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Utilization of Okara in Food Technology: Innovations in Okara Energy Bar Formulation

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Abstract

Energy bars are healthy, convenient snacks that provide sufficient nutrients. Energy bars are dense foods where fats, proteins, and carbohydrates are the main sources of calories. Okara has not been fully exploited as an important food source for human consumption in Malaysia. Okara is a major by-product of the soy milk industry that remains after soy milk extraction. Currently, okara is widely used as animal feed and natural fertilizer. Although okara is a rich source of nutrients, it has not been fully utilized as an important food source. The nutritional value of okara is quite high, where dried okara consists of fat (10%), protein (24%), dietary fiber (52.3%), ash (4%), and vitamins. The establishment of the Okara Energy Bar aims to innovate an energy bar product made from okara flour, providing energy bars that contain various nutrients and are affordable, as well as producing low-calorie protein bars that are cost-effective. The Okara Energy Bar also aims to address waste disposal issues existing in the soy milk industry in this country. Fresh okara is dried in a cabinet dryer at 50°C for 4 hours, and dried okara is ground into flour. Sensory evaluation was conducted on 50 untrained panelists using a 7-point Hedonic Scale (1- dislike very much to 7- like very much) covering 5 attributes evaluated, namely color, appearance, taste, aroma, texture, and overall acceptance. Panelists underwent a general screening test before evaluating the product. The results found that the majority of panelists gave the highest acceptance in overall acceptance.

Keywords: - Okara, energy bar, sensory evaluation

1. Introduction

In recent years, the global food landscape has witnessed a significant shift towards healthier, more sustainable eating habits. As consumers become increasingly conscious of the nutritional content and environmental impact of their food choices, there is a growing demand for innovative food products that offer both health benefits and eco-friendly credentials. In response to these changing consumer preferences, the field of food technology has emerged as a critical driver of innovation, paving the way for the development of novel solutions that address these evolving needs.

One such solution is the Okara Energy Bar, a groundbreaking product that represents a convergence of cutting-edge food technology and sustainable ingredient sourcing. At the heart of this innovation lies okara, a nutrient-rich byproduct derived from the production of soy milk. Traditionally relegated to the sidelines as waste, okara is now being recognized for its untapped potential as a versatile and sustainable ingredient with a myriad of culinary applications.

The Okara Energy Bar is the culmination of extensive research and development efforts aimed at unlocking the nutritional and functional benefits of okara. Through a combination of advanced food processing techniques and creative formulation strategies, our team of food technologists has succeeded in transforming okara into a delicious and nutritious energy bar that offers a convenient and sustainable solution for health-conscious consumers.

By harnessing the inherent properties of okara, such as its high protein and fiber content, as well as its natural binding and texturizing abilities (Čech et al., 2022), the Okara Energy Bar delivers a powerhouse of nutrients in a convenient, on-the-go concept. Moreover, by upcycling okara into a value-added food product, we are not only reducing food waste but also contributing to a more sustainable food system.

In this paper, we will delve into the intricacies of the Okara Energy Bar, exploring its nutritional composition, sensory attributes, production process, and potential market impact. Through a comprehensive analysis of this innovative product, we aim to shed light on the transformative potential of food technology in creating healthier, more sustainable food options for the future.

This detailed introduction provides a comprehensive overview of the Okara Energy Bar, highlighting its significance within the context of current food trends and emphasizing its potential to meet the evolving needs of consumers in a rapidly changing food landscape.

In numerous nations like Singapore, Hong Kong, Australia, Canada, the United States of America, South America, Europe, China, and India, soybeans and their derivatives, such as soymilk, are extensively integrated into various culinary practices and food industries (Vong & Liu, 2016). While a minor fraction

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of soy residue is used as animal feed, a significant portion is typically relegated to industrial waste. However, recent years have witnessed a surge in global attention towards this waste stream due to its favorable chemical composition. Okara comprises both functional constituents and anti-nutrients, including saponins, tannins, phytic acids, and trypsin inhibitors (Li et al., 2012; Razavizadeh et al., 2021).

