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Chemical composition and acceptability of peanut paste (*Arachis hypogaea L.*) based on proteins isolated from legumes

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Abstract

Protein-calorie malnutrition represents one of the public health problems in the world. A total of three mixtures of peanut paste were formulated with legume protein isolate at 5% each, peanut paste and lentil protein isolate (PPL), peanut paste and pea protein isolate (PPP), and peanut paste and chickpea protein isolate (PPC). To evaluate the composition of the mixtures; moisture, crude protein, total fat, ash, crude fibre, and carbohydrates were determined according to the Association of Official Analytical Chemists, Official methods of analysis (AOAC). Acceptability was assessed using the Just-About-Right scale. A hierarchical cluster analysis was performed. It was found that PPP reported higher values in protein (30.65 g) and fat (48.25 g). The scores were significantly higher for the PPP and PPC mixtures for the attributes texture ($p<0.001$), flavour ($p<0.05$), and smell ($p<0.001$). The general acceptability of the mixtures received scores >8.7. It was found that the addition of legume protein isolated at a level of 5% increased the nutritional value of the peanut paste. In addition, it obtained good acceptability for sensory attributes.

1. Introduction

Legumes, including lentils, chickpeas, peas, and peanuts, are part of an important structure of food crops consumed throughout the world (Varshney *et al*., 2013). Peanuts (*Arachis hypogaea L.*) are an essential legume crop in different regions of the world (Luo *et al*., 2020). In 2017, global peanut production was estimated to have exceeded 47 million metric tons (FAOSTAT, 2019). All over the world, it is consumed in the form of nuts, oil, peanut butter, peanut paste, among other preparations (Varshney *et al*., 2013). In addition to being an important source of essential micronutrients, it can also be a good source and alternative protein for human consumption, particularly in low and middle-income countries (Tomé, 2013; Zhang *et al.,* 2015), which makes peanuts a suitable product for reformulation from a public health point of view under the approach of the fight against protein-calorie malnutrition.

In the past, some studies have been conducted to evaluate the properties and taste of peanut paste, as well as to improve its nutritional properties (Hathorn and Sanders, 2012; Ma *et al.,* 2014). Fortified peanut pastes have become an effective method of treating protein-calorie malnutrition and are easier to use and distribute during health and nutritional emergencies (Bazzano *et al*., 2017). Moreover, peanut pastes are dense in energy and particularly palatable to children. In addition, it does not require the use of water for its preparation or cooking and they are stable for at least up to 2 years. The absence of water during the enriched peanut paste production process and the resulting low water activity in the product give it the ability to resist bacterial contamination (Briend *et al.,* 1999).

The protein content in peanut cake can reach 50%. It contains all 20 amino acids and is the best source of arginine (USDA, 2014). In terms of Protein Digestibility Corrected Amino Acid Scores (PDCAAS), peanuts, and other legumes such as soybeans are a rich source of protein equivalent to meat and egg, essential for the growth, development and maintenance of people's health (Acevedo-Pacheco and Serna-Saldívar, 2016). In addition, one of the advantages of peanut protein is that it carries with it other additional components with broad nutritional health benefits, unlike animal proteins. These components include fibre and bioactive elements such as phenolics, phytosterols, and resveratrol (Arya *et al*., 2016). They are an excellent source of micronutrients such as vitamin E, niacin, folic acid, sodium, potassium,

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among other essential components (USDA, 2014). In the same way, according to the American Peanut Council, the grade profile of peanuts is composed of approximately 50% of monounsaturated fatty acids (Feldman, 1999), which favour cardiovascular health, reducing the risk of coronary heart disease, by favouring an adequate concentration of LDL cholesterol (Matilsky *et al.,* 2009).

Although peanuts are rich in protein and several studies show the importance of using peanut protein to enrich other products, this food has also been enriched with other nutrients to enhance its health benefits (Jere *et al*., 2020), however, considering that it is a food high in fat, its consumption must be measured, so enriching peanuts with proteins would allow a higher intake of this nutrient in a lower proportion of mixture, also considering that they are more accessible especially for populations with a low socioeconomic level (Bonku and Yu, 2020).

