

Characterization and sensorial evaluation of cereal bars with jackfruit

Calila Teixeira Santos, Renata Ferreira Bonomo, Rafael da Costa Ilhéu Fontan, Paulo Bonomo, Cristiane Martins Veloso and Gabrielle Cardoso Reis Fontan

Laboratório de Engenharia de Processos, Universidade Estadual do Sudoeste da Bahia, Praça Primavera, 40, 45700-000, Itapetinga, Bahia, Brazil. *Author for correspondence. E-mail: bonomorcf@pq.cnpq.br

ABSTRACT. The objective of this study was to elaborate a homemade and alternative cereal bar using dehydrated jackfruit and seed meal as fiber source, due to the availability of this fruit in the region, without reducing the nutritional values if comparing to those already existent in the market. In order to evaluate the centesimal content and the acceptance of the homemade bars, both light and traditional bars were used as reference. The results showed that the elaborated bar presented protein values very close with products already found in the market. However, the new bars presented higher content of fibers. Formulations of 30 and 40% of seed meal were the ones with the best acceptance.

Keywords: functional product, *Artocarpus integrifolia*, nutritional value, food fiber, jackfruit.

RESUMO. Caracterização e avaliação sensorial de barras de cereais com jaca.

Objetivou-se com o presente trabalho elaborar uma barra de cereal caseira e alternativa, utilizando a jaca desidratada e o farelo da semente como fonte de fibras, a fim de aproveitar a disponibilidade dessa fruta regional, sem reduzir o valor nutricional em relação às existentes no mercado. Para avaliar a composição centesimal e aceitação das barras caseiras foram utilizadas barras comerciais na forma *light* e tradicional, como parâmetros de referências. Os resultados obtidos demonstraram que a barra formulada apresentou valores bem próximos aos produtos comercializados no mercado no que se refere à proteína, mas com teores de fibras superiores. As formulações com 30 e 40% de teor de farelo da semente foram as que tiveram maior aceitação.

Palavras-chave: produto funcional, *Artocarpus integrifolia*, valor nutricional, fibra alimentar, jaca.

Introduction

Due to the easiness of acquiring pre-prepared and frozen food in the market, together with several options offered by fast-foods and self-service restaurants, the consumption of this type of food has increased. Nowadays, eating habits have demonstrated low ingestion of fiber, which leads to nutritional problems (FREITAS; MORETTI, 2006). According to few authors, high ingestion of fiber is recommended for intestinal treatments of adults and children. The regular consumption of fiber is constantly recommended by nutritionists and official food departments (SUN-WATERHOUSE et al., 2010). Such recommendations are based on the fact that fiber presents certain effects responsible for significant modifications in human physiology, preventing chronic diseases (DREHER, 1999; AACC, 2001). The consumption of fatty food, with high energetic density and the reduction in practicing exercises have strongly influenced nutritional problems for

the youth and adults worldwide. Among these problems it is worth to point out obesity and hypertension (BRITO et al., 2004).

Cereal bars appear due to the necessity of having a product combining easiness and nutritional quality, in order to either improve or substitute snacks between meals, to complement meals, or simply gain energy in a healthy way (MURPHY, 2001; DUTCOSK et al., 2006; RYLAND et al., 2010). The consumption of cereal bars has increased mainly among young consumers. Recent research has showed that young adults ranging from 15 to 24 years old represent 62.5% of the consumers of cereal bars (BRITO et al., 2004).

Food industries have sought to identify and to attend consumers' needs, considering that this is the only way they can maintain themselves in an increasingly competitive market. The determination of acceptance by the consumer is a crucial part in a development and improvement process of products. Affective tests require a team

composed of several participants who represent the consumers population and/or potential consumers. Among these most applied methods used to measure acceptance of products is the hedonic scale, in which consumers express their acceptance following a pre-established scale, which gradually varies based on terms such as like and dislike (MORI et al., 1998; SILVA et al., 2005).

Jackfruit (*Artocarpus integrifolia*), is originally from Asia and it has acclimated well in Brazil. It is a fruit rich in carbohydrates, complex B vitamins, and minerals (RAHMAN et al., 1999; JAGADEESH et al., 2007, SOUZA et al., 2009). Jackfruit is freshly consumed, and it can be processed to candies, sweeties, frozen pulps, juices, among others. Its seed can be consumed baked or used in culinary to develop several menus. Nowadays, there are studies concerning the use of seed meal for preparing cookies, sweeties, and bread as an alternative source of carbohydrate.