Energy bars are widely used by people of all ages not only to meet immediate energy needs but also to feel satiated. However, little attention has been given to formulating low-calorie protein bars that are rich in nutrients and cost-effective. Therefore, the formulation of enriched and economical energy bars from nutrient-dense ingredients is important to meet the increasing nutritional needs of teenagers. Energy bar sales have received significant stimulus from health-conscious consumers and are usually sold at high prices. The product innovation of the 'Okara Energy Bar' emphasizes the production of healthy snacks with a 'grab and go' concept, providing energy-efficient and affordable food from less economically valuable ingredients. Additionally, the establishment of the Okara Energy Bar product aims to address the waste disposal issues existing in the soy milk industry.

Energy bars are also known as snack bars, they are typically marketed as 'ready-to-eat' foods based on whole grains. Energy bars are dense foods where fats, proteins, and carbohydrates are the main sources of calories (Verma et al., 2022). Therefore, energy bars can boost energy levels and often can replace meal intake but costing. An alternative to producing energy bar from other materials is a method to overcome this problem. Okara which has been accumulated, dried, and grind into powder to form flour is one of the best candidates to replace the protein content in energy bar that boasting a protein content ranging from 28% to 30%, which includes essential amino acids, and a fat content of 8% to 10%, primarily consisting of polyunsaturated fatty acids, along with additional nutrients like starch, sugar, potassium, and trace amounts of B-group vitamins, okara not only aids digestion but also stands as a cost-effective reservoir of plant-based protein (Préstamo et al., 2007).

In terms of food application okara have been used in different products such as in vegetable paste (Guimarães et al., 2018), bread products (Wickramarathna et al., 2003) and in beef patties (Turhan et al., 2007). Anyway, it should be underlined that very few preliminary studies focused on the use of okara to reformulate in nutrition bars. Guimarães et al. (2018) showed that the inclusion of okara in percentages with the lowest content of okara (34 g/100 g) showed the highest average in the acceptance test (8.0) and was also considered the tasters' favorite one. It was significantly different from the others in the preference ranking test. The food product enriched with okara had β-carotene (0.411mg/100 mL), compounds with antioxidant activity and isoflavones (0.15 μmol/gFM) in its composition.

The method developed in this study allowed for the creation of an energy bar enriched with okara, a by-product of the agroindustry, presenting a promising alternative for a new food product also to develop a healthy snack and utilized from abundant valuable waste as compared to the existing energy bar. Other than that, this paper as an alternative strategy that is imperative to mitigate the prevalent issue of waste on a global scale.

2. Methodology

Several preparation steps are required, which are preparation of Okara and preparation of "Okara Energy Bar".

2.1 Preparation of Okara

Soybeans were purchased from a local market in Changkat Lada, Pasir Salak, Perak, and were used as the primary ingredient for making soy milk. Dried soybeans were soaked with a water ratio of 1:10. Then, the soaked soybean undergoes grinding and extracting process; the remaining soybean hulls and pulp were collected as shown in Fig. 1. The collected soybean residue was then dried using a dehydrator (SunBeam, China) at 45°C for 4 hours until it became dry and hardened as shown in Fig. 2. Then, the dried soybean residue was ground using a grinder (Panasonic, Malaysia), sifted to obtain fine soybean residue flour, and stored in a dry, airtight container. The flow of production of okara is shown in Fig. 3.

Fig. 1. Soybean residue (okara)

Fig. 2. Okara in dehydrator (SunBeam, China)

2.2 Preparation of Okara Energy Bar

In the preparation process, oats, almonds, and sunflower seeds were gently heated in a pan to moderate temperatures to prevent overcooking. Subsequently, okara flour was meticulously combined with oats, almonds, sunflower seeds, cranberries, and raisins in a mixing bowl until achieving a homogeneous mixture. Following this, seedless dates, having been soaked in water for a duration of two hours, were cooked until thickened into a paste. This step aimed to eliminate excess moisture from the dates, thereby preventing the potential sogginess of the Okara Energy Bar and indirectly extending its shelf life. The resulting date paste was then incorporated into the mixture, alongside honey and vanilla extract, and stirred until uniformity was attained. The mixture was poured into a 10x10 baking tray lined with parchment paper and firmly pressed to ensure cohesion. Subsequently, the tray was transferred to a blast freezer for a period of 15 minutes to facilitate setting. Upon removal, the solidified mixture was cut into individual bars, thus completing the production process before undergoing for sensory evaluation.

