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Original

Acceptance of handmade products containing nuts and fructooligosaccharides

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Abstract

Introduction: **Prebiotic and food with functional properties are beneficial for consumers through prevention of many diseases.**

Aim: **Verify the acceptance of handmade product (chocolate bar, soy sweet and sweet bread) formulated based on oil seeds (flaxseed, peanut and Brazil nut) and or fructooligosaccharides (FOS).**

Methods: **Four samples of each handmade product were prepared adding different concentrations of oil seed and FOS. The sensory evaluation was performed by a sample of 373 consumers; 126, 121 and 126 tasters of chocolate bar, soy sweet and sweet bread, respectively, using a hedonic scale of nine points. The results were submitted to analysis of variance (ANOVA) and Tukey's test.**

Results and Discussion: **Observing the trials averages, we inferred that samples of sweet bread with Brazil nut and/or FOS had the greater acceptance. However, all the samples are good market alternatives because they had presented averages between 6 and 9 points, and conferred accretion of omega-3 and omega-6 fatty acids, protein, fiber, antioxidant vitamins and minerals, as well as, phytochemicals, which plays an important role in health promotion.**

Conclusion: **The handmade products formulated based on oil seeds and FOS had good acceptance and can improve the consumer dietary patterns. But, in order to prove the functionality of these products, new studies should be performed.**

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ACEPTACIÓN DE PRODUCTOS ARTESANALES FORMULADOS CON NUEVES Y FRUCTOOLIGOSACÁRIDOS

Resumen

Introducción: **Los prebióticos y alimentos con propiedades funcionales proporcionan beneficios para la salud de los consumidores a través de la prevención de muchas enfermedades.**

Objetivo: **Verificar la aceptación de productos artesanales (chocolate en barra, dulce de soja y pan dulce) formulados con nueces (linaza, maní y nueces de Brasil) y, o fructooligosacáridos (FOS).**

Métodos: **Cuatro muestras de cada producto fueron preparados con adición de diferentes concentraciones de nueces y FOS. La evaluación sensorial se realizó mediante una muestra de 373 consumidores, con 126, 121 y 126 probadores para muestras de chocolate en barra, dulce de soja y pan dulce, respectivamente, utilizándose la escala hedónica de nueve puntos. Los resultados fueron sometidos a Análisis de Varianza (ANOVA) y el test de Tukey.**

Resultados y Discusión: **Observándose las medias de los juzgamientos, se infiere que las muestras con mayor aceptación han sido de pan dulce con nueces de Brasil y, o FOS. Sin embargo, todas las muestras son buenas alternativas de mercado y se lo mostró un promedio de entre 6 y 9 puntos, más un aumento de ácidos grasos omega 3 y 6, proteínas, fibras, vitaminas, antioxidantes y minerales, así como fitoquímicos, los cuales desempeñan un papel importante en la promoción de la salud.**

Conclusión: **Los productos artesanales formulados con oleaginosas y, o FOS tuvieron una buena aceptabilidad y pueden mejorar los hábitos alimentarios de los consumidores. Pero para probar la funcionalidad de estos productos, se necesitan nuevos estudios.**

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Palabras clave: *Alimentos funcionales. Chocolate. Linaza. Maní. Nueces de Brasil. Fructooligosacárido.*

Abbreviations

ANOVA: Analysis of variance.
ANVISA: Agência Nacional de Vigilância Sanitária.
DRI: Dietary Reference Intakes.
USA: United States of America.
FDA: Food and Drugs Administration.
FOS: Fructooligosaccharides.
LOX: Lipoxygenases Enzymes.
RDA: Recommended Dietary Allowances.
SAS: Statistical Analysis Systems (software).
UL: Tolerable Upper Intake Levels.

Introduction

The incessant consumer search for food which incorporates functional properties together with good sensory characteristics generated in food companies and researchers a bigger concern about further research in this regard. Thus, such food have been studied more frequently in last year, because they confer benefits to health, energy balance and weight loss (oil seed), cardiovascular diseases and atherosclerosis, type 2 diabetes and insulin resistance[1].

