content represents an opportunity for market research, since it provides access to information posted by consumers through their narratives on digital platforms and contributes to the understanding of individual and social behaviour in real time (Massoudian, 2016).

Twitter® presents itself as an excellent source of data since its information can be considered 'open' and accessible, and can be analysed using specific data mining tools that are able to extract and process information generated by different users in all parts of the world (Massoudian, 2016). In view of the growing number of users and the characteristics of this social network, Twitter® can be used to support clinical providers, public health specialists and social scientists in better understanding public opinions, through tools to support data collection in qualitative research, in analysis of market changes and new trends (Karami *et al.*, 2018). Furthermore, it is commonly used to describe food routines and opinions; therefore, it is a potential source of data on consumer behaviour and perception (Vidal *et al.*, 2015). However, the utilisation of Twitter® on food-related consumer research is still scarce (Vidal *et al.*, 2015), and none of them concerned different diets and lifestyles. Thus, this paper proposes the use of digital social platforms, more precisely Twitter®, as a database for the identification of narratives published by users about new diets and lifestyles such as plant-based diets and veganism. The results found aim to guide the sectors of industries and services in the creation and development of new products and marketing strategies that answer these commercial niches, in addition to characterising Twitter® as an important database platform in scientific research. The main objective of the present study is therefore to assess the perception of Twitter® users in differentiating the narrative of groups that talk about 'vegan' and 'plant-based diet'.

Materials and methods

Selection criteria

This research used the following descriptors (keywords): 'vegan', 'vegan food', 'veganism', 'plant-based diet', 'plant-based nutrition' and 'whole food plant-based', appearing in text (tweets) or hashtags on Twitter® as selection criteria. These keywords were chosen according to their correlation with the central themes ('vegan' and 'plant-based diet') and their impact on Google Scholar. Keywords were written only in English; however, the language and georeferencing of the extracted content were not specified.

Data recovery and collection

The selected tweets were retrieved using the R software twitteR package (R Core Team, 2018). This package provides an interface between R and the Twitter® Application Programming Interface (API), allowing

users to search for tweets with specific keywords and collect data. For this step, a Twitter® account was created, generating access to the API for the recovery of the desired data. Data collection took place from February 2018 to February 2019. Repeated tweets and retweets were rejected, as suggested by Zhao (2016), to increase the likelihood that the analysed topics reflected the original content produced by users. The selected tweets were exported to Excel format using the R software to be analysed in data mining, which comprises the set of techniques that allows analysing large databases so that new comprehensible rules and analysis standards are created for the analyst (Otero & Gutiérrez, 2016).

Statistical analysis

The selected tweets were classified into categories by triangulation (Guerrero *et al*., 2010) using inductive coding, according to their content, being classified into seven categories: (i) advertisements and trends; (ii) culinary recipes; (iii) nutrition, physical activity, health and quality of life; (iv) socio-environmental impacts and political activism; (v) support and promotion; (vi) criticism; and (vii) negative comments. The frequency of each category was defined by the number of tweets and keywords cited corresponding to each group ('vegan' and 'plant-based diet'). The significant differences found between the two research groups were analysed using the global chi-square test (χ^2), and their sources of variation in the seven categories of each group were investigated by the chi-square test per cell (Symoneaux *et al*., 2012).

The chi-square test is a nonparametric test, used to measure hypotheses in order to assess whether there are random errors and the degree of interference of these possible errors in the study (Symoneaux *et al*., 2012). Only the categories mentioned in more than 5% of the total terms used in tweets were considered; thus, categories with a frequency lower than this number were discarded as recommended by Symoneaux *et al*. (2012).

All the analyses were performed at the level of 95% confidence using XLSTAT 2019.1 software (Addinsoft, Paris, France).

Results and discussion

The search results of 6000 tweets returned 5315 analysable tweets that demonstrate a significant difference in the frequency of the categories of each group ('vegan' and 'plant-based diet'). 685 tweets were discarded due to not frame the research standards (were repeated tweets and retweets or were not related to the themes) or because they contained themes that were not mentioned in more than 5% of the total tweets returned. The global chi-square test, used on the contingency table between the groups of veganism and plant-based diets, proved to be highly significant among the data obtained from Twitter® ($\chi^2 = 912.883$, $P < 0.0001$), showing that the users' perception was different for each theme. In this way, it was possible to apply the chi-square test per cell to analyse the source of variation in each cell, aiming to improve the statistical analysis and the interpretation of the data and allowing to properly analyse the frequency obtained in each category, indicating the most and least mentioned among consumers (Table 1).

