

Acceptability of a cereal bar source of protein and vitamin B12 by ovo-lacto-vegetarian individuals

Aceitabilidade de barra de cereal fonte de proteína e vitamina B12 por ovo-lacto-vegetarianos

Valdirene Francisca Neves dos Santos¹
Thatyane Costa¹

¹ Universidade Paulista, Instituto de Ciências da Saúde. São Paulo, SP, Brasil.

Correspondence

Valdirene Francisca Neves dos Santos
E-mail: val_ _usp@hotmail.com

Abstract

Objectives: Considering that unbalanced vegetarian diet may trigger important nutritional deficiencies, such as of vitamin B12 and protein, the objective of this study was to formulate a cereal bar source of vitamin B12 and protein, and to verify its acceptability by ovo-lacto-vegetarian individuals of a religious institution. *Methodology:* The cereal bars were elaborated with fortified cereal, whey protein, cashew nuts, corn glucose and water. The proportion of the ingredients was established in order to characterize the cereal bars as food source of protein and vitamin B12. The sensory analysis was performed for the requirements of taste, aroma, color and texture, using a structured 9-point hedonic scale. *Results:* The formulated cereal bar has met the requirements of the legislation regarding protein and vitamin B12. The bar obtained 90% or greater acceptance in all studied variables. However, the texture factor presented less acceptance when compared to other attributes. Individuals categorized in elementary education and the female gender presented greater overall acceptance of the preparation. *Discussion:* When unbalanced, vegetarian diet may trigger nutritional deficiencies and, on some occasions, the intake of supplements and fortified foods is necessary. Studies have shown that texture is a limiting factor in the preparation of cereal bars, which are well accepted especially by the female audience, and can be considered as a snack option. *Conclusion:* The cereal bar was well accepted by the ovo-lacto-vegetarian public in all variables studied. Thus, it can be adopted as a healthy quick snack.

Keywords: Diet. Vegetarian. Protein Deficiency. Vitamin B12. Food. Snacks.

Resumo

Objetivos: Considerando que a dieta vegetariana, quando não balanceada, pode desencadear carências nutricionais importantes, entre elas de vitamina B12 e proteína, objetivou-se formular barra de cereal fonte de vitamina B12 e proteína e verificar a aceitabilidade por ovo-lacto-vegetarianos de uma instituição religiosa. *Metodologia:* As barras de cereal foram elaboradas com cereal fortificado, whey protein, castanha de caju, glicose de milho e água. A proporção de ingredientes foi estabelecida de modo a caracterizá-las como alimento fonte de proteína e vitamina B12. A análise sensorial foi realizada para os requisitos sabor, aroma, cor e textura, por meio de escala hedônica estruturada verbal de 9 pontos. *Resultados:* A barra de cereal formulada atingiu as exigências da legislação, para proteína e vitamina B12. A barra obteve aceitação próxima ou superior a 90% em todas as variáveis estudadas, mas o fator textura apresentou menor aceitação quando comparado aos demais atributos. Os indivíduos categorizados em ensino fundamental e o sexo feminino demonstraram maior aceitação global da preparação. *Discussão:* A dieta vegetariana, quando não balanceada, pode desencadear carências nutricionais, e em algumas ocasiões a ingestão de suplementos e alimentos fortificados é necessária. Estudos demonstram que a textura é fator limitante na elaboração de barras de cereal, que são bem aceitas, em especial pelo público feminino, e podem ser utilizadas casualmente como opção de lanche. *Conclusão:* A barra de cereal teve boa aceitação pelo público ovo-lacto-vegetariano em todas as variáveis estudadas; assim, pode vir a ser adotada como opção de lanche rápido.

Palavras-chave: Dieta Vegetariana. Deficiência de Proteína. Vitamina B12. Alimentos. Lanches.