2. Materials and methods

2.1 Extraction of protein isolates

Dried grains of 3 types of legumes (lentils, peas, and chickpeas) were selected, and soaking was carried out for 8 hrs. Subsequently, it was liquefied with distilled water using an Oster® laboratory blender (model: BLSTVB-G00). The pH of the suspension was adjusted using a NaOH solution (1 N, ratio 1/10). The solution was mixed with HCl to generate the extraction of the protein isolate. The solution was then centrifuged at 4000 rpm for 20 mins and washed (2 times), first with a hydroalcoholic mixture (20/80, v/v) and then with distilled water (1:10 w/v). The pellet was dried in an oven at 50°C and stored in a vacuum-sealed plastic container at room temperature (27°C) until later use.

2.2 Manufacture of peanut paste

The raw material was acquired from the Amazonian producers of the northern zone of Ecuador. For the production of the peanut paste, pre-conditioning operations were carried out to remove impurities. To facilitate shelling, the peanuts were subjected to a temperature of 180°C for 15 mins with frequent movements. Next, the peeling was carried out, once it was ready and separated from the peels, it was returned to the oven, this time at 150°C for 50 mins, subsequently, the peanuts were taken out and weighed three times, until a constant weight was maintained. For grinding, it was allowed to cool for 40 mins, as soon as it reached room temperature (27°C), it was introduced into an Oster® food processor (model: BLSTFPW00011). To the paste obtained, salt and protein isolate extracted from the 3 legumes were added at 5% each: PPL, PPP and PPC. It was processed until the desired texture was achieved for later coding.

2.3 Chemical composition

2.3.1 Humidity

The humidity percentage of each sample was carried out following the considerations established by AOAC (1975). Samples were collected in porcelain crucibles. Approximately 1 g was weighed and subsequently baked at 105°C for 24 hrs. The crucibles were then allowed to cool to room temperature, reweighed on the dry samples. The humidity percentage was calculated by weight difference through the following formula: % H = [(W1 gr- W2 gr) / (W3 gr)] × 100. Where W1 is the weight of the crucible, W2 is the weight of the crucible and the sample after heating, and W3 is the weight of the crucible and the sample after cooling.

2.3.2 Crude protein

Proteins were determined through the macro-Kjeldahl method, one of the most used techniques for the determination of organic nitrogen. The method used for the determination of proteins was Micro-Kjeldahl (Pearson, 1976). The crude protein content was calculated using a conversion factor of 5.46 (Gonçalves *et al*., 2010) as mentioned below:

$$\% \text{ Crude protein} = \frac{\text{Sample titer} - \text{blank titer} \times 14 \times 5.46}{\text{Sample Weight}} \times 100$$

2.3.3 Total fat

Fat extraction was performed using the Soxhlet extraction method with hexane as solvent. After evaporation of the solvent, the residue was dried at 105° C until a constant weight was achieved. The content was obtained by weight difference using the following formula:

$$\% \text{ Lipid} = \frac{\text{Initial cup weight} - \text{Final cup weight}}{\text{Weight of sample}} \times 100$$

2.3.4 Ashes

The ashes were obtained through the calcination method, according to the recommendations of the AOAC (AOAC, 1975). Approximately, 3 g of the leaf and powdered seeds were placed in a crucible and placed in a muffle furnace at a temperature of 600°C for 9 hrs. The ash content was determined by the weight loss of the sample (% ash = [(Weight of crucible with sample - Weight of crucible with ash) / Weight of sample] × 100).

2.3.5 Crude fibre

The content of total dietary fibre was made by the enzymatic-gravimetric method (AOAC, 1975). 1 g of defatted sample was used in a crucible. After the digestive process, the sample was dried in an oven at 105°C, cooled, and weighed. Finally, the sample was incinerated at 550°C in a muffle furnace, after cooling the sample it was weighed again, considering the following formula:

$$\%\text{crude fibre} = \frac{\text{weight of digested sample} - \text{weight of ashed sample}}{\text{Weight of sample}} \times 100$$

2.3.6 Carbohydrates

The percentage of carbohydrates (nitrogen-free extract), was obtained from the difference of the subtraction of 100% minus the sum of the percentages of Moisture, crude protein, fat, fibre and ash (% Carbohydrates = 100% - [% H +% P +% G +% C +% F]).

2.4 Consumer test design

Sensory evaluation was carried out one day after the mixtures were prepared. Consumers of a total of 183, all over 18 years old, were residents of the Shushufindi canton, Sucumbios Province, Ecuador. Previously, the purpose of the research was explained to consumers and they were informed that the information provided will be used exclusively for the study. Subsequently, each participant gave their informed consent in writing. The study received the approval of the Research Ethics Committee of the Universidad Peruana Unión and was registered under number 045-2021/UPeU/FCS.

