Influence of addition of Seeds in the texture and sensory characteristics in traditional and *light* cereal bars

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ABSTRACT---- ***Cereal bars are considered promising for being practical and portable, and allow the addition of beneficial compounds such as diet fibers. The aim of this study was to elaborate cereal bars added pumpkin, chia and sesame seeds, and submit them to physical, chemical and sensory analysis. Two cereal bars were elaborated, traditional and light, submitted to both centesimal composition and sensory analysis. Texture measurement and water activity analysis were also carried out on 0, 20 and 45 storage days. A reduction of 32.82% on the energetic value of the light cereal bar was observed when compared to the traditional, and a 62.58% reduction on the amount of carbohydrates. Both traditional and light bars presented a high level of total fibers (3.97g and 3.88g/100g, respectively) and, both, 12.96/100g of lipids. During the storage period, there was an increase of cutting force in the traditional bars, and this same force reduction in the light ones, though not statistically. The results of the sensory analysis revealed that the scores for appearance, color, texture, aroma, flavor and global impression ranged between 6.0 and 8.0, and both texture and flavor attributes showed significant differences between the evaluated products, and light cereal bar presented larger notes.***

Keywords--- Cereal, texture, chia, sensory analysis.

1. INTRODUCTION

Excessive consumption of food sources of sodium, sugars, saturated fats and cholesterol, strongly associated with the higher incidence of chronic degenerative diseases, such as obesity, type II diabetes, hypercholesterolemia, hypertension, among others, has called the attention of public health agencies, regarding the higher rate of morbidity and mortality in the population [1,2,3].

Scientific studies in Brazil show significant associations between consumption of processed food and the occurrence of obesity in all ages, dyslipidemias in children and metabolic syndrome in adolescents [4,5,6].

The processed food, including ultra-processed food, are convenient, practical, portable and mostly pleasant in flavor, showing, however, a poor nutritional profile and impacting negatively on the nutritional quality of food, since they have higher levels of saturated fat, trans-fat and sugar free, and lower fiber content than natural or minimally processed food [7].

Recently, the food industry has started to invest on the reformulation of processed food, reducing the amounts of sodium, saturated and trans fats, and adding ingredients with higher fiber levels and other healthy compounds [8,9]. Included in this category, cereal bars are products considered promising because they allow the addition of a diversity of beneficial ingredients, including cereal, fruit and nuts, besides adding a sweet and pleasant taste to consumer.

The consumption of some cereal bars have been associated with physiological and metabolic effects beneficial to the human body, such as improvement of constipation and increased satiety, in addition to hypoglycemic and

hypercholesterolemic effects in humans [10,11,12]. Such effects have been attributed to the high concentration of both soluble and insoluble food fibers present in the ingredients added to cereal bars.

The effects of dietary fibers are partially related to the fact that a part of the fermentation occurs in the large intestine, producing effects on the intestinal motility, the pH of the colon and the production of by-products with important physiological functions [13]. The effects are variable in function of the nature and functionality of the diverse fibers distributed in vegetable raw materials.

High fiber consumption in diets was associated with a lower prevalence of stroke, coronary artery disease and arterial hypertension [14,15]. Dietary fibers were also related to high insulin sensitivity and reduction of pro-inflammatory cytokines such as the Interleukin-6 and TNF-α [16,17].

Intake of dietary fibers, furthermore, is related to the low prevalence of a variety of cancer, for instance, breast, colorectal, esophageal, prostate, stomach, liver, among others [18,19,20,21,22,23].

However, in expense of these considerations, the inclusion of fibers in food leads to significant sensory changes, especially in their texture and flavor. According to Lima [24], the greatest challenge for a cereal bar attractive is the combination of ingredients add to the product in addition to sensory pleasant as defined taste, texture and appearance, nutritional components and reduced calorie.

The aim of this study was to elaborate cereal bars added pumpkin seeds, chia and sesame, and submit them to physical, chemical and sensory analysis.

2. MATERIAL AND METHODS

2.1 Preparation of Cereal Bars

Cereal bars were developed in the Food Processing Lab, at the "Estudant Rafael Almeida Camarinha" Faculty of Technology in Marilia, (Fatec Marilia) state of São Paulo, Brazil. Two cereal bar types were elaborated, traditional and *light*, this last one having sucrose replaced by sorbitol (table 1).