Introduction

Vegetarianism is defined as the consumption of a diet composed predominantly of food of vegetable origin. Vegetarians are divided into different classifications which exclude total consumption of meat. However, ovo-lacto-vegetarians consume products of animal origin, such as eggs, milk and dairy products.¹

A vegetarian diet can be followed for several reasons, which may include ecological, economic, religious, ethical and health considerations. However, an unbalanced vegetarian diet, i.e., that does not include a variety of plant foods, may result in changes that negatively affect the organic functions.

These changes could include hyperhomocysteinemia, protein deficiency, anemia, decreased muscle creatinine content and menstrual disturbance in women who increase physical activity. Some of these changes may decrease the ability to perform activities that require physical effort.²

The deficiency of protein causes several disorders to the organism, and the damages can be even more serious if they occur in the early stages of life, such as: reduced ability to perform work, increased vulnerability to infections, reduced cognitive capacity, reduction in metabolic biotransformation capacity, impaired transport of vitamins and minerals, intestinal malabsorption of nutrients, among others.³

Diets that restrict the consumption of foods of animal origin may still interfere with the adequate intake of cyanocobalamin (vitamin B12).⁴ The lack of this vitamin can lead to hematological disorders, such as the reduction of hemoglobin due to poor formation in the bone marrow (megaloblastic anemia); and neurological disorders, with progressive damage to the nervous system, leading to memory deficits, cognitive dysfunctions, and dementia. In addition to cardiovascular disorders, being a risk factor for triggering atherosclerosis.^{5,6}

The 2014 *New Dietary Guidelines for the Brazilian Population* addresses a new vision of healthy eating by classifying foods into *in natura* and minimally processed, oils, fats, salt and sugar, processed foods and ultraprocessed foods. According to this material, for a balanced diet, it is recommended that *in natura* and minimally processed foods should be the basis of the diet. The consumption of processed foods should be limited; the consumption of ultraprocessed foods should be avoided; and oils, fats, salt and sugar should be used in small quantities when seasoning and cooking food, creating culinary preparations that can meet the needs of the group in question.⁷

In this way, when developing a food, one must consider the context in which the person is inserted. In the case of the globalized world in which we live, practicality and cost must also be considered.^{8,9}

In their study, Lobato et al.⁹ developed a cereal bar rich in soy protein and isoflavone, which contributed to the decrease of dyslipidemia in patients of a cardiology clinic in Londrina-PR, Brazil. The authors concluded that the development of cereal bar with functional properties provides benefits to the health of the consumer, besides being easily adhered to by the individuals due to its practicality and cost. It is worth noting that cereal bars are a practical product, easy to store and transport, which should be consumed moderately and associated with a healthy lifestyle and eating habits.

The demand for nutritious and safe food has grown in the world, and eating balanced foods is the proper way to avoid or even correct health problems. Cereal bars meet these requirements and have been increasingly consumed by the population.¹⁰ According to Lobato et al.,⁹ cereal bars are easy to be made, depending on the ingredients used, and can be sold at a low price. Moreover, because they are practical products, cereal bars can be conveniently consumed as snacks.

No studies were found that developed cereal bars aimed at the needs of the vegetarian public. Therefore, the present study aimed to prepare and evaluate the acceptance of a new snack alternative for casual consumption through the development of a cereal bar source of vitamin B12 and protein for ovo-lacto-vegetarian individuals of a Seventh-day Adventist religious institution.

Materials and Methods

This is a descriptive cross-sectional study from a health promotion perspective. It was carried out between January 2015 and December 2016, focusing on the elaboration of a cereal bar source of protein and vitamin B12 directed at the ovo-lacto-vegetarian public of a religious institution.

Development of cereal bar source of vitamin B12 and protein

All ingredients used in the formulation were purchased at stores in the city of São Paulo, Brazil. They are: morning cereal (Original Power Corn Flakes - Kellogg's®), cashew nut, corn glucose, whey protein (Pro Whey Protein - Probiótica®) and water. The formulation was named “*protein12*”.