2.3 Sensory Evaluation

Sensory evaluation of Okara Energy Bar was carried out in 2 days following Bailey et al. (1995) with slight modification. 50 untrained panelists were selected from students and staff of Pasir Salak Community College, aged between 17 and 50. Evaluators were undergoing acceptance tests in the product with defined characteristics. Scoring was carried out on a 7-point hedonic. Quality attributes include color, appearance, taste, aroma, texture, and overall acceptance. Each sample was presented to panel members.

Following this, the sensory evaluation results were carefully analyzed to determine the acceptance level of the Okara Energy Bar product, along with evaluating its mentioned attributes. Statistical analysis techniques such as mean comparison and correlation analysis were employed to interpret the data.

2.4 Nutitional Values

Nutritional value, a critical component of food quality, pertains to the proportionate balance of essential nutrients in food or diets relative to consumer nutrient requirements. In this study, the Okara Energy Bar underwent testing at an external food laboratory which is at K BioCorp for analysis several parameters, including energy content, carbohydrates, proteins, fats, total sugars, and sodium levels.

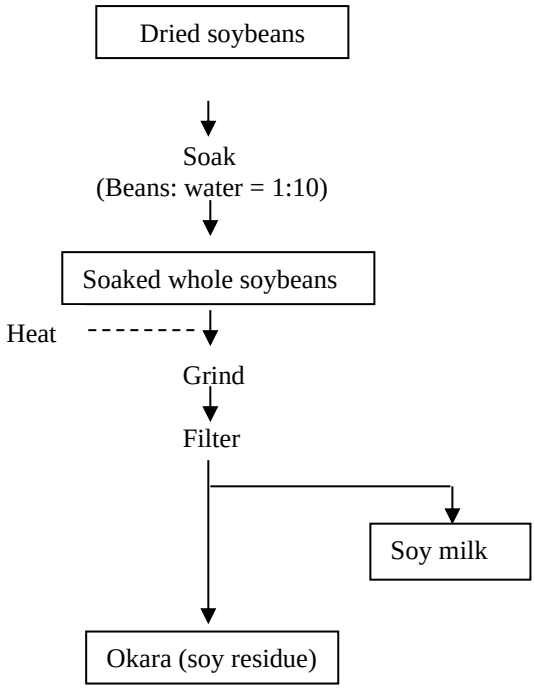
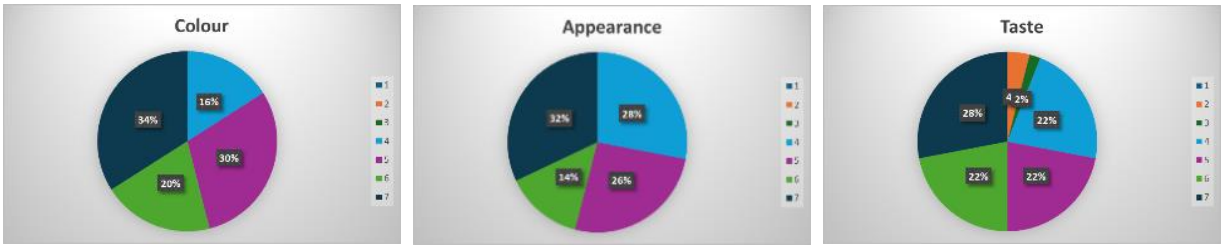


Fig. 3. Production of main and by-products of soybeans (Vong and Liu, 2016)