2.5 Just-about-right scale

To determine the acceptability of the peanut paste fortified with protein isolates, the sensory evaluation method Just-about-Right was used (Narayanan *et al.,* 2014). This scale measures from 1 to 9 the suitability of the level of sensory attributes (taste, smell, texture, and colour) present in food. The scale determines if the sensory characteristics of the food are well optimized or if, on the contrary, they need to increase or decrease in intensity. Consumers were divided into 3 groups. They were given to taste 3 types of peanut pastes with different concentrations of isolated protein from legumes. Each participant evaluated the influence of the 4 sensory attributes. Likewise, the general acceptance of the three mixtures was determined. The mixes were served through a random design to avoid carryover effects (Macfie *et al.,* 1989).

2.6 Statistical analysis

The data collected were entered into an Excel sheet, version 2013. Then, they were analysed using the statistical software package SPSS version 26 (SPSS Inc., Chicago, IL, USA). The sensory attributes for each mix were described using means (M), standard deviation (SD), and standard error of the mean (SE). The differences between the mixtures were verified using the Tukey test. Hierarchical cluster analysis was carried out using the Ward method to determine the different consumer segments. The number of clusters was selected using a dendrogram. Principal component analysis was used to verify the relationships between mixtures and display them graphically. Variables with a probability value (p-value) less than 0.05 were considered statistically significant.

3. Results

The information on the chemical composition of the mixtures with different legume protein isolates is shown in Table 1. Regarding the amount of protein present, the PPP mixture obtained a slightly higher value of 30.65 g, followed by the PPC with 30.60 g, while the PPL mixture presented a lower value equivalent to 28.91 g. Regarding the total fat content, it was observed that the PPP mixture was 48.25 g, surpassing the PPL and PPC, however, it presented the lowest amount of total carbohydrates (16.14 g). On the other hand, in humidity, the PPP mixture presented the lowest value (2.16 g) and the highest value in ash, reaching 2.8 g. The PPL mixture presented the lowest values in protein and fat but exceeded the other 2 mixtures in carbohydrates with a value of 20.36 g.

Table 1. Chemical composition of the mixtures per 100 g

Parameter	Unit	Peanut butter*	Mixtures		
			PPL	PPP	PPC
Humidity	g	1.18	2.33	2.16	2.63
Protein	g	22.50	28.91	30.65	30.60
Fat	g	51.10	45.69	48.25	47.05
Ash	g	-	2.71	2.80	2.71
Fibre	g	4.80	0.00	0.00	0.00
Total carbohydrates	g	22.30	20.36	16.14	17.01

PPL: Peanut paste with lentil protein isolate; PPP: Peanut paste with pea protein isolate; PPC: Peanut paste with chickpea protein isolate. *Values obtained from the USDA National Nutrient Database for Standard Reference (SR).

The effects of the treatment on the sensory scores of the consumers are shown in Table 2. The texture attribute showed very significant differences ($p<0.001$), being the PPP and PPC mixtures the ones that obtained the highest scores. Regarding the flavour attribute, statistically significant differences were also found ($p <0.05$), the PPL mixture obtained the highest acceptance score. The odour attribute has shown very significant differences ($p<0.001$), higher scores were observed for the PPC mixture. Regarding general acceptability, the scores were higher than 8.7 among the three mixes, on a scale of 1 to 9 (1: dislike extremely; 9: like extremely). This shows the very good acceptability of the 3 peanut

Table 2. Overall acceptability of the sensory attributes of the three blends and consumer acceptability scores

Sensory attributes	PPL	PPP	PPC	SE	*p* value
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	
Colour	8.68±0.57	8.69±0.48	8.62±0.52	0.024	0.055
Texture	8.49±0.61	8.55±0.50	8.55±0.53	0.020	<0.001*
Taste	8.46±0.59	8.40±0.50	8.44±0.54	0.017	0.011*
Odour	8.57±0.57	8.59±0.50	8.67±0.51	0.023	<0.001*
General acceptability	8.72±0.55	8.72±0.46	8.70±0.50	0.024	0.190

SE: standard error of the mean. PPL: Peanut paste with lentil protein isolate; PPP: Peanut paste with pea protein isolate; PPC: Peanut paste with chickpea protein isolate. *p<0.05 (statistical significance).

paste mixes with different protein isolates.

