SUSTAINABLE FOOD SECURITY THROUGH INNOVATIVE PLANT-BASED NUGGETS ENRICHED WITH BAMBOO SHOOTS AND MORINGA: SENSORY ACCEPTANCE AND NUTRITIONAL ANALYSIS

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ABSTRACT
Objective: This study focuses on developing V-Nutrishoots, a plant-based nugget formulated with Textured Vegetable Protein (TVP) and enriched with bamboo shoots and moringa leaves.
Research Method: The development process consisted of three phases: product formulation, sensory evaluation, and nutritional analysis. Three formulations were developed with varying proportions of TVP and bamboo shoots, followed by a sensory evaluation by 35 untrained panelists who assessed color, aroma, taste, texture, juiciness, and overall acceptance, selecting F3 (32% TVP, 64% Bamboo Shoots & 4% Moringa) as the most preferred formulation. The nutritional analysis conducted at Johor Toyyiban Lab revealed that per 100 g,
Findings: V-Nutrishoots contained 134 kcal, 2.2 g total fat, 22 g total carbohydrates, and 26.5 g protein. A comparison with existing market products showed that V-Nutrishoots had superior nutritional benefits, with significantly lower calories (134 kcal vs. 250-335 kcal) and higher protein content (26.5 g vs. 12.1-12.5 g) while maintaining a low-fat content (2.2 g vs. 14-17.2 g).
Originality: V-Nutrishoots is a healthier alternative to traditional chicken and other plant-based nuggets. To support lifelong learning in food innovation and nutrition, further research should explore antioxidant properties and conduct Texture Profile Analysis (TPA) to assess product quality and functionality.
Keywords: Food security; V-Nutrishoots; Nugget; Texture Vegetable Protein; Bamboo Shoot

1. INTRODUCTION

In today's global landscape, understanding food security is not merely an option—it is a critical foundation for achieving long-term food sustainability. The development of innovative food products must operate in tandem with food security initiatives, as both are inherently interconnected and mutually reinforcing. Food security is typically characterized by four core dimensions: availability, accessibility, utilization, and stability. These pillars encompass the consistent supply of food, the ability of individuals to access it, the proper and nutritious use of food, and the long-term reliability of the food system

Healthy eating has become an essential aspect of self-care for today's society. The public is increasingly exposed to various sources of knowledge regarding the importance of maintaining a healthy diet. As a result, many individuals are now seeking food options that can offer multiple health benefits (Baba & Basri, 2024). A wide range of food products is available in the market, giving consumers the freedom to choose items that meet their nutritional needs. Among the emerging preferences is plant-based food, which serves as an alternative to animal-based products such as chicken and red meat (Maganinho, 2024). In response to this growing demand, new

food innovations have been introduced to address consumers' needs. Therefore, this innovation study aims to develop a food product that meets the expectations of consumers seeking convenient, easy-to-consume, age-appropriate options that are also nutritionally beneficial to overall health.

Although a wide variety of food choices are available, consumers are increasingly prioritising foods that offer high nutritional value. Today's consumers are not only seeking food that is tasty and convenient to prepare, but also rich in nutrients. Among the popular options are frozen convenience foods, which attract attention due to their longer shelf life when stored properly. These include raw frozen foods, ready meals, traditional local snacks (*kuih*), and more (Bahizalsah et al., 2022). Ready meals, in particular, can be further categorised into Ready to Eat (RTE) (Khalid et al., 2024), Ready to Cook (RTC) (Mathew & Sharma, 2023), and Ready to Heat (RTH) products. These categories provide practical solutions for modern consumers who desire healthy meals but with faster preparation times. One common example is the nugget, a food item that is easy to prepare and often consumed during breakfast, teatime, or at any time of day. Frozen nuggets available in the market can be quickly prepared simply by frying, offering both convenience and satisfaction

Nuggets are commonly shaped into flattened, irregular rectangles or formed into appealing shapes (Xin, L.P. et al., 2024). Some are coated with breadcrumbs for added crispiness, while others are not (Giovani et al., 2024). Most nugget products available in the market are made from chicken or fish. However, for vegetarians or individuals who avoid meat-based products, there is a growing demand for an alternative that is not only easy to prepare but also nutritionally beneficial. In response to this need, the present study was conducted to fulfil two main objectives: To develop an innovative, plant-based nugget that is acceptable to consumers; and to analyse the nutritional content of the developed product. The resulting food innovation is called V-Nutrishoots, a plant-based nugget made using Textured Vegetable Protein (TVP) and enriched with bamboo shoot and moringa, providing a nutritious, meat-free alternative to conventional nuggets.