The proportion of the ingredients was defined in order to reach the values recommended by the RDC No. 54/2012,¹¹ which states that “source” foods must contain at least 6g of protein and at least 15% of the RDA (*Recommended Dietary Allowances*)¹² of vitamin.

It was used the Brazilian Food Composition Table (TACO)¹³ and the values contained in the packaging of the morning cereal (Original Power Corn Flakes - Kellogg's®) and whey protein (Pro Whey Protein - Probiótica®) for the determination of the energy supply and other nutrients present in the cereal bar, and for the formulation of the Compulsory Nutrition Information.¹⁴ The amount of the ingredients was also stipulated to comply with the RDC No. 359/2003,¹⁵ which recommends that cereal bars must have 30g.

Thus, for the production of each cereal bar, the following ingredients and their amounts were used: 15g of morning cereal, 5g of cashew nuts, 20g of corn glucose, 10g of whey protein (Pro Whey Protein - Probiótica®) and 3 ml of water.

Cereal bars production

The preparation of the sample took place in the Nutrition Laboratory of the Paulista University, considering the good manufacturing practices during preparation, storage and transportation.¹⁶

Firstly, in a glass cup with the aid of a metal spoon, 20g of corn glucose, 10g of whey protein and 3 ml of filtered water were homogenized forming a binding agent, which was reserved for further use. The dried ingredients were broken into smaller pieces, weighed in a digital scale and put in a bowl. Thereafter, the binding agent was slowly mixed to the dry ingredients (15 g of

morning cereal and 5 g of cashew nuts) until a paste was formed. When ready, the mixture was molded into 30g bars, packed in non-stick aluminum form and baked for 25 minutes at 180°C. Finally, the cereal bars were cooled, packed in PVC films and stored in a refrigerator for sensory analysis on the day after production.

The present study was approved by the Ethics Committee of the Paulista University, registered under the CAAE 1.322.413.

Research Participants

The study population consisted of 36 adult individuals, aged between 19 and 59 years, of both genders, ovo-lacto-vegetarians of a Seventh-day Adventist religious institution, located in the East Zone of the city of São Paulo, Brazil. This institution was chosen because of the ease of obtaining the adequate number of ovo-lacto-vegetarian individuals for the research at the same site.

The invitation to participate in the study was made through telephone contact. At the time of this contact, the researcher presented himself, explained the objectives of the research and clarified its risks and benefits, as well as possible doubts.

After the acceptance, a visit to the institution was scheduled, respecting the time and day most appropriate for the person in charge of the institution - elder / pastor. On that occasion, a research intent letter was signed by the person. Emphasis was given to the freedom of refusal to participate, or withdrawal of consent, at any stage of the research, and assurance of anonymity in the information provided.

Adults aged 19 to 59 years were considered for the survey, attending the Seventh-day Adventist religious institution.

For the sensory analysis, vegetarians of the vegan type, and semi- to strict vegetarians were excluded from the study.

The ovo-lacto-vegetarian individuals of this church were invited by the elder to participate in the research. When the invitation was accepted, a free and informed consent form was read and signed at the time of the sensory analysis.

Evaluation of the acceptability of the cereal bar

Sensory analysis occurred in an environment in the religious institution itself, a space that had natural and artificial lighting, with little interference on the brightness. The walls of the place were light colored; there was no noise or bustling places around, being free of odors that could interfere with the analysis.

In order not to interfere with acceptance, there was no contact of the participants with the sample before the test.

Samples of 30g were served in a white disposable dish covered by stainless steel *cloche*, being discovered at the moment of the analysis, which occurred individually, that is, the testers had no contact with each other.

Protein12 was evaluated by the participants regarding these attributes: texture, aroma / odor, color and taste, through the use of the affective test of acceptability. Acceptance assessment was performed using a verbal structured 9-point hedonic scale,¹⁷ ranging from 1 = extremely disliked to 9 = extremely liked.