A hierarchical cluster analysis was performed, obtaining 3 groups of consumers (Table 3), showing significant differences (p<0.05) in all clusters for the attributes of texture and odour. Group 1 (40.4% of the population) and group 2 (28.4% of the population), showed similar behaviours in the acceptability of the colour. When evaluating the acceptability of the texture in the three groups, a significant difference can be observed in group 3, which represented 31.1% of the population, with a greater acceptance for the PPC mixture (p<0.05). Groups 1 and 2 showed very significant acceptability (p<0.001) for the PPL and PPP mixtures, respectively. Regarding taste acceptability, group 3 reported higher acceptability with a score of 9, followed by group 2 with a score of 8.96 for the PPL mixture. The acceptance of group 1 in terms of taste obtained a score of 8.92 for the PPP mix. When referring to the acceptability of the sensory attribute of odour, the three groups reported scores >8 for the mixtures PPL, PPP, and PPC, respectively.

For the three study groups, there were no significant differences in overall acceptability among the three peanut butter mixes. Acceptability scores were higher than 8.4 for all mixes, with group 2 having the highest score (9) for the PPP mixture compared to the other 2 mixtures.

The acceptability among consumers was identified by gender (Table 4), which shows that 59.6% of the participants were women and 40.4% men. Likewise, it is recorded that there are no significant differences in general acceptability and sensory attributes between genders since similar scores >8 were observed.

To evaluate the preference of the respondents, a radar graph was made to measure the intensity based on the average of each category (Figure 1), where the general acceptability of the participants by the PPP

Table 3. Acceptability scores among three groups of consumers identified by cluster analysis

	n	%	PPL	PPP	PPC	SE	*p*-value
			Mean±SD	Mean±SD	Mean±SD		
Acceptability of colour							
Cluster 1	74	40.4	8.99±0.11	8.57±0.52	8.61±0.51	0.037	0.047*
Cluster 2	52	28.4	8.50±0.67	8.98±0.13	8.25±0.55	0.044	0.047*
Cluster 3	57	31.1	8.44±0.65	8.61±0.52	9.00±0.00	0.046	0.215
Acceptability of texture							
Cluster 1	74	40.4	8.99±0.11	8.42±0.49	8.49±0.50	0.033	<0.001*
Cluster 2	52	28.4	8.19±0.65	8.98±0.13	8.17±0.51	0.032	<0.001*
Cluster 3	57	31.1	8.12±0.53	8.33±0.51	9.00±0.00	0.033	0.005*
Acceptability of taste							
Cluster 1	74	40.4	8.92±0.27	8.27±0.44	8.32±0.50	0.029	0.016*
Cluster 2	52	28.4	8.17±0.58	8.96±0.19	8.02±0.37	0.032	0.016*
Cluster 3	57	31.1	8.14±0.51	8.09±0.34	9.00±0.00	0.028	0.062
Acceptability of odour							
Cluster 1	74	40.4	8.99±0.11	8.59±0.49	8.64±0.48	0.034	<0.001*
Cluster 2	52	28.4	8.31±0.64	8.98±0.13	8.38±0.63	0.042	0.003*
Cluster 3	57	31.1	8.30±0.56	8.23±0.46	9.00±0.00	0.039	<0.001*
General acceptability							
Cluster 1	74	40.4	8.99±0.11	8.64±0.48	8.69±0.49	0.035	0.259
Cluster 2	52	28.4	8.62±0.66	9.00±0.00	8.42±0.60	0.043	0.286
Cluster 3	57	31.1	8.47±0.65	8.58±0.53	8.98±0.13	0.049	0.259

SE: standard error of the mean. PPP: Peanut paste with pea protein isolate; PPC: Peanut paste with chickpea protein isolate. *p<0.05 (statistical significance).

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Table 4. Acceptability scores among consumers identified by sex

	n	%	PPL Mean±SD	PPP Mean±SD	PPC Mean±SD	SE	*p* value
Acceptability of colour							
Female	109	59.6	8.67±0.56	8.70±0.48	8.63±0.52	0.03	0.929
Male	74	40.4	8.69±0.59	8.70±0.48	8.62±0.54	0.04	
Acceptability of texture							
Female	109	59.6	8.48±0.60	8.56±0.49	8.54±0.51	0.02	0.644
Male	74	40.4	8.51±0.64	8.54±0.52	8.58±0.54	0.03	
Acceptability of taste							
Female	109	59.6	8.39±0.57	8.40±0.49	8.46±0.53	0.01	0.091
Male	74	40.4	8.58±0.59	8.42±0.52	8.43±0.55	0.03	
Acceptability of odour							
Female	109	59.6	8.57±0.56	8.60±0.49	8.74±0.46	0.02	0.287
Male	74	40.4	8.59±0.59	8.58±0.52	8.58±0.57	0.03	
General acceptability							
Female	109	59.6	8.74±0.53	8.74±0.43	8.72±0.48	0.03	0.297
Male	74	40.4	8.69±0.59	8.69±0.49	8.68±0.52	8.68	