Functional foods are not the only ones that provide benefits to health. Prebiotics share the same function. Among then, fructooligosaccharides (FOS) are fructose polymers linked to one molecule of glucose. They belong to oligosaccharide group, are totally resistant to digestion in upper digestive tract and are used almost entirely by bifidobacteria in colon. Among their benefits, when usually ingested, is the growth of beneficial intestinal microbiota, intestinal function modulation, lipid profile improve (specially triglycerides) and suppression of putrefactive substances production[2]. FOS are considered fibers, therefore they are widely used in food with the finality of increase their concentration[3].

Some food, as oil seeds, have also been highlighted in relation to health benefits[4]. The flaxseed has in its composition about 30 to 40% of fat, 20 to 25% of protein (limiting aminoacids: lysine, methionine and cysteine), 20 to 28% of total fiber (75% insoluble and 25% soluble), A, B, D, E vitamins and minerals, as potassium and phosphorus. Among vegetable food, flaxseed is considered as largest omega-3 fat acid source, because, there are almost 57% of total lipid in its composition[5].

The true nuts (Brazil nuts) and edible seeds (peanuts) contains high amount of lipids (between 40 and 60%) and proteins (between 8 and 20%). In relation to protein quality, these food present an essential aminoacids profile which attend the most of children and adults (limiting aminoacids: lysine, methionine and cysteine). Moreover, they are oleic fatty acid source (omega-9), linoleic (omega-6), have good relationship of omega-6 with linolenic (omega-3) which correspond to 232.21, and are considered phytosterols source, especially the β-sistosterol, E vitamin, selenium and fibers, mainly, insoluble fibers[4]. In view of this nutrient profile, these food consumption is related to risk reducing for many chronic diseases, as cardiovascular, some types of cancers (e.g.: prostate, esophagus, stomach, colon and rectum)[4,6].

Volp et al.[7] analyzed diet quality indexes and observed that the food environment of human is complex and multidimensional, and that the measure of consumption does not show adequately the complexity of food choices, diet variety or the nature of food patterns. Additionally, they also observed that there are indexes which help to assess of diet quality, but they were created based on American recommendations. So, there is a necessity to develop indexes adapted to Brazilian population based on typical food and portions established in Brazilian food pyramid and guides. But, in order to develop researches which evaluate the diet quality of the individual or determine the food patterns of a population, is necessary to base on in nutrition principles which include the proportionality, variety and moderation[8].

So, despite of the benefits that FOS and oil seeds concede to health, little is known about sensorial characteristics when we added to handmade food in different proportions. Therefore, the aim of this study was develop new handmade food products (e.g.: chocolate bar, soy sweet and sweet bread) and evaluate the addition effect of different concentration of FOS and/or oil seeds (flaxseed, peanut and Brazil nut) on their acceptance by students of a Minas Gerais university (in Brazil) in order to improve the population food pattern.

Material e methods

Material

- *Experiment 1 (Chocolate bar with FOS and/or flaxseed):* Four samples of chocolate bars were prepared adding different concentration of FOS and crushed flaxseed (table I). We chose to use dark chocolate in chocolate bar formulation.
- *Experiment 2 (Soy sweet with FOS and/or peanut – an adaptation of birth sweet, typical in Brazil):* Four samples of bleached common soy sweet were prepared adding different concentration of FOS and peanut (table I).
- *Experiment 3 (Sweet Bread with FOS and/or Brazil nut):* Four samples of sweet bread were prepared adding different concentration of FOS and Brazil nut (table I).

All products used in handmade products preparation were obtained in local market.