This study focuses on evaluating consumer acceptance of a plant-based nugget through sensory analysis involving three different formulations, namely F1, F2, and F3. Consumer acceptance was assessed based on six sensory attributes: colour, aroma, taste, texture, juiciness, and overall acceptance. Significant differences between the formulations were analysed to identify the most preferred product. The formulation with the highest level of acceptance, as determined by sensory panelists, was further analysed for its nutritional composition. The nutritional analysis focused on four key aspects: energy, total fat, total carbohydrates, and protein content. To demonstrate the quality of the developed product, a comparative discussion was carried out with existing commercial nugget products available in the market. The findings of this study suggest that the development of a novel food product using plant-based ingredients as a substitute for commonly used animal-based sources in nuggets can offer a nutritious alternative. This innovation contributes to diversifying healthy food options and meets the needs of a wider range of consumers, including those who seek meat-free diets.

2. LITERATURE REVIEW

Food security is essential for all individuals to meet their basic food needs. It is generally understood through four main dimensions. The first is food availability, which refers to the sufficient production and supply of food. The second is accessibility, which highlights the ability of individuals to obtain food based on their economic and physical capacity. The third dimension is utilization, referring to the proper use of food, including good nutrition, food safety, and hygiene to ensure health. Lastly, stability relates to the consistent and uninterrupted access to food, even in times of economic crises, extreme weather, or conflicts. Therefore, it is important for all stakeholders to

understand that food security means ensuring the availability of sufficient, healthy, and safe food that is easily accessible to everyone.

In addressing the goals of food security, it is important to recognise that food production alone is not sufficient to fulfil its four key dimensions. A comprehensive approach must also consider issues related to access, nutrition, and sustainability. Therefore, special attention must be given to promoting sustainable agriculture, establishing efficient food supply chains, ensuring affordable and consumer-friendly food pricing, and increasing public awareness through education. These efforts are essential in building a resilient and inclusive food system that supports long-term food security for all.

This study focuses on the development of a nugget-based product. Nuggets are commonly classified as frozen food products and are typically made from ingredients such as chicken (Xin et al., 2024) or fish (Kusumawardani et al., 2023). They are considered convenient foods that can be prepared easily either by deep-frying or using an air fryer. Nuggets available in the market generally come in two main coating types: those coated with tempura batter and those coated with breadcrumbs, each offering a different texture and mouthfeel.

The development of plant-based nuggets represents an innovative approach that contributes to food security, particularly in addressing the challenges related to the reliance on animal-based resources such as chicken and fish. The use of plant-derived ingredients supports the reduction of dependency on meat-based components (Pierre et al., 2024). The production of nuggets as meat analogues is viewed as a necessary step toward expanding the variety of plant-based food options. This innovation aligns with the study by Maganinho et al. (2024), which explored the use of tofu and seitan as substitutes in nugget formulation. Meat analogues are plant-based food products that are designed to mimic the texture, taste, appearance, and function of conventional meat products (Moorthi et al., 2022). These products are intended to offer consumers a similar sensory and culinary experience while supporting more sustainable and inclusive dietary choices.

