27 A 29 DE OUTUBRO DE 2020
ON LINE
7º Simpósio de Segurança Alimentar
Inovação com sustentabilidade

DEVELOPMENT OF SNACKS ENRICHED WITH AÇAÍ PULP POWDER

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RESUMO – O açaí é uma fruta com elevada concentração de nutrientes e compostos bioativos popularmente conhecido como superfruta. O objetivo deste estudo foi desenvolver extrusados enriquecidos com polpa de açaí em pó e avaliar a influência desse fruto na composição nutricional destes snacks. Extrusados adicionados com 0, 2, 4 e 6% de açaí foram produzidos usando uma extrusora dupla rosca co-rotativa. A incorporação de açaí aumentou a concentração de proteínas e minerais em 6,3% e 32,2%, respectivamente. Portanto, concluímos que o açaí pode ser utilizado com sucesso no desenvolvimento de extrusados inovadores, melhorando suas propriedades nutricionais, sendo uma alternativa para consumidores interessados em alimentos de conveniência mais saudáveis.

ABSTRACT – Açaí is a fruit with a high concentration of nutrients and bioactive compounds popularly called superfruit. The goal of this study was to develop extrudates enriched with açaí pulp powder and evaluate the influence of this fruit on the nutritional composition of these snacks. Extrudates added with 0, 2, 4 and 6 % of açaí were produced using a co-rotating twin-screw extruder. The incorporation of açaí increased the protein and minerals concentration up to 6.3% and 32.2%, respectively. Therefore, we conclude that açaí can be successfully used to develop innovative extrudates by enhancing their nutritional properties, being an alternative for consumers interested in healthier convenience food.

PALAVRAS-CHAVE: extrusão; composição proximal; nutrição; *Euterpe oleracea* Mart.

KEYWORDS: extrusion; proximate composition; nutrition; *Euterpe oleracea* Mart.

1. INTRODUCTION

Açaí (*Euterpe oleracea* Mart.) is a fruit popularly called as “superfood” due to its high content of nutrients and bioactive compounds (e.g. carotenoids, flavonoids, acid linoleic, and linolenic) (Llorent-Martínez et al., 2013; Yamaguchi et al., 2015). This popular fruit often consumed by different populations worldwide. The economic potential of this fruit is mainly related to açaí beverages that are exported as energy drinks (Yamaguchi et al., 2015).

Studies have demonstrated the health benefits of açaí (Peixoto et al., 2016; Romualdo et al., 2015). Furthermore, studies investigating açaí as ingredient have shown good sensory acceptability (Silva et al., 2016).

Nowadays, the interest in ready-to-eat food in the form of snacks has increased worldwide (Dalbhagat et al., 2019). Therefore, natural ingredients can be incorporate in extrudate formulations to improve the nutritional properties (Obradović et al., 2015). Previous studies already examined the effects of different fruits in extrudates enrichment (Hirth et al., 2015; Potter et al., 2013). However, to the best of our knowledge, no studies are available regarding açaí addition to expanded snacks. Thus, the goal of this study was to develop extrudates enriched with açaí pulp powder and evaluate the influence of this fruit on the nutritional composition of these snacks.

2. MATERIAL AND METHODS

2.1 Raw materials

Rice flour and corn flour were obtained from Zwicky (Müllheim-Wigoltingen, Switzerland). Açaí pulp was purchased from Amazonbai (Macapá, Amapá, Brazil). The pulp was frozen at -80 °C in an ultrafreezer and freeze-dried at -55 °C for 48 h. After, the açaí powder (moisture content of 3.6%) was vacuum packed and stored at -18 °C in laminated bags.

2.2 Samples preparation

The control formulation was prepared using the ratio 2:1 of rice and corn flours according to previous research (Lucas et al., 2018). Furthermore, other formulations added with 2%, 4%, and 6% of freeze-dried açaí were developed by replacing the same amount of flours. The ingredients were mixed before the addition to the extruder.