Methods

- *Samples preparation*. The samples were prepared in Dietary Technique Laboratory of an university of

Table I
Ingredients added to handmade food product

Ingredients	Chocolate bar samples (g.100 g^{-1})			
	Chocolate with FOS *	Chocolate with Flaxseed	Chocolate with FOS* + Flaxseed	Control
FOS*	12.0	–	12.0	–
Flaxseed	–	24.0	12.0	–
Ingredients	Soy sweet samples (g.100 g^{-1})			
	Soy sweet with FOS	Soy sweet with peanut	Soy sweet witn FOS* + peanut	Control
FOS*	12.0	–	12.0	–
Peanut	–	24.0	12.0	–
Ingredientes	Sweet Bread samples (g.100 g^{-1})			
	Sweet Bread with FOS*	Sweet Bread with Brazil nut	Sweet Bread with FOS* + Brazil nut	Control
FOS*	6.0	–	6.0	–
Brazil nut	–	12.0	6.0	–

* FOS= fructooligosaccharides.

Minas Gerais, in Brazil. The ingredient amount added to samples is presented in table I. The FOS and oil seeds amount added were calculated on the handmade food product total weight.

– *Sensory analysis*. The sensory evaluation of chocolate bar, soy sweet and sweet bread samples was realized by 373 consumers (126, 121 and 126, respectively). The consumers evaluated the overall acceptance of formulation, using a nine-point hedonic scale (Annex 1) adapted of Reis e Minim[9]. The test was performed at a university campus (Muriaé – Minas Gerais, Brazil) with students of different majors.
  Samples were evaluated, in the same section, by each consumer, where it was served in monadic form, in encoded portion, with random number of three digits. The experiment was structured according to the randomized complete block design.
– *Statistical analysis*. The data related to acceptance of four samples were submitted to analysis of variance (ANOVA) and *Tukey*'s test at 5% of probability having as variation sources, samples and consumers. ANOVA was used to analyze the hedonic scale results considering jointly all consumers evaluations. So, we assumed that all presented the same behavior, disregarding the individuality[9]. *Tukey's* test was used to deduce the unstructured qualitative factors effect, since it is a test for comparing averages[10]. Statistical analysis were performed using *Statistical Analysis Systems software* (SAS) version 9.0.

Results and Discussion

The judgment averages for each handmade food product samples are presented in table II. Control *chocolate bar* showed the major judgment average for chocolate bar sample. It did not differ statistically from sample of chocolate bar with FOS. However, the chocolate bar containing only flaxseed showed the smaller judgment average, differing significantly from the other samples, as shown by *Tukey's test*. The chocolate bar added with FOS and flaxseed also obtained a different significantly average from others samples. The control chocolate bar samples, added with FOS or with FOS plus flaxseed showed judgment averages between 7 and 8 ranging from the hedonic terms «liked moderately» and «liked so much». However, the chocolate bar sample added only with flaxseed obtained judgment averages between 6 and 7, ranging from the hedonic terms «liked slightly» and «liked moderately». So, observing the judgment averages for different samples, it is possible infer that all samples are good market alternatives, since they presented judgment averages between 6 and 8 (nine-point hedonic scale). This observation becomes important since chocolate is a great acceptance market product, in which there was a modification that added substances with relevant functional properties for consumer public. Chocolate is a functional food, since it has high concentration of phenolic compounds. The flavonoids are the most abundant phenolic compounds in cocoa. According to Ding et al.[11] many studies suggest that cocoa flavonoids can act as antioxidants reducing the risk or delaying the development of cardiovascular diseases, cancer, hypertension and insulin resistance.