Data processing

For the analysis of the results, the nature and variability of the studied variables were considered. The study variables were presented according to the absolute and relative frequencies.

To facilitate the comparison between the acceptability of the cereal bar and schooling, gender and schooling categories and acceptance of the cereal bar characteristics were grouped. The schooling was arranged in: complete and incomplete elementary school, grouped in elementary school; complete high school, incomplete technical and higher education, grouped in complete high school; and complete higher education and graduate education, grouped in higher education.

The acceptance criteria were grouped into “I liked” and “I disliked”; with “I liked” covering the following items: 6 - I liked it slightly, 7 - I liked it moderately, 8 - I liked it very much, 9 - I extremely liked it; yet, the “I disliked” covered: 1 - I extremely disliked it, 2 - I disliked it very much, 3 - I disliked it moderately, 4 - I disliked it slightly.

Results

Sensory analysis was performed by 36 ovo-lacto-vegetarian individuals, of which 52.8% were male (n = 19) and 47.2% female (n = 17). The mean age was 38.8 years (18-59 years).

In Table 1, the energy and nutrient composition of the developed cereal bar is described, where it is observed that the amount of nutrients present in the cereal bar allows to characterize it as a source of vitamin B12 and protein.

Table 2 presents the percentage of the educational level of the research participants. The majority of the sample corresponds to the categories of complete higher education (30.6%) and complete high school (27.8%); only one participant did not specify his/her schooling (2.8%).

Table 1. Nutritional information of the cereal bar source of vitamin B12 and protein, São Paulo, 2016.

Nutritional Information 30g (1 unit)		
	Amount per serving	VD%*
Energetic Value	146Kcal/ 757 KJ	8%
Carbohydrate	34,7g	7%
Protein	6,3g	1%
Total Fat	2,44g	1%
Saturated fat	0,28g	-
Trans Fat	-	-
Food Fiber	-	-
Sodium	90,3mg	4%
Vitamin B12	0,4 ug	17%

(*) % Daily values based on a 2,000 kcal or 8,400 KJ diet. Daily values may be higher or lower depending on energy needs.

Table 2. Percentage evaluation of the schooling level of ovo-lacto vegetarian individuals participating in the sensory analysis. São Paulo, 2016.

Education / Gender	Female n=17 (%)	Male n=19 (%)	Total n=36 (%)
Incomplete Elementary School	0	5.3	2.8
Complete Elementary School	5.88	10.5	8.3
Incomplete High School	0	0	0
Complete High School	17.6	36.8	27.8
Technical education	0	10.5	5.6
Incomplete Higher Education	23.5	15.8	19.4
Complete Higher Education	47	15.8	30.6
Graduate Studies	5.88	0	2.8

Figure 1 shows the percentage of good acceptability in relation to all requirements of the cereal bar by ovo-lacto-vegetarians, according to their level of schooling. Individuals categorized as “elementary school” showed greater acceptance of the cereal bar, since 100% of them liked some of the characteristics of the product. The “high school” category showed less acceptance of the cereal bar in relation to the taste, aroma and texture. While the “higher education” category presented good general acceptance of the cereal bar.