Textured Vegetable Protein (TVP) is an innovative ingredient widely used in the development of meat analogues. TVP is a high-protein food material, commonly derived from soybeans or other suitable legumes. It is frequently incorporated into plant-based meat products due to its ability to replicate the fibrous texture of meat (Amjanyakun et al., 2024), while also offering significant nutritional benefits, particularly in terms of protein and dietary fibre content. According to a study by Esbroeck et al., (2024), many types of TVP contain up to 60% protein, depending on the processing methods used. In addition, TVP is typically low in fat and cholesterol, and contains a moderate level of carbohydrates, making it a suitable ingredient for individuals seeking healthier, diet-conscious food alternatives. TVP is commonly used in a variety of plant-based food applications, including burger patties, nuggets, sausages, and many other meat substitute products (Siddiqui et al., 2024). Its versatility and nutritional profile make it a key component in the advancement of sustainable and health-oriented food innovations.

The improvement of product quality does not rely solely on the use of Textured Vegetable Protein (TVP). Additional plant-based ingredients can be incorporated to enhance the nutritional value of the product while also promoting the diversification and utilisation of locally available plant sources in nugget production. Bamboo shoots are one such ingredient that is readily available in Malaysia. However, their application in food products remains limited. They are typically used in traditional dishes such as *masak lemak* and other local cuisines. This study explores the use of bamboo shoots from the species Dendrocalamus asper, which are commonly found in the Muar district of Johor. Bamboo shoots are known to contain high levels of protein, carbohydrates, minerals, and vitamins (Ma et al., 2024). In addition, they are rich in dietary fiber and antioxidants, making them a valuable functional ingredient in health-

oriented food products (Nurlila et al., 2024). Table 1 presents the nutritional composition of bamboo shoots collected from two different states.

Table 1: Nutritional Composition of Bamboo Shoots (*D. asper*) Kong et al., (2020)

Parameter	***Dendrocalamus asper* from Perak (g/100 g)**	***Dendrocalamus asper* from Sabah (g/100 g)**
Fresh Weight		
Moisture	94.27 ± 0.42	93.15 ± 0.07
Ash	0.50 ± 0.10	0.66 ± 0.03
Dry Weight		
Crude protein	21.67 ± 0.24	26.43 ± 0.31
Crude fat	3.17 ± 0.15	2.28 ± 0.05
Crude fiber	14.07 ± 0.15	9.37 ± 0.16

Another locally available plant source found in the Muar district of Johor is moringa. The leaves of the moringa plant are utilised in this study due to their high nutritional value, including significant amounts of protein and carbohydrates (Hairul, Palal & Abidin, 2024), as well as their strong antioxidant properties. Table 2 presents the nutritional comparison of moringa leaves based on findings from two different studies. Despite their high nutritional content, the use of moringa leaves in cooking remains limited. Traditionally, they are incorporated into local dishes such as *masak lemak* (Hairul et al., 2024) or mixed with eggs to prepare omelets. Recently, however, there has been a growing interest in moringa-based food innovations, particularly in the development of functional foods aimed at improving human health. This suggests a promising potential for expanding the use of moringa as a key ingredient in health-focused food products.

Table 2: Nutritional Composition of Moringa Oleifera Leaves

Nutritional Composition	***Sultana S., (2020)* (%)**	**Handayani et al., *(2022)* (%)**
Moisture	7.55 – 8.65	7.80
Crude Protein	22.99 – 29.36	29.6
Crude Fat	4.03 - 9.51	6.98
Carbohydrate	47.25 – 56.25	39.4
Crude Fiber	6.00 – 9.60	6.91
Ash	8.05 – 10.38	9.32

3. METHODOLOGY

The development of new food products plays a vital role in enhancing food security. In this study, an innovative product known as V-Nutrishoots was developed—a plant-based meat analogue nugget formulated using Textured Vegetable Protein (TVP) and bamboo shoots as primary ingredients and enriched with moringa. The development process involved three main stages. Firstly, product development was carried out through the creation of three different formulations to identify the most suitable version. Secondly, a sensory evaluation was conducted to assess consumer acceptance and determine the preferred formulation. Lastly, the selected formulation underwent nutritional analysis, and the results were compared with existing commercial nugget products available in the market. The study highlights the potential of V-Nutrishoots as a nutritious and sustainable alternative that supports the diversification of plant-based food sources.