The acceptance of dark chocolate sample added flaxseed (with or without FOS) was the lower in relation to samples without flaxseed, probably, due to the change in chocolate texture created by flaxseed addiction. The

Annex I

Hedonic Scale used in acceptance evaluation of handmade food products

Acceptance test of (product) enriched with (oilseed) and fructooligosaccharide

Name: _____ Gender: F( ) M( ) Age: _____ Date: _____/_____/_____

You are receiving a encoded sample of (product). Please, taste and evaluate how much you liked or disliked it using the below scale.	You are receiving a encoded sample of (product). Please, taste and evaluate how much you liked or disliked it using the below scale.	You are receiving a encoded sample of (product). Please, taste and evaluate how much you liked or disliked it using the below scale.	You are receiving a encoded sample of (product). Please, taste and evaluate how much you liked or disliked it using the below scale.
Sample n. _____	Sample n. _____	Sample n. _____	Sample n. _____
( ) liked extremely	( ) liked extremely	( ) liked extremely	( ) liked extremely
( ) liked so much	( ) liked so much	( ) liked so much	( ) liked so much
( ) liked moderately	( ) liked moderately	( ) liked moderately	( ) liked moderately
( ) liked slightly	( ) liked slightly	( ) liked slightly	( ) liked slightly
( ) not liked nor disliked	( ) not liked nor disliked	( ) not liked nor disliked	( ) not liked nor disliked
( ) disliked sligahtly	( ) disliked slightly	( ) disliked slightly	( ) disliked slightly
( ) disliked moderately	( ) disliked moderately	( ) disliked moderately	( ) disliked moderately
( ) disliked so much	( ) disliked so much	( ) disliked so much	( ) disliked so much
( ) disliked extremely	( ) disliked extremely	( ) disliked extremely	( ) disliked extremely

Table II

Judgment averages for different samples of handmade food products

Chocolate bar samples	*Averages*†
Control	7.82[a]
FOS*	7.74[a]
FOS* + Flaxseed	7.22[b]
Flaxseed	6.36[c]
Soy sweet samples	*Averages*†
Peanut	7.27[a]
FOS* + Peanut	7.06[a]
FOS*	6.22[b]
Control	5.19[c]
Sweet Bread samples	*Averages*†
Brazil nut	8.18[a]
FOS* + Brazil nut	7.94[ab]
FOS*	7.79[b]
Control	7.63[b]

*FOS = fructooligosaccharides.

†Averages followed by different letters differ between themselves at 5% of probability, by *Tukey test*.

chocolate bar acquired a granulated texture by crushed flaxseed. This property is not always well accepted by consumer, since it changes, even mildly, the traditional composition and sensory characteristic of chocolate bar.

In a study of roll acceptability plus flaxseed and wheat flour, there was little or no alteration in flavor in comparison to common salt bread. The flaxseed bread had nice flavor and physicochemical characteristics similar to traditional roll, and excellent acceptance by consumers[12]. Similar results were found in a study about honey bread added with flaxseed, obtaining good sensory evaluation and product high acceptability[13].

The flaxseed addiction to dark chocolate bar confers increase of various nutrients. Fibers, for example, reduce cholesterolemia, improve the intestinal microbiota and induce satiety[5]. Polyunsaturated fatty acids (Omega-3 and Omega-6) act positively on lipid profile, reduce the blood viscosity, promote greater endothelium relaxation, and have antiarrhythmic[14], anti-inflammatory and antithrombotics[15] effects. Moreover, lignans act on liver similarly to estrogen, confer antioxidant and, possibly, anticancer activity.[15] Additionally, they can interfere in hepatic metabolism improving lipid profile, thyroid metabolism, increasing triiodothyronine concentration, and enhance the bile acids excretion, reducing the dietary cholesterol absorption[16].

In United States of America (USA), *Food and Drugs Administration* (FDA) indicates the incorporation of up to 12% of flaxseed in food products. In Brazil, there are no rules or standards which limit the exact amount of flaxseed which should be added to food products in order to they could have characteristic of food rich in functional properties[17].