Table 1: Ingredients used in the traditional and *light* cereal bars added seeds

	Traditional bar	***Light* bar**
Dry ingredients (%)		
Oat	12	12
Chia	8	9
Sesame	8	9
Pumpkin seeds	8	9
Dehydrated banana	8	9
Rice flakes	6	7
Agglutination syrup ingredients (%)		
Crystal sugar	26	15
Glucose syrup	13	7
Sorbitol syrup	-	12
Maltodextrin	6.5	6.5
Vegetable fat	2.5	2.5
Lecithin	2	2

Cereal bars were prepared following the methodology described by Freitas and Moretti [25] with ingredients obtained from the local market, and the sorbitol was gave in by a food enterprise of this region. The dry ingredients were homogenized separately.

The agglutinating syrup was prepared in a stainless steel container to melt and dissolve the sugars, and the sorbitol to the *light* bar, followed by the addition of pre-dissolved maltodextrin, vegetable fat, and lecithin. The ingredients were kept under constant stirring, and the content of total soluble solids was checked periodically with a bench top refractometer until syrup with 86 °Brix was obtained.

The dry ingredients were incorporated into the agglutination syrup at a temperature of approximately 95 °C and 100 ºC, respectively, for the traditional and *light* bars, and the mass was kept under constant stirring until it was completely homogenized. Using a stainless steel cylinder, the mass was then laminated in a stainless steel mold to a thickness of 1 cm cooled to a temperature of 9 °C for 15 minutes, and cut into rectangular bars, each weighing 20 g and having a standard size (10 × 3 × 1 cm) and packed in polyethylene laminate packages, similar to the packages used in commercial products. The cereal bars were stored under ambient temperature for further analysis.

2.2 Centesimal Composition Analysis

The moisture, ashes, lipids, carbohydrates, proteins, total food fiber, sodium and calcium analysis were done at the Physical and Chemical Analysis Lab in Fatec Marilia/SP, in accordance with the Adolfo Lutz Institute (ALI) [26].

2.3 Texture and Water Activity Analysis

The texture and water activity analysis were done at the Physical and Chemical Analysis Lab in Fatec Marilia/SP. The analysis were done in triplicate, in accordance with the ALI [26], in three different storage times (0, 20 and 45 days), in which the bars were removed from their original packages. The texture analysis was carried out using a Stable Micro Systems TAXT plus, with the Probe HDP/BS, being the compression test with two ruptures. The equipment was calibrated with a 10 Kg weight, having the return distance set at 17 mm, speed of 2.0 mm/s, pre-test speed of 1.5 mm/s and post-test speed of 10 mm/s. In both the first two tests, the rupture sensibility was of 1000N and, in the last one, 3000N.

For the water activity, the samples, after removed from their packages, were crushed and put on the Aqualab (Aw) equipment [26].

2.4 Sensory Analysis

Sixty non-trained tasters, of both sexes, evaluated the sensory characteristics of cereal bars. The tasters received two codified samples with random numbers and a sensory analysis form, through which were evaluated acceptability of the samples, through by affective method (consumer testing), using a nine-point structured Hedonic Scale, ranging from 1 (greatly disliked) and 9 (greatly liked). The evaluated sensory attributes were appearance, color, aroma, texture, flavor and global impression (Teixeira et al., 1987) [27].

An assessment related to the consumers' purchase intention was also carried out regarding the cereal bars. A 5-point scale was used, in which 1 indicated that the consumers definitely would not buy; 2 consumers would probably not buy; 3 consumers may/may not buy; 4 consumers would probably buy and 5 consumers would definitely buy.

The acceptability index (AI) was calculated for each attribute, using the expression AI = A/ (B*100), where A = average obtained, B = highest grade obtained from the hedonic scale, in accordance with Teixeira et al (1987) [27].

2.5 Statistical Analysis

The statistical analysis method used for the texture, water activity and sensory analysis was the Student's *t*-test, and, for the buy intention, the Chi-squared distribution (p value = 0.0000).

3. RESULTS AND DISCUSSION

3.1 Centesimal Composition

The centesimal composition analysis results (table 2) showed that there was a 35.82% reduction in the energetic value of the *light* cereal bar compared to the traditional one, and a 62.58% reduction in the carbohydrates value, thus, being named *light* according to the Brazilian Legislation [28].

In a study performed by Tombini [29], cereal bars elaborated with chia-seeds were proved to show energetic value of 316 Kcal/100g and 62.72% of carbohydrates. Peuckert el al. [30] found carbohydrate levels similar to the ones of the *light* bar in this study, in cereal bars formulated with Camu-camu seeds (14.96 g/100g).