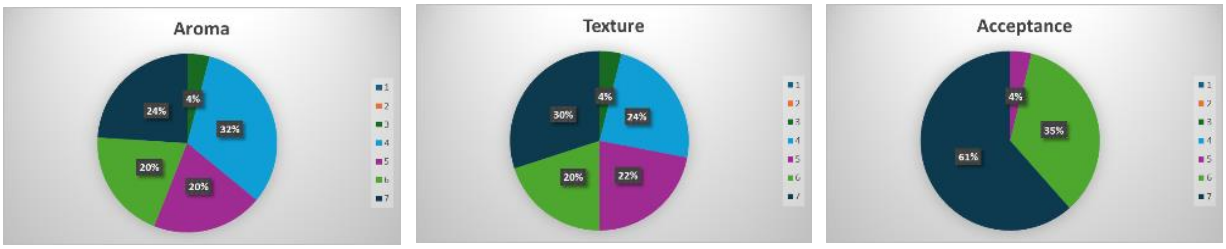
3. Result and Discussion

3.1 Sensory Evaluation Acceptance

The aim of this study was to investigate the acceptance and sensory attributes of the Okara Energy Bar among consumers. Data were collected through sensory evaluation tests conducted with a panel of participants from the Food Processing and Quality Control Certificate Program at Pasir Salak Community College. The methods utilized in this study ensured rigorous evaluation of the product's sensory profile, encompassing attributes such as color, appearance, taste, aroma, texture, and overall acceptance. The findings of sensory test of Okara Energy Bar are shown in Fig. 4.



(a) (b) (c)



(d) (e) (f)

Fig. 4. Findings of sensory test of Okara Energy Bar for (a) colour acceptance, (b) appearance acceptance, (c) taste appearance, (d) aroma acceptance, (e) texture acceptance and (f) acceptance

In the total of 50 panelists for the hedonic test for evaluating the colour, appearance, taste, aroma, and texture acceptance as shown in Fig. 4. Fig. 4 (a) shows that 34% of the panelists rated like very much for the product's colour appearance. 32% of panelists had rated like very much for the appearance acceptance of the products as shown in Fig. 4 (b). Next, 28% of the panelists had rated very much in the taste of Okara Energy Bar as shown in Fig. 4 (c) while the aroma acceptance as Fig. 4 (d) shows that panelist had rated 32% neither like nor dislike the product aroma. Lastly, the panelist had rated 30% of the texture product acceptance as shown in Fig. 4 (e). The result led to the overall acceptance of the product is 61% of the panelist rated like very much.

Based on Table 1 above shows the mean score of the overall acceptance of Okara Energy bar is 6.60 which is like moderately to like very much. This proved that all panelists agree that this product is acceptable to be consumed.

Table 1. Analysis of acceptance

	N	Minimum	Maximum	Mean	Std. Deviation
Acceptance	50	5	7	6.60	.571

The results of the sensory evaluation tests provided valuable insights into the acceptance level and sensory characteristics of the Okara Energy Bar. Overall, the product was well-received by the panelists, with positive ratings observed across various attributes. Notably, the Okara Energy Bar exhibited favorable scores for taste, texture, and overall acceptance, indicating its potential as a viable food product.

The findings of the sensory evaluation revealed insightful outcomes regarding the acceptance level and attributes of the Okara Energy Bar among the panelists. Through meticulous analysis, several key observations emerged, shedding light on various aspects of the product's sensory profile. These results offer valuable insights into consumer preferences and perceptions, providing a deeper understanding of the Okara Energy Bar's market potential. Additionally, the implications of these findings extend beyond sensory preferences, offering valuable information for product refinement and marketing strategies. Overall, the results underscore the importance of sensory evaluation in gauging consumer acceptance and informing product development decisions.

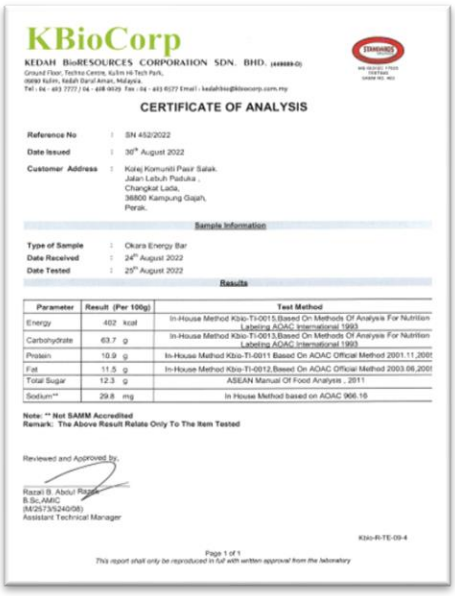
3.2 Nutritional value

Table 2 describes the nutritional value contained in per serving of Okara Energy bar as per serving of 100gm. It proved that per serving contains 402kcal of energy, 63.7g of carbohydrate, 10.9g of protein, 11.5g of fat, 12.3g of total sugar and 29.8 of sodium. This result is comprised from the natural ingredients used in the making of Okara Energy Bar.