In relation to *soy sweet* sample, we observed that the highest judgment average was for soy sweet plus

peanut. It did not differ statistically the other soy sweet sample which contained FOS and peanut. However, we observed that control soy sweet had the lowest judgment average, differing significantly the other sample. The soy sweet added with FOS, also obtained averages significantly different of others. The samples of soy sweet with peanut and soy sweet with FOS and peanut obtained acceptance averages between 7 and 8, ranging from the hedonic terms «liked moderately» and «like so much». Since the sample of soy sweet added with FOS obtained acceptance averages between 6 and 7, ranging from the hedonic terms «liked slightly» and «liked moderately». The control soy sweet had acceptance averages between 5 and 6, corresponding to the hedonic terms «not liked nor disliked». So, observing the judgment averages for different samples, it is possible to infer that soy and its derivates are, in fact, appreciated by a small segment of the population. The addition of peanut, mainly, and or FOS significantly improved the sensory characteristics, and consequently, their acceptance. Moreover, such modification also added food with important functional properties for consumer public.

The smallest acceptance of control soy sweet, probably, was due to same sensory characteristic modification in consequence of physical changes in soyprotein during the process of reduction of lipoxygenase action by heat (blanching process) applied to grain in preliminary stage of sweet preparation. The blanching process aims to reduce the unpleasant taste and flavor produced by lipoxygenases enzymes (LOX) action, which are present in soy grain as LOX-1, LOX-2 and LOX-3 forms[18].

Nevertheless, soy products can be mixed with many healthy ingredients, which have better acceptance by consumer, in order to improve their acceptability. In this study we used peanut for this purpose.

The results about the acceptability of soy sweet added with peanut are interesting, since peanut is an abundant protein source as soy, and its consumption can attenuate the deficiency of animal protein in poor regions. In relation to chemical composition, the peanut has 44.57% of lipid, 24.03% of protein, 12.01% of carbohydrate, 11.30 g of fibers and 545.29 Kcal/100 g. Among the lipid profile, it has 14.81% of saturated fat, 43.93% of monounsaturated, 37.81% of polyunsaturated and the omega-6/omega-3 index of 129.38. Among the minerals, it is calcium, iron, zinc, magnesium, potassium, sodium, copper and phosphorus source.[4] Thus, the peanut use in soy sweet is considered promising, since it reduce the soy unpleasant taste and flavor, besides being abundant in minerals which participate the several enzymes synthesis.

The daily intake of at least 25 g of soyprotein can help reduce the cholesterol since its consumption is associated with a balanced diet and healthy living habits[19]. Isoflavones is one of the main soy bioactive substances, which reduce the risk of certain types of cancer. Protease inhibitor (Trypsin inhibitor), saponins, daidzein, genistein, glycitein, phytosterols and oligosaccharides are also present in soy. They can act in reduction of chronic disease development risk[20]. School feeding American government programs showed that soy can replace the animal protein up to 30%, without impairment[21]. Moreover, soyprotein can change the pattern of genes expression related to lipid metabolism in liver and adipose tissue, favoring the maintenance organic homeostasis[20].

Griel *et al*.[22] evaluating the peanut consumption effects on anthropometric parameters and diet quality, observed that peanut and its derivatives improve the diet nutritional profile. They also realized that these food inclusions do not promote weight gain for consumer since his energetic intake does not exceed the recommendations. So, the peanut and peanut butter intake can stimulate the healthy diet consumption, reducing chronic disease risk.

In relation to *sweet bread* samples, we observed that sweet bread added with Brazil nut and sweet bread added with FOS and Brazil nut had major judgment averages. The acceptance of latter was not statistically different of sweet bread added with FOS and control sweet bread. The samples of sweet bread with Brazil nut had acceptance average between 8 and 9, ranging from the hedonic terms «liked so much» and «liked extremely». However, the samples of sweet bread added with FOS and Brazil nut, sweet bread with FOS and control sweet bread had acceptance average between 7 and 8, ranging from the hedonic terms «liked moderately» and «liked so much». So, observing the judgment averages for different samples, it is possible infer that these samples are excellent alternatively market, since they had judgment averages between 7 and 9 (9-point scale). This observation is important, since the bread is part of Brazilians dietary pattern. Moreover, the addition of Brazil nut, mainly, and FOS provide better sensory characteristics, beyond functional properties which are very wanted by consumers.