SE: standard error of the mean. PPP: Peanut paste with pea protein isolate; PPC: Peanut paste with chickpea protein isolate.

mixture is evidenced. On the other hand, greater acceptability is observed in relation to colour and texture in the PPP mixture, with respect to flavour, the PPL shows a higher value with respect to the other mixtures. The sensory attribute of smell has been more accepted in the PPC mixture, without neglecting that the scores for all mixtures have exceeded the value of 8 on a scale of 1 to 9.

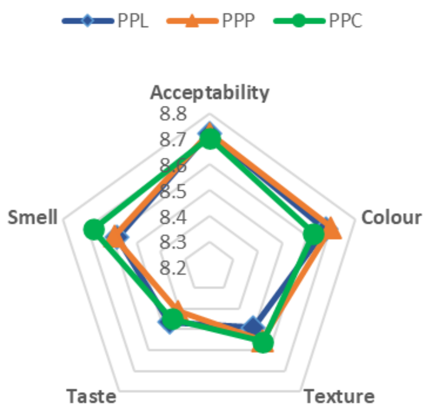

Figure 1. Measurement of intensity based on the average of each category

4. Discussion

This study aimed to develop and evaluate the acceptability of a protein-based peanut paste isolated from three types of legumes, lentils, peas, and chickpeas. The main results of this study indicate that peanut paste mixes are an excellent source of protein and total fat. In addition, in general, all mixtures were sensory well accepted.

When evaluating the nutritional composition of fortified peanut pastes, the amount of protein found ranged from 28.9 to 30.6 g. According to the USDA SR (USDA, 2018), the protein content of a peanut paste is on average 22.5 g, although these values can be influenced by maturity, the cultivation, and the growing environment of the seeds, among other factors (Basha *et al.,* 1976). The use of protein isolates increases and optimizes the nutritional composition of the food without affecting the sensory attributes as shown by the results of the current study. Similar data were reported in other studies (Gupta *et al.,* 2021), in which, when fortifying a pasta with quinoa protein isolate, a considerable increase in protein content has been observed, improving not only the nutritional quality but also the texture attribute. The use of protein isolates constitutes a valuable tool that can favour the production of foods enriched with proteins of high nutritional quality and low cost to contribute to reducing the risk of suffering from protein-calorie malnutrition.

On the other hand, the total fat content found in the three peanut paste mixtures is between 45.6 and 48.2 g, these values are lower than those recorded in the USDA SR (51.1 g) (USDA, 2018). This could be due to the fact that there is an inversely proportional relationship between fat and protein, being that if the peanut has a higher protein content, it will present a lower fat content (Sarvamangala *et al.,* 2011). Even so, the results of the current study show that the blends had considerable total fat content. Much emphasis is placed on the nature of the fatty acids present in peanuts, highlighting 25.4 g of monounsaturated acids, 12.3 g of polyunsaturated and less saturated fatty acids (USDA, 2018). The amount of trans fat in peanut butter is 156 times less than what is needed to meet the 0 g limit for trans fat on food labels (Sanders, 2001). Studies reported that diets high in monounsaturated fats reduced LDL cholesterol by 14%, while DHL cholesterol remained at normal levels with an adequate reduction in triglycerides (Pelkman *et al*., 2004). The consumption of peanuts and derivatives has more beneficial effects on cardiovascular health

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compared to low-fat diets (Arya *et al.,* 2016). In addition, emerging findings have shown that the fats present in peanuts play an important role in fighting caloric malnutrition, providing the necessary healthy calories. (Arya *et al*., 2016). Likewise, the high caloric density provided by these mixtures could be used as a nutritional supplement in special situations and under high metabolic demands (OMS/FAO, 2003; Jäger *et al.,* 2017).