Table 2. Nutritional value of Okara Energy Bar

Parameter	Result (per 100g)
Energy	402kcal
Carbohydrate	63.7g
Protein	10.9g
Fat	11.5g
Total Sugar	12.3g
Sodium	29.8mg

Furthermore, the nutrition value of the ingredients had been sent to KBioCorp lab for further confirmation. The result is shown in Fig. 5.


KBioCorp

KEDAH BioRESOURCES CORPORATION SDN. BHD.

CERTIFICATE OF ANALYSIS

Reference No : SN 452/2022

Date Issued : 30th August 2022

Customer Address : Kolej Komuniti Pasir Salak, Jalan Lebuh Pasiluka , Changkat Lada, 36800 Kampung Gajah, Perak.

Sample Information

Type of Sample : Okara Energy Bar

Date Received : 24th August 2022

Date Tested : 25th August 2022

Results

Parameter	Result (Per 100g)	Test Method
Energy	402 kcal	In-House Method Kbio-TI-0015,Based On Methods Of Analysis For Nutrition Labeling AOAC International 1993
Carbohydrate	63.7 g	In-House Method Kbio-TI-0013,Based On Methods Of Analysis For Nutrition Labeling AOAC International 1993
Protein	10.9 g	In-House Method Kbio-TI-0011 Based On AOAC Official Method 2001.11,2001
Fat	11.5 g	In-House Method Kbio-TI-0012,Based On AOAC Official Method 2003.06,2001
Total Sugar	12.3 g	ASEAN Manual Of Food Analysis , 2011
Sodium**	29.8 mg	In House Method based on AOAC 906.10

Note: ** Not SAMM Accredited
Remark: The Above Result Relate Only To The Item Tested

Reviewed and Approved by:

Razali B. Abdul Razak
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(M/2573/5240/08)
Assistant Technical Manager

Kbio-R-TE-09-4

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Fig. 5. Certificate of analysis Okara Energy Bar by KBioCorp

3.3 Energy Value

Energy bars are compact, nutrient-dense food products designed to provide quick energy and sustenance. Initially popular among athletes and outdoor enthusiasts, they have evolved into a versatile option for busy individuals seeking a quick meal replacement. These bars typically combine proteins, carbohydrates, fats, and various vitamins and minerals, making them a potentially balanced meal in a convenient form.

The correct amount of energy provided by each energy bar can vary depending on the brand, size, and specific formulation of the bar. Generally, energy bars are designed to provide a convenient source of calories and nutrients to fuel physical activity or provide a quick snack between meals.

As the result, Okara Energy bar categorized as Meal Replacement Bars due its energy is 402 calories and it is in between 300 to 500 calories according to Doe et al. (2024). Based on Jovanov et al. (2021), consider factors such as macronutrient composition, ingredient quality and intended use to find the best energy bar for specific goals and lifestyle of an individual.

4. Conclusion

Nutritional value in Table 2 had shown that Okara Energy bar has high value of energy and has positive dietary measure to certain target group of people such as athletes, students, and very busy individuals as it is objective as "ready-to-eat" foods. By converting beneficial waste of soy product to health-conscious food product, had initially provided another selection of energy-efficient and affordable food toward communities. Furthermore, from the hedonic rating Scale had shown that 88% of respondents had accepted the product of Okara Energy Bar.

In conclusion, this research study has provided valuable insights into the nutritional composition and consumer preferences of energy bars. Through a comprehensive analysis of various factors, several key findings have emerged.

Investigation into the nutritional content of energy bars revealed a wide variability in calorie counts, macronutrient composition, and ingredient profiles across different brands and products. Energy bars focused on providing a balanced mix of carbohydrates, proteins, and fats, others emphasized specific nutritional benefits such as high protein content or low sugar content. This diversity underscores the importance of understanding individual dietary needs and preferences.

Examination of consumer preferences through the hedonic rating scale highlighted the significance of taste, texture, and appearance in influencing acceptance decisions. Consumers often prioritize sensory attributes and convenience when choosing energy bars.

In summary, this research study contributes to the understanding of energy bars as a convenient and functional food product. By examining nutritional composition, consumer preferences, and market trends, it is identified opportunities for improvement and innovation within the energy bar industry. With continued research and collaboration, and work towards creating products that meet the diverse needs of consumers while promoting health, sustainability, and enjoyment.

Acknowledgement

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