The first stage in the development of the V-Nutrishoots nugget involved the selection of raw materials. One of the primary ingredients used was Textured Vegetable

Protein (TVP), which was sourced from GMT2 Malaysia Sdn. Bhd., currently operating under the name Handyware Industrial Malaysia Sdn. Bhd. Fresh bamboo shoots (*Dendrocalamus asper*) were purchased from local suppliers in Muar, Johor, while moringa leaves were collected from the Pagoh Jaya area in Pagoh. These key ingredients were then combined with other supplementary components to formulate the plant-based nugget. Each nugget was portioned at 20 grams per piece, following the method described by Abiala et al., (2023), and shaped according to a predefined mould design.

Ensuring the development of a product that is acceptable to consumers, three formulations F1, F2, and F3 were designed. These formulations differ based on the percentage composition of TVP and bamboo shoots used in the nugget formulation. The varying ratios were intended to determine the most suitable combination in terms of texture, flavour, and overall sensory acceptance. Table 3 presents the differences in the proportions of the main ingredients used in the production of V-Nutrishoots nuggets.

Table 3: Formulation of Ingredients for V-Nutrishoots Nuggets

Ingredients	**F1**	**F2**	**F3**
TVP	64%	43%	32%
Bamboo Shoots	32%	53%	64%
Moringa	4%	4%	4%

The second stage involved sensory evaluation. The three developed formulations (F1, F2, and F3) were presented to 35 untrained panelists to assess overall product acceptability. This method aligns with previous studies by Palal et al., (2023), who also used three different formulations in their sensory analysis, and by Amorim et al. (2022), who engaged 35 panelists in a hedonic test. Each panelist was provided with a hedonic questionnaire based on a 9-point scale, ranging from “dislike extremely” to “like extremely” (Oh et al.,2024). The evaluation focused on six sensory attributes: color, aroma, taste, texture, juiciness, and overall acceptability, as outlined by Talab et al. (2023). The goal was to determine which formulation received the highest level of acceptance among panelists for further nutritional analysis.

The sensory data collected from the panelists were compiled and recorded for analysis. The Statistical Package for the Social Sciences (SPSS Statistics Version 26) was used to analyse the data and determine whether there were any statistically significant differences among the three formulations (Zain, 2024). Based on the results, the most preferred formulation identified through the sensory evaluation was selected for the third stage of the study. This stage involved the nutritional assessment of the selected V-Nutrishoots nugget sample, focusing on key nutritional parameters to validate the product's health value and suitability as a plant-based meat analogue.

The most preferred formulation of V-Nutrishoots nugget was subsequently sent to a laboratory registered under the Ministry of Health Malaysia (MOH) for nutritional analysis. The analysis was conducted by Johor Toyyiban Laboratories Sdn. Bhd., which was selected as the accredited testing facility. The laboratory analysed four key nutritional parameters: energy content, total carbohydrates, protein, and total fat. The results of the nutritional analysis were then compared with several commercially available nugget products in the market to evaluate the relative nutritional value and potential advantages of the V-Nutrishoots formulation.

4. RESULTS AND DISCUSSIONS

The results of this study were analysed and discussed to assess the success of the innovation in developing a food product that supports food security. This aligns with the broader goal of producing plant-based food products that can serve as viable meat analogues, addressing both nutritional needs and sustainability concerns. The discussion focuses on the achievement of the research objectives, which include the

successful development of the V-Nutrishoots nugget, the sensory evaluation conducted across three different formulations to determine consumer acceptance, and the nutritional analysis performed on the most preferred formulation. These outcomes collectively highlight the potential of V-Nutrishoots as a nutritious, acceptable, and sustainable plant-based alternative to conventional meat products.

The V-Nutrishoots nugget was successfully developed using only Textured Vegetable Protein (TVP) and bamboo shoots as the primary ingredients. The addition of other complementary components, including moringa leaf powder, contributed to the creation of a nugget that closely resembles conventional products available on the market. Although the formulation is entirely plant-based, the combination of ingredients used gives V-Nutrishoots its own unique advantages. The success of this product development can be further observed and validated through the sensory analysis results and nutritional composition, which are discussed in the following sections.