Table 2: Results of the centesimal composition analysis of the traditional and *light* bars

	Traditional bar	***Light* bar**
Energetic value (Kcal)	277	177.76
Moisture 105° C (g/100g)	6.46	7.35
Ashes (g/100g)	1.80	2.16
Lipids (g/100g)	12.96	12.96
Total carbohydrates (g/100g)	39.74	14.87
Proteins (g/100g)	0.35	0.41
Total food fiber (g/100g)	3.97	3.88
Sodium (mg/100g)	38.0	38.3
Calcium (mg/100g)	139.3	159.9

The moisture value of the traditional cereal bar was inferior to the *light* one, even though for both formulations the values were inferior when compared to some studies. Arévalo-Pinedo et al. [31] observed 8.45% and 8.75% moisture values in cereal bars formulated with Babaçu almond (*Orbygnia speciosa)* dry flour. According to this study's authors, the low moisture allows for safety against the spoilage microorganisms growth, as most of the fermentative bacteria, molds and yeast grow in high amounts of moisture in the product.

The traditional and *light* cereal bars' lipid levels resulted similar in this study (12.96%). It's important to highlight that the raw materials used in the bars, such as the pumpkin, chia and sesame seeds show considerable levels of health-beneficial polyunsaturated fats, for their effects in lowering the serum levels of total cholesterol, triglycerides, and systemic arterial pressure [32,33,34]. Rutz et al. [35], in their bars elaborated based on pressed peanut oil residual cake, obtained lipid levels of 11.29%, and Mourão et al. [36], obtained levels between 5.19 and 17.43%, in different cereal bars with high fiber levels.

Both traditional and *light* cereal bars showed expressive fiber levels, 3.97g/100 and 3.88g/100, respectively. Thus, they can be considered fiber source food, as, according to the Brazilian Legislation, to acquire this allegation, the food has to have at least 3% of total fibers [28].

Note that the *light* cereal bar obtained similar results to the traditional one, but, its energetic value is significantly lower than the traditional, favoring its consumption, in light of the fiber benefits to the human body already mentioned.

3.2 Texture

The results of the texture, in three storage times, at 0, 20 and 45 days, for both traditional and *light* cereal bars are described in table 3.

The results showed that over the period of storage of the bars there was an increase of cutting force in the traditional bars, represented by "Force 1", although there was no statistically significant difference, considering the storage time. On the other hand, numerically, the values of the same force to the *light* cereal bar declined with the storage time, however, did not differ statistically. Considering the disruptive force, represented in Table 3 by "Force 2", it is observed that there was no significant difference in both bars, however, numerically, from the time 0 to 45th day, the values for this force increased in the traditional bar, even having to ~~to~~ replace the sensitivity of equipment breakage 1000 gF to 3000 gF. Oppositely, the *light* cereal bars were less firm, easier to break, whereas the numeric values of Force 2 decreased during the storage time.

According to Szczesniak [37] texture modification in cereal-based food can be due to absorption or moisture loss, packing material and storage conditions.

The lowest concentration of sugar in the *light* bars may have influenced the texture of these, depending on the property of crystallization, and consequently, hardness of sucrose have been replaced partially by the wetting power of sorbitol [38].

Table 3: Results of the texture analysis of the traditional and *light* cereal bars

	Forces	Time 0	20 days	45 days	p-value*
Traditional	Force 1[1]	68.7 ± 34.9	149.6 ± 84.4	214.4 ± 66.6	0.0878
	Force 2	80.2 ± 26.06	53.6 ± 58.1	106.8 ± 100.4	0.6611
Light	Force 1	35.5 ± 29.8	31.6 ± 3.09	29.6 ± 6.19	0.9155
	Force 2	40.1 ± 38.4	24.1 ± 15.0	10.1 ± 1.09	0.3674

[1] The values are expressed in gF (gram-force), average ± standard deviation
* p-value ≤ 0.05 = significant

Marques [39] in his study also noticed an increase in the cut and hardness of the bars added of acerola-seed-flour and acerola-residues-flour, in function of a higher compaction of the bars, due to the presence of food fibers.

Similarly, Silva [10] observed that, as if adding more passion fruit residue, the higher were the values of cut and rupture forces of the bars, due to compaction, caused by the presence of fibers in the residue, and by the decrease of constituents that create empty spaces.

3.3 Water Activity Analysis

The results of the water activity analysis, carried out in the traditional and *light* bars along the storage times (0, 20 and 45 days) showed that there was no significant difference for both cereal bars. Between the bars, the values for water activity in time 0 were similar, although slightly higher in the *light* bars. These data corroborate with the values of

moisture to 105º C, since the *light* bar presented higher values of moisture compared to traditional bar, with 7.35% and 6.46%, respectively. The *light* bars, despite the use of sorbitol, showed no significant change in the values of water activity, during the storage period.