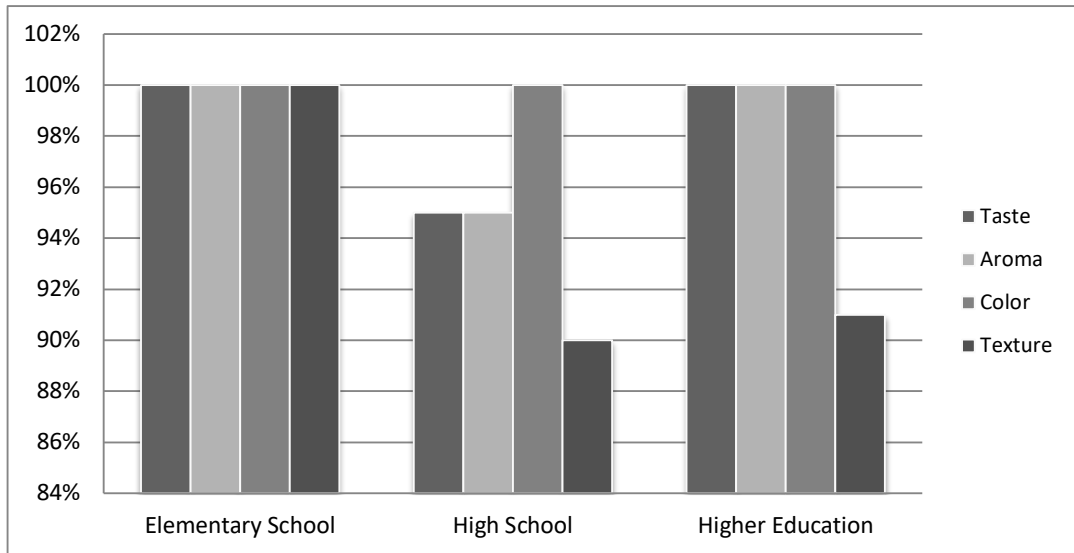


Figure 1. Percentage evaluation of good acceptability regarding the taste, aroma, color and texture of the cereal bar, according to schooling level, by ovo-lacto-vegetarian individuals. São Paulo, 2016.

Table 3 presents the percentage of acceptability of the taste, aroma, color and texture of the *protein12* cereal bar by ovo-lacto-vegetarians. It is observed that 97.3% of the ovo-lacto-vegetarian individuals demonstrated to like the taste of the cereal bar. Female gender presented greater acceptance, where 41.1% said they extremely liked the taste of the cereal bar. Regarding the male gender, 63.1% reported they liked very much the taste of the cereal bar.

Regarding the acceptability of the aroma, 94.5% of the individuals reported they liked it in some way. The female gender also showed greater acceptability of this factor, where 58.8% said they liked very much the aroma and 17.6% said they extremely liked it. Yet, regarding the male gender, 47.4% reported they liked very much the aroma and 21.1% said they extremely liked it.

Regarding the color of the cereal bar, it presented good acceptance since none of the individuals disliked this requirement. Women demonstrated greater acceptance of this factor: 35.3 % liked it very much and 35.3% extremely liked it; while 31.6% said they liked it very much and 31.6% said they extremely liked it.

The cereal bar was also well accepted for texture, since 91.7% of the individuals liked this factor in some way. However, the male gender showed greater acceptance of it: 68.4% said they liked the cereal bar texture very much or extremely, while 64.8% of the female said they liked it very much or extremely.

Table 3. Percentage evaluation of acceptability regarding the taste, aroma, color and texture of the cereal bar by ovo-lacto-vegetarian individuals. São Paulo, 2016.

Criteria	Evaluation	Female (n=17) (%)	Male (n=19) (%)	Total (n=36) (%)
Taste	1 - Extremely disliked it	0	0	0
	2 - I disliked it very much	0	0	0
	3 - I disliked it moderately	0	5.3	2.8
	4 - I disliked it slightly	0	0	0
	5 - Indifferent	0	0	0
	6 - I liked it slightly	5.9	0	2.8
	7 - I liked it moderately	11.8	10.5	11.1
	8 - I liked it very much	41.2	63.1	52.8
	9 - I extremely liked it	41.2	21.1	30.6
Aroma	1 - Extremely disliked it	0	0	0
	2 - I disliked it very much	0	0	0
	3 - I disliked it moderately	0	5.3	2.8
	4 - I disliked it slightly	0	0	0
	5 - Indifferent	0	5.3	2.8
	6 - I liked it slightly	0	10.6	5.6