According to the results presented by the analysis of the chi-square test per cell, the category 'Advertisements and Trends' was significantly more frequent for the vegan group. This category covers information about places that sell specific products of this nature, offers of these over the Internet and market trends. The significant growth in the search for vegetarian and vegan foods in the last decade reinforces the importance of supplying these products, becoming an important part of the gourmet industry and attracting a larger niche of customers who follow this lifestyle (Twine, 2018). Indeed, serving vegans is a challenging task, which requires knowledge-based management and depends on a complete understanding of the vegan segment and its characteristics, as well as familiarity with vegan cooking techniques, such as attractive recipes and ingredients without foods of animal origin, meeting the precepts of sensory quality expected and offering opportunities for business growth to serve this emerging public (Lang, 2020).

Another theme of differentiation was the category 'Culinary Recipes', presenting considerable results for the identification of the narratives of the vegan group, being represented by terms such as 'Cook'; 'Meat Free Monday'; 'Delicious'; 'Vegan Cuisine'; 'Meatless Meals', as well as several tweets recounting information about food preparations made by users, as well as the disclosure of the preparation method and the final product, and indications of cookbooks on the subject. Social media characterises an important dimension of the infrastructure for sharing vegan recipes, given that they offer global access to creativity in food and culinary experiments, divided by 'open source' with several users, sharing images and recipes from their preparation creations allowing vegan cuisine to expand to different parts of the world (Twine, 2018). Meat consumption has plateaued and even decreased in high-income countries, while it has risen dramatically in many middle-income countries, especially in China, East Asia and India. However, India has a long tradition of vegetarianism among some communities (Godfray *et al*., 2018).

The search for vegan culinary recipes is very promising for industries that wish to develop new products

Table 1 Contingency table for the 'vegan' and 'plant-based diet' (PBD) groups showing the seven main categories and their respective frequency of mention in tweets containing keywords related to veganism and plant-based diets.

Categories	VEGAN[1]	PBD[2]	Examples
Advertisements and Trends	488 (+)	332 (−)	Snack Bar[1]; Burger Place[1]; Vegan Shop[1]; Marketing[1] / Free Samples Available[2]; Niches Markets[2].
Culinary Recipes	434 (+)	145 (−)	Meat Free Monday[1]; Recipes for breakfast[1]; Meatless meals[1]; Vegan Cuisine[1] / Whole Foods[2]; Detox[2]; Fresh[2]; Fiber[2]; Based in vegetables[2].
Nutrition, Physical Activity and Health and Quality of Life	318 (−)	1.218 (+)	Training[1]; Performance[1]; Lifestyle[1] /Transformation[2]; Lose Weight[2]; Diet[2]; Athletic[2]; Welfare[2]; Less medications[2]; Quality of Life[2]; Reduction[2] ; Reversal[2]; Prevention[2]; Healthy Intestinal Microbioma[2].
Social-environmental Impacts and Political Activism	330	338	Poverty[1]; Compassion[1]; Animal Suffering[1]; Slaughterhouse[1]; Animal Cruelty[1]; Animal Rights[1]; Leave Animals off Your Plate1 / Climate Catastrophe[2]; Carbon Footprint[2]; Sustainability[2]; Eco[2]; Planet Health[2].
Support and Promotion	562	494	Popularization[1]; Successful[1]; Positive[1]; Journey[1]; Favorable[1]; Passion[1]; Alternatives[1]; Celebration[1]; Discipline[1]; Ethical[1] / Motivation[2]; Change[2]; Inspiring[2]; Goal[2]; I Never Felt Better[2]; Feel Good[2].
Criticism	230 (+)	66 (−)	Friends don't call me to dinner[1]; Excluding[1]; Expensive[1]; Few Options[1]; Restritive[1]; Laborious[1-2].
Negative Comments	281 (+)	79 (−)	Sick[1]; Weak[1]; Homosexual[1]; Fragile[1]; Weird[1]; Appealing[1]; Vegetable Pain[1]; Almond Milkers[1]; A Drug[1]; Weak People Eat Vegetables[1]; For Donkeys[1]; Plants Feel Pain[1] / Smells Like Wet Grass[2].
Total	2.643	2.672	