The sensory analysis was conducted to evaluate consumer acceptance of the developed product. The findings were discussed based on the results obtained from the SPSS statistical analysis. These results provide insights into the preferences of the panellists for each formulation. Table 4 presents the outcomes of the hedonic test, while Figure 1 illustrates the sensory profile of the formulations in the form of a spider web chart.

Table 4: Mean Hedonic Scores (Consumer Acceptance) for Sensory Attributes of Samples

Sample	**F1**	**F2**	**F3**
Colour	5.29 ± 1.40 b	5.31 ± 1.40 b	7.31 ±1.13 a
Aroma	4.97 ± 1.64 b	5.37 ± 1.57 b	7.34 ± 0.80 a
Taste	5.23 ± 1.50 b	5.71 ± 1.64 b	8.00 ± 1.09 a
Texture	5.11 ± 1.40 b	5.11 ± 1.45 b	7.31 ± 1.13 a
Juiciness	5.00 ± 1.52 b	4.77 ± 1.72b	7.23 ± 1.14 a
Overall acceptance	5.23 ± 1.17 b	5.40 ± 1.40 b	8.31 ± 0.72 a

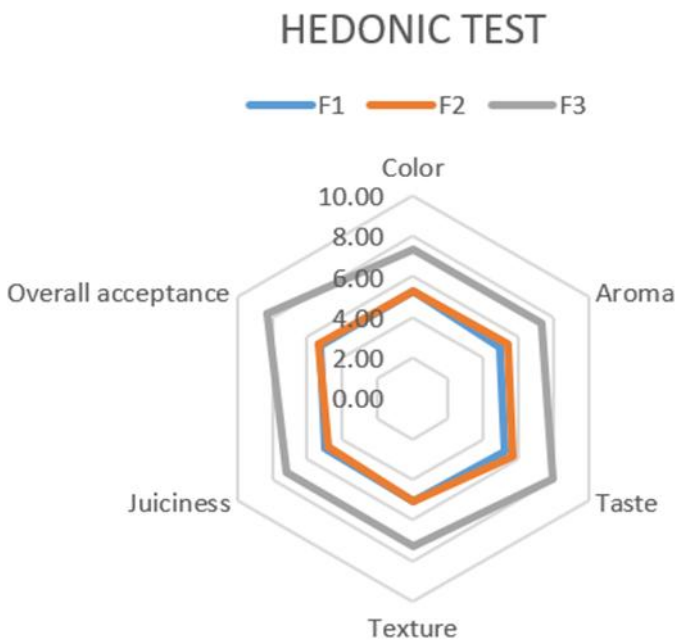

Figure 1: Sensory Profile (Attribute Intensity) of Samples

Referring to Table 4, the findings indicate that panellists showed a stronger preference for the colour of Formulation 3 (F3), which received the highest mean score

of (7.31 ± 1.13^{a}), compared to F1 (5.29 ± 1.40^{b}) and F2 (5.31 ± 1.40^{b}). The results demonstrate a statistically significant difference between F3 and the other two formulations. The combination of ingredients used in F3 contributed to a visually appealing colour, even in the absence of animal-based ingredients such as chicken or fish. The naturally light colour of bamboo shoots played an important role in enhancing the internal appearance of the V-Nutrishoots nugget, making it comparable to the colour of conventional nugget products commonly available in the market.

In terms of aroma, Formulation 3 (F3) received the highest acceptance among panellists, with a mean score of 7.34 ± 0.80^{a}, significantly outperforming F1 (4.97 ± 1.64^{b}) and F2 (5.37 ± 1.57^{b}), as shown in Table 4. This indicates that the aroma produced by F3 was generally well accepted. The use of additional flavouring ingredients, such as hydrolysed vegetable protein and plant-based chicken flavouring, likely contributed to this positive reception. These ingredients enhanced the aroma profile of the V-Nutrishoots nugget, making it more reminiscent of traditional chicken-based nuggets, despite being entirely plant-based.