to be continued

Criteria	Evaluation	Female (n=17) (%)	Male (n=19) (%)	Total (n=36) (%)
	7 - I liked it moderately	23.5	10.6	16.7
	8 - I liked it very much	58.8	47.4	52.8
	9 - I extremely liked it	17.6	21.1	19.4
Color	1 - Extremely disliked it	0	0	0
	2 - I disliked it very much	0	0	0
	3 - I disliked it moderately	0	0	0
	4 - I disliked it slightly	0	0	0
	5 - Indifferent	0	0	0
	6 - I liked it slightly	11.8	5.3	8.3
	7 - I liked it moderately	17.6	31.6	25
	8 - I liked it very much	35.3	31.6	33.3
	9 - I extremely liked it	35.3	31.6	33.3
Texture	1 - Extremely disliked it	0	0	0
	2 - I disliked it very much	0	0	0
	3 - I disliked it moderately	5.9	0	1
	4 - I disliked it slightly	11.8	0	5.6
	5 - Indifferent	0	0	0
	6 - I liked it slightly	5.9	15.8	11.1
	7 - I liked it moderately	11.8	15.8	13.9
	8 - I liked it very much	23.6	31.6	27.8
	9 - I extremely liked it	41.2	36.8	38.9

Discussion

Proteins perform several functions indispensable to the organism, such as structural, regulatory, as well as function of defense and transport through the biological fluids. They are organic compounds essential to the body, formed by the combination of about 20 amino acids in various proportions. Of these amino acids, eight are not synthesized by the body. Thus, it is of great importance to reach the nutritional recommendations for this nutrient through a balanced and diversified diet.¹⁸

It is known that the human body produces some amino acids, but the health professionals' concern about the vegetarian diet refers to the adequate intake of the amino acids not synthesized by the body.^{1,19}

However, no research was found revealing that vegetarian individuals normally have inadequate protein intake.

On the other hand, diets that restrict the consumption of animal origin food may interfere with the adequate intake of vitamin B12, which is a water soluble vitamin synthesized by microorganisms, predominantly present in animal origin food.²⁰ Vitamin B12 is essential for the functioning of virtually all cells, the main ones being: intestinal cells, nerve cells and the bone marrow. This vitamin is still helpful in the process of blood cell maturation and myelin sheath formation.²¹

An experimental study with rats indicated that diet with vitamin B12 deficiency may favor a decrease in the levels of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) in the liver and plasma of these animals.²² Cyanocobalamin deficiency is a health problem for the vegetarian individuals, especially for vegan ones, if there is no regular supplementation or habitual consumption of fortified foods.²³

Although some foods, such as soy products, seaweed and fermented vegetables, are indicated as sources of vitamin B12, this claim is in fact inadequate since the cobalamin in the constitution of these foods is an inactive analogue of vitamin B12. Therefore, they are not considered safe and sufficient to meet the needs and avoid nutritional deficiencies.^{19,1}

According to the American Academy of Nutrition and Dietetics (ADA), vegetarian diets require reliable sources of vitamin B12, such as fortified foods or supplements.²⁴ The *protein12* is a fortified formulation with vitamin B12 and protein.

Since the inadequate consumption of these nutrients can trigger important nutritional deficiencies, this formulation could easily serve as a fast and healthy snack option, especially for ovo-lacto-vegetarians, since this public presented good acceptance of the cereal bar, which evidences the relevance of creating healthy options like this one.

The formulation of the cereal bar source of vitamin B12 and protein had good acceptance in most of the analyzed attributes, except for the texture, which presented less acceptance when compared to the other attributes. The same result was obtained by Colussi et al.²⁵ in their formulation (oat and golden linseed cereal bar): in one of their tests, the texture was an impacting factor in the acceptability of the cereal bar.