Regarding the acceptability of the sensory attributes, it was observed that the texture of the peanut pastes was highly accepted by consumers, despite the fact that when adding the protein isolate, the paste did not have the same characteristics as the butter of conventional peanuts. This may be due to the protein content present, as presented in other studies (Giuberti *et al.,* 2018; Hu *et al.,* 2020), in which a higher amount of protein could influence the texture attribute since higher levels of protein can contribute to a firmer and more compact structure of a pasta. On the other hand, peanut butter always has a smooth consistency and can be easily added to complementary foods. However, adding an extra protein content through the protein isolate produces an absorption of moisture and fat, which reduces the chances of obtaining the desired thickness or texture compared to commercial butter (Ocheme *et al.,* 2018). Even so, the mixtures of the current study presented very good acceptability regarding the texture attribute, making the fortified mixtures a healthy protein alternative for the low-income population.

The percentage of the protein isolate that was introduced in the preparation did not negatively influence the flavour attribute. By containing a minimum value of 5% added, the peanut paste achieved good acceptability by consumers. It is possible that these findings are due to the little addition made in the composition of the mixture. Similar reports were seen in other studies (Lu *et al.,* 2019), in which the most accepted mixtures were those that contained a low percentage of addition of defatted flour compared to those that had a high percentage of substitutions. In the same way, another study found greater acceptability in the flavour attribute for those products made with substitutions of refined wheat flour of less than 20% (Yadav *et al.,* 2012). In general, the fats and oils that have been used in food preparation contribute to palatability, improving the taste, texture, and appearance of food (Sarvamangala *et al.,* 2011). In the current study, the fats present in the peanut paste have satisfactorily contributed to the pleasant taste of the mixtures due to the high palatability they generate. In addition to the fat component, proteins and carbohydrates, especially sugars, are important precursors of the characteristic flavour of peanuts (Davis and Dean, 2016). Moreover, the flavour of peanuts is accentuated when it is subjected to term processes (roasting) or biological fermentation, which favours the components present in peanuts to undergo a series of reactions to produce volatile compounds such as pyrazine, furan, aldehydes, alcohols, ketones, acids, lipids, sulphur compounds, alkenes, among others, that adhere the special aroma to roasted seeds and their derived products (Crippen *et al*., 1992; Cuicui and Lixia, 2018). However, considering that taste is one of the most important indexes to measure the quality and acceptability of food, some peanut-based products are marketed with varied aromas so that consumers do not get tired of the frequent consumption of a single flavour, leaving open the possibility of innovating the presentation of these fortified mixtures with the incorporation of other aromas or flavours (Jones *et al.,* 2014).

The general acceptability of the three mixtures scored very high. This could be explained by the fact that the 4 sensory attributes were very well assimilated by consumers. Similar findings were reported in one study (Sanders *et al.,* 2014) in which when fortifying butter with peanut shells, the panellists reported that the addition of this component did not affect the acceptability of the attributes of flavour, texture or general acceptability. In addition, they met the identity standards established by the FDA (Cuj *et al.,* 2016). In another study, a product made from peanut paste, milk, and micronutrients was proposed to provide a range of between 50 to 60% of the daily recommendations for micronutrients for children, this product obtained very good acceptability and, as a supplement, emphasizes its use in the fight against malnutrition in vulnerable populations in developing countries. In general, by-products made from peanuts show good acceptability and can be used in a versatile way in a healthy diet, keeping adequate intake recommendations to avoid high consumption (Hu *et al.,* 2020; Soller *et al.,* 2020).

4.1 Limitations

In the study, some limitations should be considered. In the first place, only participants over 18 years of age were considered in future research and similarly, it is suggested to consider the participation of children in the evaluation of the acceptability of peanut paste. Furthermore, the consumers were recruited from the inhabitants of a small town in the province of Sucumbios, Ecuador, the conclusions cannot be generalized. Second, the sociodemographic data of the study participants were not considered. Third, politeness bias may have led consumers to under-report aspects of the acceptability of sensory attributes that they did not like. Therefore, the actual acceptability of the evaluated peanut paste may be less than that reported by the participants in this study.

5. Conclusion

In conclusion, it can be affirmed that the addition of protein isolates increases the nutritional value of peanut paste, making it a fortified food and a key option to fight against protein-calorie malnutrition. Very good acceptability was obtained for formulations of peanut paste with three different types of protein isolates based on legumes among consumers, without differences in acceptance between sexes because both showed similar acceptability. These results show the need to develop fortified products based on plants and easy to improve the nutritional status of vulnerable populations.

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