Taste is one of the most critical factors in sensory evaluation. In this study, Formulation 3 (F3) recorded the highest mean score of 8.00 ± 1.09^{a}, indicating strong acceptance by the panellists, while F1 and F2 scored 5.23 ± 1.50^{b} and 5.71 ± 1.64^{b}, respectively. The results demonstrate a statistically significant difference, with F3 being significantly preferred in terms of flavour. The enhanced acceptability of F3 can be attributed to the effective combination of ingredients, which successfully produced a pleasant and familiar taste profile, even though the nugget was entirely plant-based. This suggests that a well-balanced formulation using plant-based flavour enhancers can result in a product that is both appealing and competitive with traditional meat-based nuggets.

The texture of a nugget is a key attribute, particularly as most panellists are familiar with the texture of commercially available meat-based nuggets. Therefore, achieving a texture that closely mimics conventional nuggets is essential. The results were encouraging, with Formulation 3 (F3) receiving a significantly higher mean score of 7.31 ± 1.13^{a}, compared to F1 (5.11 ± 1.40^{b}) and F2 (5.11 ± 1.45^{b}). Both F1 and F2 recorded lower scores and showed no significant difference between each other. These findings suggest that F3 successfully replicated the desired texture, contributing to its overall higher sensory acceptability and demonstrating the effectiveness of the selected ingredients in achieving a meat-like mouthfeel.

Juiciness is an essential quality in nugget production, as products that become too dry after frying can negatively affect texture and overall eating experience. Based on the findings, Formulation 3 (F3) received the highest mean score of 7.23 ± 1.14^{a}, significantly outperforming F1 (5.00 ± 1.52^{b}) and F2 (4.77 ± 1.72^{b}). The high acceptance of F3 in terms of juiciness indicates that the V-Nutrishoots nugget was well received by panellists, even though it is entirely plant-based. This suggests that the formulation effectively retained moisture and delivered a desirable texture, comparable to conventional meat-based nuggets.

The overall acceptability results clearly indicate that Formulation 3 (F3) received the highest panellist score of 8.31 ± 0.72^{a}, while F1 (5.23 ± 1.17^{b}) and F2 (5.40 ± 1.40^{b}) recorded significantly lower scores. Referring to Figure 1, the sensory profile spider web chart visually illustrates that F3 consistently dominates across all evaluated attributes, forming the widest and most complete sensory profile among the three formulations. This strong performance across multiple sensory dimensions highlights the panellists' overall preference for F3. The success of F3 in terms of overall acceptance underscores the potential of developing plant-based alternative products that not only meet consumer expectations but also contribute meaningfully to addressing food security challenges.

Among the three formulations, Formulation 3 (F3) was identified as the most preferred based on sensory evaluation results. Therefore, F3 was selected for nutritional analysis to further assess its potential as a plant-based meat analogue. The

sample was sent to Johor Toyyiban Laboratories Sdn. Bhd., a laboratory registered under the Ministry of Health Malaysia (MOH), for testing. The analysis focused on four key nutritional components: energy, total carbohydrate, protein, and total fat. The results obtained from the laboratory are presented in Table 5.

Table 5: Nutritional Composition of V-Nutrishoot Nuggets

NUTRITION INFORMATION		
		Serving Size: 150 g
	Per 100g	Per Serving 150 g
Energy	563 kJ	845 kJ
	134 kcal	201 kcal
Total Fat	2.2 g	3.3 g
Total Carbohydrate	22 g	33 g
Protein	26.5 g	39.8 g

The nutritional analysis results indicate that the developed product is low in calories, with an energy value of 563 kJ per 100 g. It also contains relatively low amounts of total fat (2.2 g/100 g) and total carbohydrates (22 g/100 g), making it a healthier alternative to conventional nuggets. In contrast, the protein content is notably high at 26.5 g/100 g, which can be attributed to the incorporation of Textured Vegetable Protein (TVP) and bamboo shoots—both of which are known for their high protein and fibre content. These findings support the product's potential as a nutritious, plant-based alternative suitable for consumers seeking protein-rich and lower-fat dietary options.