*Result of the chi-square test per cell. Significance per cell (+) or (−) indicates that the observed value is greater or less than the expected theoretical value. The numbers (1) and (2) represent examples of words and expressions cited in the tweets related to veganism and plant-based diets, respectively.

and step up their portfolio, increasing their competitive potential and attending the needs of this growing audience. Baron *et al*. (2018) report that the way companies integrate social concerns in their innovations varies depending on the industrial capacity to absorb new knowledge, contributing to a more robust innovation in food technology. In this sense, the interactions between the scientific community and the food industry are important conditions for product innovation as they stimulate the creation of innovative formulations (Khan *et al*., 2016). One good example is the cultured meat, an innovative way of synthesising meat from animal tissue samples, which uses the biotechnology originally developed for medical research and organ transplants. This technology is still in experimental stage; therefore, the scientific advancement depends on inputs from large food processing companies. However, it lacks funding for ongoing initiatives (Rorheim *et al*., 2016).

Currently, one of the biggest challenges faced by the food industry is the need to answer the trend to produce clean label and free from foods, considering the needs of consumers concerned with health, ethics and sustainability. The growing incentive to veganism generates substantial interest in the development of substitute products that meet these market trends, increasing the use of vegetable proteins and proposing the creation of new products of high nutritional value without additives and preservatives, as evidenced by Mustafa & Reaney (2020) that used the culinary residue from the cooking water of chickpeas (aquafaba) as an emulsifier, thickener and foam for various vegetable culinary recipes, saving energy and reducing costs by reusing a product usually discarded.

Lascialfari *et al*. (2019) reported that the main ready-to-eat substitute products found on the market consist of pasta, precooked mixtures of grains and alternative foods to meat, demonstrating that there is pent-up demand and potential for industrial growth in this segment. In order to elucidate new commercial niches, Olsson (2018) invested in the creation of vegan culinary recipes based on molecular gastronomy, whose principle is based on applied knowledge to improve food products, increasing the competitive potential for obtaining products of colours, flavours and formats different from the same ingredient base.

The category 'Cristicism' was also a category of differentiation between vegan and plant-based diet groups. It observed many posts containing criticisms from users about certain aspects of veganism, as evidenced in the following tweets: 'Friends don't call me to dinner', 'Excluding', 'Few Options', 'Restrictive'. The narratives found demonstrate that there is still a social pressure due to the lack of products and the low collective acceptance, although veganism is on the rise. Vegans may experience strained social relationships, mainly because many individuals refuse to try vegan foods. This may result in loss of friendships, decrease

in contact, and/or exclusion from social activities. Therefore, to be vegan can have a quite high social cost (Markowski & Roxburgh, 2019).

Many users reported difficulties in maintaining this lifestyle, especially because it takes more work, since it requires preparation of meals and, when choosing to consume vegan products ready for consumption, the higher cost can also be another impediment (Carfi *et al*., 2018; Bryant, 2019). Furthermore, there is a lack of options when eating out (Corrin & Papadopoulos, 2017). Vegan-processed products have some characteristics: they provide convenience to consumers, even at the cost, but they are not always healthy since they may contain substances and other synthetic products that aim to increase conservation for long periods of time, as is the case with foods produced with excess of salt, oil and sugars (Fulgoni & Drewnowski, 2019). These products are hypercaloric if consumed in excess, not being the best alternative to vegetable food, which should be aimed at eating fresh vegetable foods and whole grains, as recommended in plant-based diets (Vandevijvere *et al*., 2015). Therefore, there is a huge market for industrial growth in the sector of minimally processed vegetable products that serve as an alternative for individuals who choose variables of this type of food.