The chemical composition of Brazil nut consist of 64.94% of lipid, 11.14% of protein, 6.27% of carbohydrate, 87.02 g of fibers and 665.98 Kcal/100g. In relation to lipid profile, it has 25.47% of saturated fat, 29.03% of monounsaturated, 44.31% of polyunsaturated and the omega-6/ omega-3 index of 232.21[4]. About the minerals, Brazil nut is abundant in selenium, containing 236.8 µg/ 8 g (29.6 µg/g) of nut, an average, equivalent of two units[23]. This addition also brings benefits. The selenium recommendation for adults, according to *Dietary Reference Intakes* (DRI) is at least of 55 µg/day (RDA - *Recommended Dietary Allowances*), and maximum intake (UL - *Tolerable Upper Intake Levels*) of 400 µg/day[24]. Therefore, a portion of 50 g of bread added with Brazil nut supply the minimum recommended intake. Regarding to metabolic syndrome components (adiposity, dyslipidemia, hypertension, hyperglycemia), the selenium, probably, presents benefic effects in prevention and treatment of

type 2 diabetes and cardiovascular diseases, besides confers antioxidant effects[25]. Additionally, Brazil nut is a resveratrol an arginine source, which act on platelet aggregation inhibition and vasodilatation, by nitric oxide release[4].

Generally, in this study, samples with FOS had major acceptance in relation to others, which can be assigned to its sweetener power. Its sweet flavor is similar to saccharose, which is our traditional sweetener[26]. FOS is 0.4 to 0.6 fold more sweet than saccharose, however provide only 1 calorie/g[27]. Dental caries prevention is other benefit of these sweeteners[26] due to FOS excellent technological properties of flavor, texture and do not alter the product characteristic where is added[28].

FOS are added to food because they promote benefits, as bifid bacteria growth , suppression of putrefactive bacteria growth, reduction of toxic metabolites accumulation resulting from fermentation processes and consequent reduction of colon cancer incidence, besides prevent constipation[2,28]. FOS also reduces cholesterolemia, because they are metabolized by colonic bacteria producing short-chain fatty acids, as propionate, which inhibit hydroxymethyl-glutaryl-CoA reductase enzyme, responsible by endogenous cholesterol synthesis[29].

A study showed that FOS increased bifidobacteria amount in patients with hematologic neoplasms undergoing chemotherapy treatment[30].

According to National Health Surveillance Agency (ANVISA- Agência Nacional de Vigilância Sanitária), solid product added with FOS must contain at least 3 g of FOS (fibers) in each portion in order to have functional allegation[19]. In present study, such proportion was used in samples preparation[31].

Conclusion

According to results observed in sensory evaluation of dark chocolate bar, control samples and samples added with FOS had better acceptance, but these do not differ as the overall acceptance. The addition of FOS to dark chocolate bar was benefic, because gave pleasant sweetener power to consumers taste. Although, FOS and flaxseed given additional benefits to food.

The highest judgment average was to control chocolate bar. In relation to soy sweet, samples with peanut and peanut plus FOS had the best acceptance, differing from others. The control soy sweet had the worst acceptance. The addition previously mentioned conferred nutritional and sensory value to product, since soy has a flavor enjoyed by a small segment of Brazilian population. Thus, this is an alternative to increase the soy intake in Brazil. Regarding to sweet bread, samples added with Brazil nut and Brazil nut plus FOS had better acceptance. The last had the same acceptance than sample with FOS. FOS addition to bread conferred a sweeter taste and provided an improvement in its nutritional value. Thus, these foods can be inserted in human diet in order to improve Brazilian dietary pattern. However, despite of all alleged benefits and great acceptance by consumer, new studies must be performed to prove the functionality and grant functional allegation to these handicraft products formulated based on oilseed and FOS.

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