A cereal bar with organic acerola fiber²⁶ showed 32.5% acceptability for its taste. The results obtained in the present formulation were higher: 97.3% of the tasters liked the taste of the formulation in some way. The acerola-based formulation also showed less acceptance in the “texture” requirement, where 40% of the tasters reported not approving it, whereas in the current formulation only 8.4% of the individuals disliked this factor.

The cereal bar based on babassu almond flour developed by Arévalo-Pinedo et al.²⁷ had good acceptance by the testers. The most approved requirement was its color, followed by taste, aroma and texture. In the current study, the approval results were similar, with the color being the highest approval item, followed by taste, aroma and texture as the lowest approval item.

In a study on the acceptability of cereal bars with bark and guava seed,²⁸ the formulation presented low taste acceptance. It was not observed in the present study. In contrast, the “texture” requirement was well accepted in the guava formulation, which was not the case with *protein12*, since this was the lowest acceptance item.

The acceptance test performed with a cereal bar flavored with umbu pulp²⁹ presented low acceptance in relation to texture, and good acceptance in relation to other attributes, as well as the current study.

Pereira et al.³⁰ created a cereal bar with residue of soybean extract and dehydrated vegetables, which presented good acceptance, except for the formulation made with beet, whose coloration was a limiting factor in the acceptability of the bar. Color was not a limiting factor in the acceptance of *protein12*.

The iron-fortified cereal bar formulated by Sampaio et al.³¹ also presented good acceptance in most of the evaluated items, despite the limitation regarding the acceptance of the texture, as well as the current formulation.

A quinoa cereal bar³² had global acceptance of 95%, but also presented limitation in the acceptability of its texture. And a cereal bar with the addition of cassava bagasse³³ presented less acceptance as more bagasse was added, since this factor interfered in the texture of the preparation, which reaffirms the importance of texture in the acceptance of the products.

The acceptability of a cereal bar with plum meal³⁴ was lower than that of the current formulation, since the mean acceptance was focused on “indifferent” and “slightly liked it” whereas, in the current study, none of the testers showed indifference on aspects of the cereal bar.

It is clear that the greatest limitation of the current formulation and prior formulations compared to industrialized ones is the texture of the cereal bars, since the use of stabilizers and additives occurs predominantly in industry sector and the consumer is already accustomed with the texture of industrialized bars.

According to Teixeira et al.,³⁵ for a product to be considered as acceptable in relation to its sensory properties, an acceptability index of at least 70% is required. Through the results, it can be observed that the formulation presented acceptance index higher than 90% for all the requirements, being characterized as well accepted by most testers.

In a study carried out by Degáspari et al.,³⁶ whose objective was to evaluate the nutritional profile of cereal bar consumers, there was greater tendency of consumption of cereal bars by the group of women. This fact may occur due to the female preference for sweet taste, mainly due to hormonal factors. The data corroborate the current study, since it is possible to notice a variation in the acceptance of *protein12* among the genders, as women presented greater acceptance regarding taste and aroma, whereas men presented acceptance regarding the texture. Both evaluated the color positively.

The study carried out by Degáspari et al.³⁶ also evidenced the greater consumption of cereal bars by high income population. It is known that income has close relationship with the level of schooling. In the present study, it was noticed that the individuals categorized in “elementary school” presented greater acceptance of the cereal bar.

There are few formulations fortified with vitamin B12, which limits the comparison of the current formulation in relation to this factor. In addition, since this is an estimated amount of protein and vitamin B12, it is difficult to compare it with previous studies that considered centesimal analysis to verify the nutritional contribution of the preparation.

Conclusion

The cereal bar source of vitamin B12 and protein was well accepted by the ovo-lacto-vegetarian public in all variables studied. In this way, it can be adopted as a fast snack option, since vegetarian diet, when unbalanced, can lead to nutritional deficiencies. Thus, vitamin-enriched foods may prove to be good choices for this public.

Contributors

Santos VFN and Costa T participated in all steps of the study, from designing to reviewing the final version of the article.

Conflict of interests: The authors declare no conflict of interest.

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