Table 4: Water activity analysis results on the traditional and *light* bars

	Time 0	20 days	45 days	p-value**
Traditional	0.52 ± 0.004*	0.53 ± 0.001	0.59 ± 0.03	0.3249
Light	0.54 ± 0.005	0.53 ± 0.010	0.59 ± 0.012	0.2875

* average ± standard deviation
**p-value ≤ 0.05 = significant

In a study elaborated by Arévalo-Pinedo et al. [31] the water activity in cereal bars elaborated with Babaçu flour (*Orbygnia speciosa*) pointed out that values ranged from 0.499 and 0.546 during 120 days that were stored at ambient temperature and packaged in aluminized plastic.

After 60 days, Gutkoski et al. [40] obtained in their oat-based cereal bars with high food fiber contents, values of 0.659 for the water activity. On the other hand, Sampaio [41] found lower water activity values in his bars added iron, ranging from 0.363 to 0.405. For any bacteria type, the minimum content of water activity allowed for its growth is 0.75, while osmophilic yeasts and xerophilic fungi can develop in water activity around 0.61 and 0.65 [42,43].

3.4 Sensory Analysis

The results of the sensory analysis showed that for both traditional and *light* bars, the scores for appearance, color, aroma, texture, flavor and global impression obtained values between 6.0 and 8.0 (Table 5). The texture and flavor attributes showed significant difference between the evaluated products, and *light* cereal bars obtained larger notes for these attributes.

Table 5: Sensory analysis results for traditional and *light* pumpkin, chia and sesame-seed added cereal bar

Parameters	Traditional	*Light*	p-value
Appearance	7.05 ± 1.96 A[1]	7.45 ± 1.54 A	0.2039
Color	6.95 ± 1.76 A	7.55 ± 1.36 A	0.0501
Aroma	7.15 ± 1.18 A	7.40 ± 1.19 A	0.1499
Texture	7.00 ± 1.84 A	7.70 ± 1.08 B	0.0321
Flavor	7.00 ± 2.03 A	8.05 ± 1.76 B	0.0339
Global impression	7.10 ± 1.94 A	7.80 ± 1.70 A	0.1166

[1]Averages and coefficient variation. Averages with the same letter do not differ among them, by Tukey test at 5% significance.

Peuckert et al. [30] evaluated the acceptability of cereal bars added textured soy protein and Camu-camu seed, being observed lower scores for flavor (5.20) and texture (5.32). Sampaio [41] identified that between the formulations of iron fortified cereal bars, the sample with less firmness was preferred among consumers. According to the author, the consumers are used to consuming smoother-textured bars, turning this into a determinative factor on the choice of the samples.

The averages attributed by the tasters for the texture of the bars corroborate the results of texturometria analysis, since the notes for this attribute were statistically higher for the *light* formulation, namely, that showed lower significant resistance to shear force, and therefore better chewiness.

Arévalo-Pinedo et al. [31] found values between 7.5 and 7.9 for texture in cereal bars elaborated with Babaçu flour, and values between 8.0 and 8.1 for flavor of this bars, with similar results to the scores for flavor of the cereal bar *light* in this study. According to Dias et al. [44], the flavor is one of the sensory attributes most valued by consumers at the time of purchase. In cereal bars prepared by Gutkoski et al. [40] with total fiber concentrations of 12%, 16% and 20%, average 7.05 notes were observed for the flavor attribute in the formulations. According to Rutz et al. [35] in their work with cereal bars based on residual pie peanut oil extraction by pressing, the notes for flavor and texture represented on hedonic scale the attributes “regularly liked” and “liked a lot”, being similar to the values found in this study.

Cereal bars with pumpkin seed flour produced by Silva [45] showed values between 6.0 and 7.0 for appearance, flavor, texture and global impression, similar in this study.