The shortage of low-cost products with high nutritional value has gathered researches to seek for alternative protein sources which attend to matters concerning low production costs.

Due to its different flavor, jackfruit can become an innovator ingredient of cereal bars, which offers an exotic flavor, and an increase in its nutritional quality. Also, it can be used for reducing production costs due to its low cost. Therefore, the objective of this study it to elaborate a homemade and alternative cereal bar of jackfruit without reducing nutritional values comparing to those already available for consumers.

Material and methods

Jackfruit was obtained in the free market of Itapetinga and region. They were opened and seeds were selected. The last were washed in water in order to remove fiber, dried at room temperature, and ground. Further, the product was stored in plastic recipients at room temperature. Jackfruit pulp with 75.4% (wet basis) of moisture was dried in a trail drier at 65°C with an air velocity of 1.5 m s⁻¹, for 6 hours, until a moisture content near to 20% (wet basis), and then it was submitted to grounding. Three formulations of cereal bars were tested, with a variation only in relation to dehydrated jackfruit

seed meal, respectively 50:50, 60:40 and 70:30 for formulations I, II and III. These relationships were used to verify the influence of seed meal concentration on product acceptance. Cereal bars were prepared according to the formulation presented in Table 1.

Table 1. Final formulation of jackfruit cereal bars.

Ingredient	Formulations (g 100 g ⁻¹)		
	I	II	III
Sugar	25.5 g	25.5 g	25.5 g
Glucose syrup	14 g	14 g	14 g
Vegetable fat	2.5 g	2.5 g	2.5 g
Fine oat	10 g	10 g	10 g
Thick oat	10 g	10 g	10 g
Dehydrated Jackfruit	19 g	22.8 g	26.6 g
Seed meal	19 g	15.2 g	11.4 g

Elaboration of bars

The ingredients were mixed manually in a plastic recipient for 20 minutes approximately, until obtaining homogeneous mass. Furthermore, the mass was put on aluminum trays covered with aluminum paper and submitted to the oven at 110°C for 15 minutes. After cooling, bars were cut, wrapped with flexible film and let at rest until analyses. Cereal bars were produced in the morning and sensorial analyses carried out in the afternoon at the same day. The Figure 1 shows the production of different cereal bars.

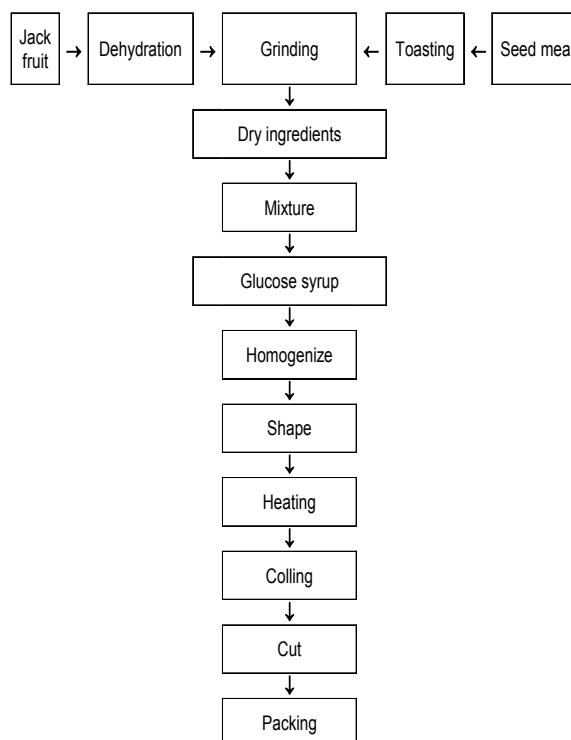


Figure 1. Scheme of elaboration of cereal bars.

Proximate analysis

Dehydrated jackfruit, seed meal and cereal bars were submitted to physical chemical analyses for protein determination (Kjeldahl method), fat (Soxhlet method), ash content, and moisture content in a oven at 105°C, as described by AOAC (1996) and determination of pure fiber in accordance to the method described by Silva and Queiroz (2002). Samples of 50 g by repetition were used to analyses, conducted in triplicate each one.

