USE OF ARABIC COFFEE (*Coffea arábica*) BY-PRODUCT FOR COOKIE PRODUCTION

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Introduction

Consumer demand for healthier foods, as well as environmental concerns, has currently grown, and this scenario has led food industries to seek new sources of product enrichment [1]. The use of agroindustrial by-products as food ingredients has great potential, as they are nutritionally rich. These contain fibers and proteins in their composition, and are sources of bioactive compounds with antioxidant potential [2]. Brazil is currently the world's largest producer of Arabica coffee, whose commercial and economic importance has increased continuously, with production of 50.9 million bags of coffee in 2022 and estimated growth of 7.5% for 2023 [3]. A result of coffee processing is the generation of large quantities of by-products, around 30 to 50% of the total weight of the coffee fruit produced. Wet processing methods involve removing the external parts of the fruit in a series of steps, including pulping, fermenting, washing, and drying, which produces the by-product called pulp [4]. These by-products are often used as natural fertilizers or, in most cases, considered waste and discarded inappropriately, which results in damage to the environment [5]. Therefore, the use of these by-products more efficiently seems highly desirable. The objective of this study was to evaluate the physical characteristics of cookies produced with different percentages of coffee by-product (pulp).

Materials and methods

The Arabica coffee by-product (pulp) was obtained through donation from a producer in the mountainous region of the state of Rio de Janeiro and was dried in a ventilated oven at a temperature of 55 °C, until it reached ±12% humidity. To obtain the flour, the dried pulp was grounded in a blender (Philco) and a domestic mill (Mr.Coffe-IDS 57), after which it was sieved in a 250 µm tammis (60 mesh). The flour was stored in vacuum bags and kept in desiccators (ambient temperature 21±2 ºC). Four cookies formulations were developed, using a completely randomized experimental design, with a control formulation containing 100% wheat flour (BC) and 3 formulations with partial replacement by coffee by-product flour of 10%, 20% and 30%, named B10, B20 and B30, respectively. The cookies were prepared manually, by first mixing the dry ingredients (flour, sugar, baking soda and salt) then butter and filtered water were added, homogenized until a smooth dough was obtained. The physical analyzes of the cookies included the procedures described in the AACC method 10-50D (1995) before and after cooking to determine weight, thickness, diameter and volume [6]. The cookies were weighted on a domestic digital scale. The thickness of the cookies were determined using a caliper and the diameter was determined with a millimeter scale ruler. From the pre- and post-cooking weight of the cookies, the thermal factor and yield percentage of the finished product were calculated. Data were subjected to analysis of variance (ANOVA), and the treatments were compared with each other at a 5% level of significance ($p \leq 0.05$). For samples that differed statistically, the *t* test was used to compare means and Bonferroni correction.

Results and discussion

The results obtained from the physical analyzes of the cookies are presented in Table 1.

Table 1 – Results of physical analyzes of cookies developed with different percent of by-product flour.

Determinations		**Cookies**			
		BC	**B10**	**B20**	**B30**
Weight (g)	Pre-cooking	$16.28^a \pm 0.43$	$15.81^a \pm 0.30$	$16.10^a \pm 0.32$	$15.76^a \pm 0.12$
	Post-cooking	$14.94^a \pm 0.41$	$14.70^a \pm 0.35$	$14.79^a \pm 0.33$	$14.60^a \pm 0.15$
Thickness (mm)	Pre-cooking	$9.63^a \pm 0.29$	$9.13^a \pm 0.76$	$9.20^a \pm 0.66$	$9.83^a \pm 0.55$
	Post-cooking	$10.27^a \pm 0.40$	$10.37^a \pm 0.55$	$10.30^a \pm 0.87$	$10.80^a \pm 0,61$
Diameter (cm)	Pre-cooking	$4.67^a \pm 0.15$	$4.83^a \pm 0.15$	$4.77^a \pm 0.20$	$4.60^a \pm 0.30$
	Post-cooking	$6.00^a \pm 0.26$	$5.67^{ab} \pm 0.15$	$5.80^a \pm 0.10$	$5.40^b \pm 0.10$
Volume (cm^3)	Pre-cooking	$17.11^a \pm 1.11$	$18.35^a \pm 1.16$	$17.86^a \pm 1.57$	$16.66^a \pm 2.17$
	Post-cooking	$28.30^a \pm 2.47$	$25.22^{ab} \pm 1.35$	$26.41^a \pm 0.91$	$22.90^b \pm 0.85$
Performance (%)	-	$91.75^a \pm 0.22$	$92.98^a \pm 0.60$	$91.84^a \pm 0.29$	$92.64^a \pm 0.44$
Thermal factor	-	$0.92^a \pm 0.002$	$0.93^a \pm 0.005$	$0.92^a \pm 0.002$	$0.93^a \pm 0.004$

Mean values ± standard deviation

Means followed by equal letters horizontally do not differ significantly from each other ($p \leq 0.05$).

According to Table 1, it can be observed that the pre and post-cooking physical determinations for the weight and thickness parameters did not differ statistically between the formulations developed. For diameter and volume analyses, there was no significant difference between pre-baking cookies, however, after baking these parameters showed some differences. Regarding the yield parameter, although no significant differences were observed, it is possible to observe an increase in the yield percentage of cookies with the addition of the coffee by-product compared to the control treatment. Formulations B10 and B20 did not differ significantly from BC for any of the analyzed parameters. In the post-cooking diameter and volume analyses, a significant difference was found between the BC and B30 treatments, suggesting that this level of flour replacement (30%) significantly impacted these parameters in the cookies after baking. Gocmen et al. (2019), in the preparation of biscuits with the addition of the coffee by-product, silverskin, they found that as the levels of addition of the by-product were increased, there was a significant decrease (5.75-5.0 cm) in the post-cooking diameter, the same observed in this study (6.0-5.4 cm). The authors suggest that the addition of the by-product affected the cookie's spreading ratio due to the high fiber and protein content present in its composition [7].

Conclusion

The results obtained demonstrate that it is possible to replace up to 20% of wheat flour with coffee by-product flour, for cookie preparation, without changing the physical characteristics. To verify the behavior of the formulations, it is important to perform the physicochemical and microbiological analyses recommended by legislation for this product. The use of coffee by-products as a food ingredient could present itself as an economical and beneficial option in the preparation of products.

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