A comparative analysis was conducted between the developed V-Nutrishoots nugget and two commercially available products to assess its nutritional standing. Product X represents a plant-based nugget, while Product Y is a conventional chicken nugget. This comparison aimed to highlight how the nutritional profile of the innovative product aligns with, or potentially surpasses, existing market options. The comparison focused on key nutritional components including energy, total fat, total carbohydrate, and protein content. The results of this comparative analysis are presented in Table 6.

Table 6: Nutritional Value Comparison

NUTRITION INFORMATION			
SERVING SIZE:	**PER SERVING 100g**		
Nutritional Parameter	V-Nutrishoot (Plant Base Nugget)	Product X (Plant Base Nugget)	Product Y (Chicken Nugget)
Energy	134 kcal	250 kcal	335 kcal
Total Fat	2.2 g	14 g	17.2 g
Total Carbohydrate	22 g	16.1 g	27 g
Protein	26.5 g	12.5 g	12.1 g
Recourses	Johor Toyyiban Lab	Packaging X Brand	Packaging Y Brand

Referring to Table 6, the nutritional comparison between the three nugget products clearly demonstrates that the V-Nutrishoots nugget is competitive with existing commercial products, including both plant-based and chicken-based nuggets. The results suggest that the innovative formulation not only meets the nutritional standards of current market alternatives but also offers a balanced profile—low in fat and carbohydrates, while maintaining a high protein content. These findings reinforce

the product's potential to serve as a viable and nutritious option in the growing plant-based food segment.

The comparison reveals a significant difference in energy content among the three products. The V-Nutrishoots nugget provides a notably lower caloric value of 134 kcal per 100 g, compared to Product X (250 kcal/100 g) and Product Y (335 kcal/100 g). This substantial reduction in energy content positions the V-Nutrishoots nugget as a health-conscious alternative, particularly suitable for individuals seeking to manage their daily caloric intake or adopt a lower-energy diet. The formulation supports the growing demand for lighter, plant-based meal options without compromising on satiety or nutritional quality.

In terms of total fat content, many health-conscious consumers actively seek foods that are lower in fat as part of their daily dietary choices. The V-Nutrishoots nugget contains only 2.2 g of total fat per 100 g, which is substantially lower than Product X (14 g/100 g) and Product Y (17.2 g/100 g). This remarkable reduction in fat content highlights the product's suitability for low-fat diets and may appeal to individuals concerned with cardiovascular health, weight management, or overall fat intake. The formulation demonstrates that plant-based products can offer nutrient-dense options without the high fat typically found in conventional nuggets.

The V-Nutrishoots nugget contains 22 g of total carbohydrates per 100 g, which is lower than Product Y (27 g/100 g) but slightly higher than Product X (16.1 g/100 g). This positions the carbohydrate content of V-Nutrishoots at a moderate level, making it a suitable option for individuals who are mindful of their carbohydrate intake yet still require adequate energy for daily activities. The formulation maintains a balanced nutritional profile that supports diet-conscious consumers, while also providing sufficient carbohydrates to contribute to satiety and energy.

Based on the nutritional comparison, the V-Nutrishoots nugget demonstrates a clear advantage in terms of protein content, making it a strong candidate as a preferred plant-based option. Despite not being derived from animal sources, the product delivers a remarkably high protein level of 26.5 g per 100 g, which significantly exceeds that of Product X (12.5 g/100 g) and Product Y (12.1 g/100 g). This highlights the effectiveness of using Textured Vegetable Protein (TVP) and bamboo shoots as alternative protein sources. The result confirms that plant-based innovations can offer high nutritional value, particularly for consumers seeking protein-rich diets without relying on animal-based ingredients.

5. CONCLUSIONS

The findings of this study demonstrate the successful development of an innovative food product, aligned with the goals of food security, particularly the need to reduce reliance on animal-based ingredients. The formulated product not only offers high nutritional value but also shows potential for commercialisation and market acceptance. The study successfully achieved all two objectives: the development of a novel product with positive consumer acceptance, and favourable nutritional outcomes.

Future research may focus on additional aspects, such as the textural profiling of the product and comparisons with existing commercial nuggets. Moreover, further analysis on the antioxidant properties would be valuable to support the use of moringa and bamboo shoots as functional ingredients in plant-based meat analogues.

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