Sensory analysis

Samples of each formulation of cereal bars were evaluated by 60 non-trained testers ranging from 18 to 50 years old, of both sexes. Acceptance test was conducted in individual cabins under light bulb, at the Laboratory of Sensory Analysis located at the Southwest Bahia State University.

Samples of cereal bars were presented to testers under room temperature, in a three digit code. The order of presentation was randomly established by the design of a table of numbers. The section was conducted presenting three samples of cereal bars corresponding to three formulations varying in their seed meal content and dehydrates jackfruit in 50/50 (formulation I), 40/60 (formulation II) and 30/70 (formulation III), monadically presented. The hedonic scale was structured in nine points, which the minimum grade corresponded to the term “extremely disliked” and the highest grade corresponded to the term “extremely liked”. The following characteristics were evaluated by the tester: global impression, aroma, flavor, color, and texture.

Statistical analysis

In order to test the differences among the formulation, the Analysis of Variance (ANOVA) was conducted. Data obtained from the sensorial analysis were evaluated using the Analysis of Variance (ANOVA), comparing averages using Duncan's test at 10% probability, using the statistic software SAEG v 8.1 (RIBEIRO JUNIOR, 2001).

Results and Discussion

Characterization of the raw-material and cereal bars

The values of protein, lipids, ashes and moisture content of the three formulations found in this work

were not different among themselves. Results of centesimal content of elaborated cereal bars, as well as dehydrated jackfruit and seed meal are shown in Table 2. The formulations of cereal bars presented in an average 4.8 and 4.6% of protein, a desirable value if compared to values found in the market (which average values range from 3.0 to 4.0%). Seed meal presented a considerable protein value (4.61%) taking into account that it is a residual. Formulations I, II and III contain, in percentages, proteins from FJ (seed meal) + JD (dehydrated jackfruit) of 76.76%, 75.43 and 72.17%, in dry bases. According to the results shown in Table 2, one verifies that the selection of fruit and seed meal as a protein source is adequate, because dehydrated jackfruit and seed meal contributes to 75% of the protein content of this cereal bar, and the rest was from the oat. Brito et al. (2004), once formulating cereal bars, obtained higher protein values (6.27 g 100 g⁻¹) if compared to those obtained in this study (4.8 and 4.6 g 100 g⁻¹). This may be explained by the use of oat formulation and corn starch cookies, which probably had more influence in the total protein content of the bar if compared to seed meal and dehydrated jackfruit used in the formulations of this study. Lipid content in bars I, II and III, if compared to bars of other authors (BRITO et al., 2004; FREITAS; MORETTI, 2006) was high. This was probably due to the amount of hydrogenated fat (2.5 g 100 g⁻¹) used in these formulations. The objective of this addition was to avoid water addition in order to promote uniformity, due to the fact that water could promote rehydration of jackfruit, which is not interesting if concerning the final texture of the bar. According to Mattos and Martins (2000), the value found for fibers (among 4.10 and 4.60 g 100 g⁻¹) allows to classify homemade cereal bars as a product of moderate fiber content.

Comparing portions of the product (25 g⁻¹) with brands found in the market, as described in Table 3, it may be observed that the lipid value found in this study is close to the ones commercially used. Regarding carbohydrate and fiber contents, elaborated bars presented a lower carbohydrate content and higher fiber content if compared to other bars. This fact may be explained by the addition of seed meal, which has high total fiber content (24.4 g 100 g⁻¹) and low carbohydrate content (3.76 g 100 g⁻¹).

Table 2. Approximate centesimal content (% wet base) of jackfruit cereal bar.

	Dehydrated jackfruit	Seed meal	Formulation I	Formulation II	Formulation III
Caloric value (kcal 100 g ⁻¹)	271.18	242.88	419.06	414.85	413.21
Protein (Nx6.25)	2.73±0.03	4.61±0.04	4.80±0.035	4.60±0.029	4.60±0.03
Fat	1.94±0.02	0.80±0.007	8.68±0.04	6.22±0.03	7.81±0.03
Ash	2.47±0.03	12.12±0.09	1.59±0.03	1.38±0.029	1.56±0.025
Moisture	19.83±0.09	54.31±0.10	21.02±0.09	21.40±0.08	20.26±0.10
Carbohydrate*	63.43	3.76	42.50	44.10	45.40
Fiber	9.60±0.30	24.40±0.25	4.60±0.09	4.10±0.09	4.50±0.08

*Calculated by difference.