The category 'Negative comments' was also a category of differentiation between vegan and PBD groups. According to the findings, it is also noted that several individuals were hostile to followers of veganism in the category 'Negative Comments', revealing stereotypes to the vegan public according to the examples found: 'Sick', 'Thin', 'Fragile', 'Weak', 'Homosexual', 'Feminist'. The results obtained clearly express the tension when addressing themes such as veganism; however, it was observed that this tension does not always occur when individuals tweet about plant-based diets. These results are in line with the results found by Lundahl (2018). In general, people see vegans from a negative perspective (Markowski & Roxburgh, 2019), which probably helps to explain why vegans feel more stigmatised for following their diets (Nezlek & Forestell, 2020).

It has been observed that omnivores hold more negative attitudes towards vegans than towards plant-based diet individuals, mainly because of the association of vegans with ecological issues, while plant-based diet individuals are associated with health motivations (Bryant, 2019; Nezlek & Forestell, 2020). Meat is highly associated with masculinity, and veganism is viewed as a stereotypically feminine behaviour (Rosenfeld, 2020). Furthermore, vegans are viewed as oversensitive as well as physically and mentally weak (Markowski & Roxburgh, 2019). These statements may explain the terms 'weak', 'homosexual', 'fragile' and 'feminist' used for the vegan group. Corrin & Papadopoulos (2017) reported many negative terms associated with veganism, including restrictive, hippie, faddists, sentimentalists, unhealthy and weak. It is important to acknowledge that the negative perceptions of veganism are likely dissonance-reducing strategies (Rothgerber, 2017). Previous studies report that there is a social distance when choosing this lifestyle (Macinnis & Hodson, 2017); however, the growth of the vegan market, the adherence to this lifestyle and the increased debate on the subject have contributed to the demystification of the segment and greater popular acceptance (Dedehayir *et al*., 2017).

The results referring to the 'plant-based' revealed that the category 'Nutrition, Physical Activity, Health and Quality of Life' was the one with the greatest significance, reflecting that the users of this segment were concerned with weight control, health improvement, increased longevity and quality of life. It is also noteworthy that the practice of physical activities was a question closely related to the intake of plant-based diets by Twitter® users. These findings and users' perception corroborate several studies that observed that predominantly vegetable diets, rich in fresh and whole foods, have high amounts of fibres, antioxidants and phytochemicals, and can have positive effects on health and longevity (Crimarco *et al*., 2020). Craddock *et al*. (2016) report that the consumption of balanced plant-based diets can improve and optimise physical results, representing new opportunities in this segment.

Although the categories 'Support and Promotion' and 'Socio-environmental Impacts and Political Activism' were not significant to differentiate both users' narratives, they were widely cited. With regard to 'Support and Promotion', recent research points to an increase in conscious food consumption and lifestyle movements such as plant-based diets and veganism (Cherry, 2015). The analysis of Instagram® posts made by Pilař *et al*. (2016) with more than 1 million words revealed that the terms 'healthy', 'great' and 'good' were commonly used in photographs together with the terms 'organic', 'vegan', 'fresh', 'local', 'gluten free', 'delicious', bringing a positive feeling to these descriptors. In fact, it is widely acknowledged that the name given to a food can affect subsequent evaluations and impressions of it (Bryant & Barnett, 2019). In this way, vegan foods can be more appreciated if they appear alongside with labels containing positive terms, while they can have low acceptance if consumers associate them with a sacrifice in taste. Krpan & Houtsma (2020) tested how reframing the name of vegetarian food category impacted the choice of dishes from this category in restaurant menus. They observed that environmental ('Environmentally Friendly Main Courses for a Happy Planet'), social ('Refreshing Main Courses for Relaxing Conversations') and neutral (vegetarian and nonvegetarian dishes mixed in the same section 'Main Courses')

frames boosted the vegetarian choice compared to a vegetarian frame ('Vegetarian Main Courses').

Another factor that justifies the high number of tweets found that promotes the support and promotion of these diets and lifestyle are the affective and motivational states of individuals in the period of transition to veganism. Many individuals share motivational and optimistic messages to encourage themselves and others to follow and stay in this lifestyle (Acevedo *et al.*, 2018). These researchers also report that the more motivated the person is, the more persistent his activities are. These facts can see some of the factors that justify the growing number of 'Support and Promotion' posts on veganism and plant-based diets on social networks.