2.3 Extrusion

The raw material previously homogenized was added in the extruder using a K-Tron powder feeder (Coperion K-Tron, Niederlenz, Switzerland). The extrudates were produced using a co-rotating twin-screw extruder (Model DNDL-44, Bühler, Uzwil, Switzerland) with a 900 mm length and L/D = 20.45. The configuration of the screw was composed of conveying, mixing and kneading elements. The parameters selected were screw speed of 250 rpm, a feed rate of 12.6 kg/h, and 143ºC as the temperature in the last zone (Lucas et al., 2018).

Water was introduced in the process until the mixture reaches 16.2% of the moisture initially. Corrections in this content were made using mass balance and the process parameters were monitored constantly. In the end, a circular die was used, and the samples were cut using a single knife. Then, the extrudates were dried in an oven until reach a moisture content of less than 6%, cooled, and stored in metalized bags for further analyses.

2.4 Proximate composition of snacks

The proximate composition was evaluated using AOAC Official Methods (1995). Moisture was determined in the oven at 105ºC; protein content was obtained using the Kjeldahl method using a conversion factor of 6.25. The lipid concentration was obtained using the Soxhlet and ash by using a muffle furnace at 550ºC. Carbohydrates were calculated by difference.

2.5 Protein digestibility of snacks

In vitro protein digestibility was determined using pepsin and pancreatin following the method described by Rathod and Annapure (2016).

2.6 Statistical analyses

The analysis of results was performed by analysis of variance (ANOVA), and the means were compared by Tukey's test at $p < 0.05$. Data were analyzed using Statistica software version 7.0.

3. RESULTS AND DISCUSSION

The proximate composition of the extrudates formulations is displayed in Table 1. The addition of açaí powder significantly increased the protein concentration, being 6.25% higher in the sample enriched with 6% of açaí than the sample without açaí. Similar to our results, Azzollini et al. (2018) and Lucas et al. (2018) observed increases in protein after enriching extrudates with insect and *Spirulina*, respectively.

Regarding the protein digestibility, the results of all samples were high and close to those reported by Azzollini et al. (2018) and Rathod and Annapure (2016) for extrudates. According to Dalbhagat et al. (2019), this probably occurs due to the mechanical shear in the extrusion process that disrupts the protein molecules and improves their digestibility.

Table 1 – Proximate composition and protein digestibility of the extrudates.

	0% açaí	2% açaí	4% açaí	6% açaí
Protein (g/100g)	8.80 ± 0.01^{d}	8.97 ± 0.10^{c}	9.20 ± 0.03^{b}	9.35 ± 0.01^{a}
Protein digestibility (%)	83.69 ± 3.34^{a}	87.72 ± 2.77^{a}	82.11 ± 5.65^{a}	87.05 ± 1.77^{a}
Lipids (g/100g)	0.10 ± 0.02^{d}	0.24 ± 0.00^{c}	0.51 ± 0.06^{b}	0.86 ± 0.08^{a}
Ashes (g/100g)	0.59 ± 0.01^{d}	0.65 ± 0.00^{c}	0.71 ± 0.02^{b}	0.78 ± 0.01^{a}
Carbohydrates (g/100g)	90.51	90.14	89.58	89.01

Means ± standard deviation ($n = 3$). Different letters in the same line indicate significant differences between samples ($p < 0.05$). Results expressed on a dry basis.

According to Yamaguchi et al. (2015), in açaí lipid portion, there are linoleic and linolenic essential fatty acids. The lipid content in the snacks increased significantly ($p<0.05$) after açaí incorporation, being 8-fold higher in the sample with 6% of fruit than in snack without açaí. However, the contents obtained for lipids in all formulations were lower than expected if considered the content present in the açaí pulp powder (54.2% lipid on a dry basis). The variation in fat content could be due to the formation of complexes between amylose and lipids during the extrusion process (Dalbhagat et al. 2019). Regarding the minerals for all açaí enriched samples, the content increased significantly. The snacks added with 2, 4, and 6% of açaí powder showed ashes content 10.17%, 20.34%, and 32.20% higher than the sample without açaí, respectively.