Table 3. Centesimal content of Formulations I, II and III of cereal bars and commercial bars (D (light) and E (traditional)).

	I	II	III	D*	E*
Carbohydrate (g)	10.625	11.025	11.350	19.000	17.000
Fat (g)	2.17	1.56	1.95	1.00	4.00
Protein (g)	1.21	1.15	1.15	1.00	1.00
Fiber (g)	1.15	1.03	1.13	1.00	1.00

*Composition of labels.

Sensory analysis

The grades given by testers concerning sensorial preference is shown in Table 4. The three formulations presented a good sensory acceptance, in a general standpoint. However, texture sensation caused by the combination of the ingredients obtained lower averages of sensory preference.

Table 4. Averages of grades given by testers for sensorial preferences of jackfruit cereal bars.¹

Formulation	Aroma	Color	Taste	Texture	Global Impression
III	6.9 ^a	6.9 ^a	7.1 ^a	6.6 ^c	7.1 ^a
II	6.5 ^a	6.6 ^c	6.8 ^b	6.3 ^{ab}	6.8 ^{ab}
I	5.9 ^b	6.1 ^b	5.9 ^b	5.7 ^b	6.3 ^b

¹Means, in the same column, followed by the same letter are not significantly different (Duncan's test, $p > 0.1$).

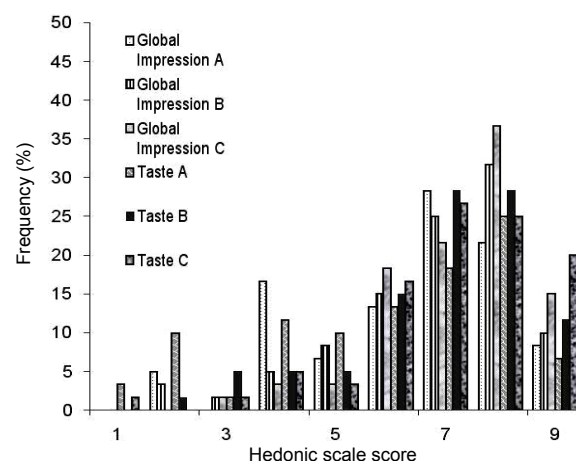
Concerning sensory characteristics: global impression and texture, formulation II obtained intermediary average, which did not significantly differed ($p > 0.1$) from Formulations III (30% of seed meal) and I (50% of seed meal).

Regarding color and aroma, Formulation III, with a lower content of seed meal (30%) obtained the best averages (6.9 and 6.9, respectively), but it did not significantly differed ($p > 0.1$) from Formulation II which contained 40% of seed meal.

Considering taste, Formulation III obtained the highest grade, 7.1, but it did not significantly differed ($p > 0.1$) from Formulation II. Formulation 1 which contains 50% of dehydrated jackfruit and 50% of seed meal presented lower preference grades if compared to the others.

Figure 2 shows the frequency of grades for the following characteristics: Global Impression and Flavor, due to the relevance of these characteristics, from the three formulation of jackfruit cereal bar. It is possible to verify that 30% of the grades concerning Global Impression for formulations B

and C are among 7 and 9, which indicates "moderately liked" and "extremely liked". Furthermore, more than 25% of the grades concerning flavor of the three formulations were among this same grade interval.

**Figure 2.** Distribution of grade frequencies for global impression and taste of the three formulations of jackfruit cereal bar.

Conclusion

Based on the obtained results we can conclude that the cereal bar elaborated from seed meal of jackfruit and dehydrated jackfruit satisfactorily attends nutritional values if compared to other in the market. Concerning sensorial characteristics, formulations containing 30 and 40% of seed meal of jackfruit were preferred by testers. Regarding nutritional value, the variation of seed meal and dehydrated jackfruit content did not present significant differences. However, if considering the testers' acceptance, the best formulation is the one which contains 40% of seed meal and 60% of dehydrated jackfruit, due to the use of higher amount of seed meal. Moreover, this formulation did not differ from formulations containing 30% of seed meal and 60% of dehydrated jackfruit.