The results present in the narratives about 'Socio-environmental Impacts and Political Activism' configure tweets about climate change and the social impacts caused by the production and creation, on a large scale, of the consumption of animals. Continued use of soil and high productivity of monocultures, especially soybeans, result in a series of environmental costs, including increased soil compaction and erosion, reduced biodiversity, groundwater pollution, water scarcity, eutrophication of rivers and lakes, and impacts on atmospheric, climate and ocean waters (Niva *et al.*, 2017). The production of red meat involves an environmental burden; therefore, some European countries, taking into account human health and 'health of the planet', recommend limiting the consumption of red meat in their new national food guidelines (Rosenfeld, 2020). Due to these factors, innovations in the food sector are focused on the use of legumes in their formulation, being called eco-innovations, contributing to the maintenance of more sustainable agricultural systems and reducing the need for synthetic fertilisers and animal production, which are the main causes of greenhouse gas emissions in agriculture (Magrini *et al.*, 2018).

In this category, tweets about 'Political Activism' against animal exploitation and cruelty also stand out, a factor that appears as an emerging social identity generator in Western societies, implying an attitude of respect with nonhuman animals. Currently, the animal issue and well-being are subjects of great prominence and widely commented on social networks (Thomas *et al.*, 2019), as found in the analysed tweets. The ethical issue of animal husbandry is the most common motivation for people to become vegan and products that fit these guidelines can emerge as promising options to serve this emerging audience (Broad, 2018; Rosenfeld, 2019).

Conclusion

The results obtained allowed to identify the elements of differentiation in the narratives of Twitter® users who talk about veganism and plant-based diets. In general, tweets related to veganism are more focused on the dissemination of culinary recipes and veganism trends, as well as criticisms and negative comments concerning this audience. This result is in line with new market trends that seek a healthier and more sustainable vision, although there is resistance to these changes as evidenced in a significant number of tweets. The narratives associated with plant-based diets were more inclined towards concerns about healthy eating and other practices focused on health, quality of life and longevity, possibly due to well-being and health issues.

The present work elucidated the importance of Twitter® in applied research as a database for understanding the perception of users, providing results that can be appreciated by industries and the scientific community in the creation and improvement of new products and messaging. Furthermore, the results can be of potential use to animal advocates of understanding how these terms tend to be used differently, so that they can adjust their terminology.

As for the methods, the methodology used was able to elucidate the differences in the users' narratives and Twitter® proved to be an effective platform that serves as a database in the opinion poll using open information, helping to understand the desires of this slice of the population and serving as a basis for industry and the scientific community in the development of new products and approximation with the target audience. However, it is important to note that the disadvantage of this analysis is the need to obtain a lot of data to create a pattern.

Understanding the differentiation between both themes is of the utmost importance to serve both audiences with quality and permanence, offering products and services according to specific requirements and needs. Thus, it is concluded that companies and the scientific community must address both themes according to the preferred perspective of each group, generating new products, services and scientific knowledge in the reference niches. Therefore, the terminology 'plant-based' should be used to convey health benefits, while 'vegan' might convey ethical concerns and consumer identity more prominently.

As a limitation, the present work captured only tweets in English, without reference to location. Thus, in order to obtain a more in-depth knowledge of the needs and customs of a specific group, it is recommended that further research be done delimiting the areas of coverage.

Conflict of interest

The authors declare not to have conflict of interest.

Author contributions

Adriano G. Cruz: Conceptualization (equal); supervision (equal). **Erick A. Almeida:** Conceptualization (equal); supervision (equal). **Monica Porto:** Conceptualization (equal); funding acquisition (equal); writing-original draft (equal). **Denise R.P. Azeredo:** Formal analysis (equal); supervision (equal). **Marina Barandela:** Methodology (equal); writing-original draft (equal). **Rafael Marrafa:** Data curation (equal); methodology (equal); writing-original draft (equal). **Tatiana C. Pimentel:** Investigation (equal); writing-review & editing (equal). **Carla A. B. Sass:** Writing-review & editing (equal). **Monica Paganni:** Writing-review & editing (equal). **Tiago M. Dantas:** Data curation (equal); software (equal); validation (equal).

Ethical approval

Ethics approval was not required for this research.

Peer review

The peer review history for this article is available at https://publons.com/publon/10.1111/ijfs.14743.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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