4. CONCLUSIONS

The incorporation of açaí to extrudates significantly increased the protein concentration up to 6.3 % and the mineral content up to 32.2%. Additionally, açaí added snacks presented high protein digestibility without significant differences between the samples. Thus, açaí can be used to develop innovative snacks, with higher protein and mineral content. Açaí enriched extrudates can be utilized by consumers interested in healthier convenience food.

5. ACKNOWLEDGEMENTS

The authors are very thankful to the Ministry of Science, Technology, Innovations, and Communications (MCTIC) of Brazil (Project 01200.004564/2015-12) and the Coordination for the Improvement of Higher Education Personnel (CAPES) for the scholarship supported by the Program Sandwich PhD Abroad (PDSE) under Process nº{88881.186834/2018-01}.

6. REFERENCES

AOAC. (1995). *Official Methods of Analysis of the association of analytical chemists international.* (16th ed.). Virginia: AOAC International.

Azzollini, D., Derossi, A., Fogliano, V., Lakemond, C. M. M., & Severini, C. (2018). Effects of formulation and process conditions on microstructure, texture and digestibility of extruded insect-riched snacks. *Innovative Food Science and Emerging Technologies*, 45, 344–353.

Dalbhagat, C. G., Mahato, D. K., & Mishra, H. N. (2019). Effect of extrusion processing on physicochemical, functional and nutritional characteristics of rice and rice-based products: A review. *Trends in Food Science & Technology*, 85, 226–240.

Hirth, M., Preiß, R., Mayer-Miebach, E., & Schuchmann, H.P. (2015). Influence of HTST extrusion cooking process parameters on the stability of anthocyanins, procyanidins and hydroxycinnamic acids as the main bioactive chokeberry polyphenols. *LWT - Food Science and Technology*, 62, 511-516.

Llorent-Martínez, E. J., Fernández-de Córdova, M. L., Ortega-Barrales, P., & Ruiz-Medina, A. 2013. Characterization and comparison of the chemical composition of exotic superfoods. *Microchemical Journal*, 110, 444-451.

Lucas, B. F., Morais, M. G., Santos, T. D., & Costa, J. A. V. (2018). *Spirulina* for snack enrichment: Nutritional, physical and sensory evaluations. *LWT - Food Science and Technology*, 90, 270–276.

Obradović, V., Babić, J., Šubarić, D., Jozinović, A., Ačkar, D., & Klarić, I. (2015). Influence of dried Hokkaido pumpkin and ascorbic acid addition on chemical properties and colour of corn extrudates. *Food Chemistry*, 183, 136-143.

Peixoto, H., Roxo, M., Krstin, S., Wang, X., & Wink, M. (2016). Anthocyanin-rich extract of Acai (*Euterpe precatoria* Mart.) mediates neuroprotective activities in *Caenorhabditis elegans*. *Journal of Functional Foods*, 26, 385–393.

Potter, R., Stojceska, V., & Plunkett, A. (2013). The use of fruit powders in extruded snacks suitable for Children's diets. *LWT - Food Science and Technology*, 51, 537-544.

Rathod, R. P., & Annapure, U. S. (2016). Effect of extrusion process on antinutritional factors and protein and starch digestibility of lentil splits. *LWT - Food Science and Technology*, 66, 114-123.

Romualdo, G. R., Fragoso, M. F., Borguini, R. G., Santiago, M. C. P. A., Fernandes, A. A. H., & Barbisan, L. F. (2015). Protective effects of spray-dried açaí (*Euterpe oleracea* Mart) fruit pulp against initiation step of colon carcinogenesis. *Food Research International*, 77, 432–440.

Silva, L. B., Queiroz, M. B., Fadini, A. L., Fonseca, R. C. C., Germer, S. P. M., & Efraim, P. (2016). Chewy candy as a model system to study the influence of polyols and fruit pulp (açai) on texture and sensorial properties. *LWT - Food Science and Technology*, 65, 268-274.

Yamaguchi, K. K. L., Pereira, L. F. R., Lamarão, C. V., Lima, E. S., & Veiga-Junior, V. F. (2015). Amazon açaí: Chemistry and biological activities: A review. *Food Chemistry*, 179, 137–151.