Acknowledgements

The authors would like to thank the Bahia State Research Fund Agency (Fapesb) and CNPq for their financial support.

References

- AACC-American Association of Cereal Chemists. The definition of dietary fibre. **Cereal Foods World**, v. 46, n. 3, p. 112-129, 2001.
- AOAC-Association of Official Analytical Chemists. **Official methods of analysis**. 16th ed. Gaithersburg, 1996.
- BRITO, I. P.; CAMPOS, J. M.; SOUZA, T. F. L.; WAKIYAMA, C.; AZEREDO, G. A. Elaboração e avaliação global de barra de cereais caseira. **Boletim CEPPA**, v. 22, n. 1, p. 35-50, 2004.
- DREHER, M. Food sources and uses of dietary fibre. In: CHO, S. S. (Ed.). **Complex carbohydrates in foods**. New York: Marcel Dekker, 1999. p. 385-394.
- DUTCOSKY, S. D.; GROSSMANN, M. V. E.; SILVA, S. S. F. R.; WELSCH, A. K. Combined sensory optimization of a prebiotic cereal product using multicomponent mixture experiments. **Food Chemistry**, v. 98, n. 4, p. 630-638, 2006.
- FREITAS, D. G. C.; MORETTI, R. H. Caracterização e avaliação sensorial de barra de cereais funcional de alto teor protéico e vitamínico. **Ciência e Tecnologia de Alimentos**, v. 26, n. 2, p. 318-324, 2006.
- JAGADEESH, S.; REDDY, L. B. S.; SWAMY, G. S. K.; GORB, K.; RAGHAVAN, G. S. V. Chemical composition of jackfruit (*Artocarpus heterophyllus*) selections of Western Ghats of India. **Food Chemistry**, v. 102, n. 1, p. 361-365, 2007.
- MATTOS, L. L.; MARTINS, I. S. Consumo de fibras alimentares em população adulta. **Revista de Saúde Pública**, v. 34, n. 1, p. 50-55, 2000.
- MORI, E. E. M.; YOTSUYANAGI, K.; FERREIRA, V. L. F. Análise sensorial de goiabadas de marcas comerciais. **Ciência e Tecnologia de Alimentos**, v. 18, n. 1, p. 105-110, 1998.
- MURPHY, O. Non-polyol low-digestible carbohydrates: food applications and functional benefits. **British Journal of Nutrition**, v. 85, suppl. 1, p. 47-53, 2001.
- RAHMAN, M. A.; NAHAR, N.; JABBAR, M. A.; MOSIHUZZAMAN, M. Variation of carbohydrate composition of two forms of fruit from jack tree (*Artocarpus heterophyllus*) with maturity and climatic conditions. **Food Chemistry**, v. 65, n. 1, p. 91-97, 1999.
- RIBEIRO JÚNIOR, J. I. **Análises estatísticas no SAEG**. Viçosa: UFV, 2001.
- RYLAND, D.; VAISEY-GENSER, M.; ARNTFIELD, S. D.; MALCOLMSON, L. J. Development of a nutritious acceptable snack bar using micronized flaked lentils, **Food Research International**, v. 43, n. 2, p. 642-649, 2010.
- SILVA, A. F.; MINIM, V. P. R.; RIBEIRO, M. M. Análise sensorial de diferentes marcas comerciais de café (*Coffea arabica* L.) orgânico. **Ciência e Agrotecnologia**, v. 29, n. 6, p. 1224-1230, 2005.
- SILVA, D. J.; QUEIROZ, A. C. **Análise de Alimentos: métodos químicos e biológicos**. Viçosa: UFV, 2002.
- SOUZA, T. S.; CHAVES, M. A.; BONOMO, R. C. F.; SOARES, R. D.; PINTO, E. G.; COTA, I. R. Desidratação osmótica de frutículos de jaca (*Artocarpus integrifolia* L.): aplicação de modelos matemáticos. **Acta Scientiarum. Technology**, v. 31, n. 2, p. 225-230, 2009.
- SUN-WATERHOUSE, D.; TEOH, A.; MASSAROTTO, C.; WIBISONO, R.; WADHWA, S. Comparative analysis of fruit-based functional snack bars. **Food Chemistry**, v. 119, n. 4, p. 1369-1379, 2010.

Received on February 27, 2009.

Accepted on November 18, 2009.

License information: This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.