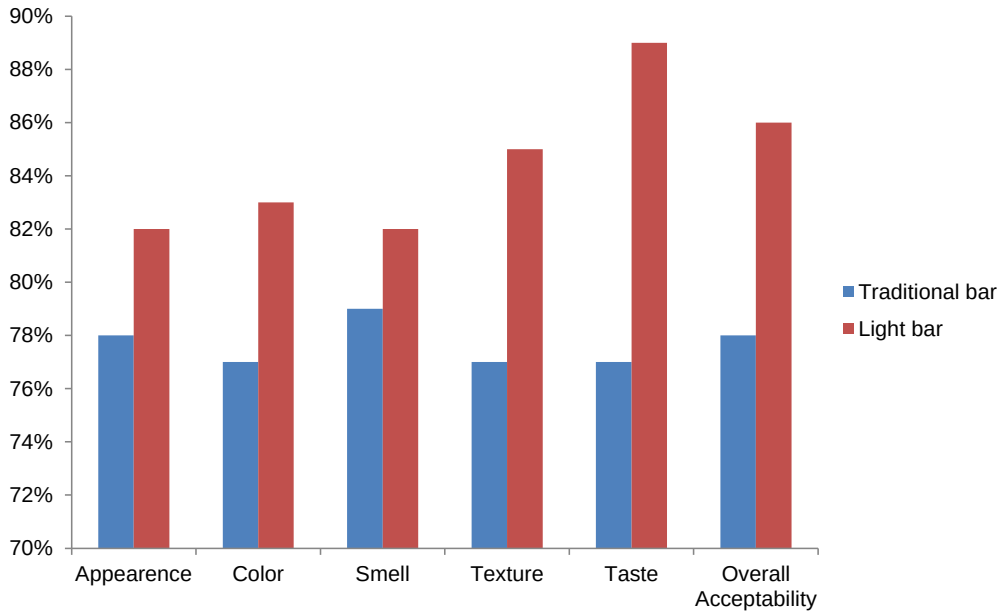

Figure 1: Acceptability Indexes (AI) of the traditional and *light* cereal bars added pumpkin, chia and sesame seeds

Figure 1 shows that the attributes obtained Acceptability Indexes (AI) between 77% and 89%, therefore, it can be said that both bars have been well accepted by tasters, since indexes above 70% feature product acceptability [27]. The obtained results for the purchase intention are described in Figure 2.

The *light* cereal bar showed higher purchase intention among the tasters (51.67%) in this study. Similar results were observed with regard to the intention to purchase the bars of chia (51%) developed in the study of Tombini [29].

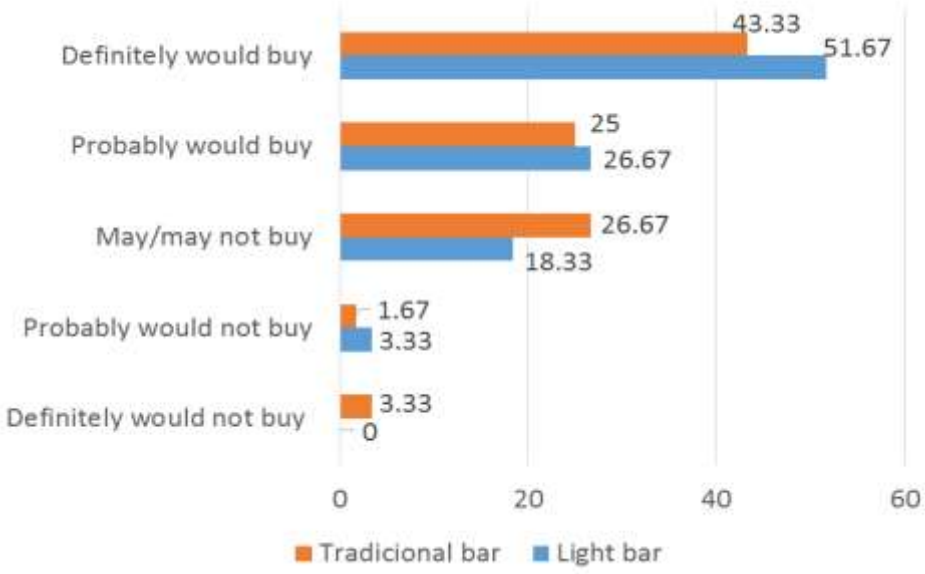

Figure 2: Purchase intention of both traditional and *light* cereal bars added pumpkin, chia and sesame seeds

According to Souza et al. [46], in their study it was possible to verify that cereal bars added 10% of sesame seeds were the most accepted according to sensory analysis and the ones which showed higher acceptability on the market, as 64.51% focused between "definitely would buy" and "probably would buy". Cereal bars added with pumpkin seed flour also showed higher buy intentions according to Silva [36].

3. CONCLUSIONS

The *light* cereal bar, added chia, pumpkin and sesame seeds showed a 35.82% reduction of the energetic value and 62.58% of the carbohydrates value, compared to the traditional bar, and both can be considered fiber source food. Despite the inclusion of these elements in the products, the texturometria and the sensory analysis revealed that the *light*

bar was more softness and better chewiness, plus larger notes in the texture and flavor. Both cereal bars were considered accepted by the tasters, whereas the Acceptability Indexes were higher than 70%.

Conflict of interest statement

Authors declare that they have no conflict of interest.

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