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Análise fisico-quimica e sensorial de biscoito produzido com farinha mista de batata (*Solanum Tuberosum L.*) e beterraba (*Beta Vulgaris L.*)

Physical-chemical and sensory evaluation of cookie made with potato (*Solanum Tuberosum L.*) and beet (*Beta Vulgaris L.*) Mixed flour

Análisis físico-químico y sensorial de galletas producidas con harina mixta de patata (*Solanum Tuberosum L.*) y remolacha (*Beta Vulgaris L.*)

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Resumo

Este estudo teve como objetivo desenvolver um biscoito a partir da farinha mista derivada de polpa desidratada da beterraba e batata, por meio de secagem em um secador de bandeja e avaliando suas características físico-químicas e sensoriais. Foram preparadas três formulações: Padrão (0%), Tipo I (10%) e Tipo II (20%). A porcentagem corresponde à farinha misturada adicionada à formulação básica. Os dados do processo de secagem da farinha mostraram uma perda de umidade das batatas e beterrabas em torno de 83,5 e 86,2%, respectivamente. Os biscoitos Tipo I e II apresentaram uma composição química média de 0,3 a 0,7% de umidade, 70% de carboidratos para ambas, 5 e 7% de proteína, 22 e 20% de gordura e 2% de minerais para ambos, com um valor calorífico médio de 505 e 491 kcal x 100 g-1. Todas as formulações apresentaram aceitação satisfatória por meio de análise sensorial, e não houve diferença estatística entre os tipos de biscoitos para todos os atributos. O modelo Midilli descreve a cinética de secagem com um bom parâmetro de ajuste. Portanto, este produto é muito promissor, levando em consideração a gama de nutrientes adicionais das matérias-primas (principalmente minerais), valor calorífico semelhante ao encontrado no mercado brasileiro e aceitação do consumidor, além da possibilidade de uso como corante.

Palavras-chave: Secagem; Umidade; Consumidor; Modelo midilli.

Abstract

This study aimed to develop a cookie from the mixed flour derived from dehydrated pulp of beet and potatoes, by drying in a tray dryer and assessing their physical-chemical and sensory characteristics. Three formulations were prepared: Standard (0%), Type I (10%) and Type II (20%). The percentage correspond to the mixed flour added to the basic formulation. The data of the flour drying process showed a moisture loss of the potatoes and beet around 83.5 and 86.2%, respectively. The Type I and II cookies had an average chemical composition respective 0.3 to 0.7% moisture, 70% carbohydrates for both, 5 and 7% protein, 22 and 20% fat and 2% minerals for both, with an average calorific value of 505 and 491 kcal x 100 g-1. All formulations showed satisfactory acceptance through sensory analysis, and there was no statistical difference between the types of cookie for all attributes. The model Midilli describes the drying kinetics with a good parameter of fit. So, this product is very promising, taking into account the range of additional nutrients from the raw materials (mainly minerals), calorific value similar to those found on Brazilian market and consumer acceptance, besides the possibility of use as a coloring agent.

Keywords: Drying; Moisture; Consumer; Model midilli.

Resumen

Este estudio tuvo como objetivo desarrollar una galleta a partir de harina mixta derivada de pulpa deshidratada de remolacha y papas, mediante secado en una secadora de bandejas y evaluando sus características físico-químicas y sensoriales. Se prepararon tres formulaciones: estándar (0%), tipo I (10%) y tipo II (20%). El porcentaje corresponde a la harina mixta añadida a la formulación básica. Los datos del proceso de secado de la harina mostraron una pérdida de humedad de las papas y las remolachas en torno al 83.5 y 86.2%, respectivamente. Las galletas Tipo I y II tenían una composición química promedio de 0.3 a 0.7% de humedad, 70% de carbohidratos para ambos, 5 y 7% de proteínas, 22 y 20% de grasas y 2% de minerales para ambos, con un poder calorífico medio de 505 y 491 kcal x 100 g-1. Todas las formulaciones mostraron una aceptación satisfactoria a través del análisis sensorial, y no hubo diferencia estadística entre los tipos de cookies para todos los atributos. El modelo Midilli describe la cinética de secado con un buen parámetro de ajuste. Por lo tanto, este producto es muy prometedor, teniendo en cuenta la gama de nutrientes adicionales de las materias primas (principalmente minerales), un valor calorífico similar al encontrado en el mercado brasileño y la aceptación del consumidor, además de la posibilidad de usarlo como colorante.

Palabras clave: Secado; Humedad; Consumidor; Modelo midilli.

1. Introduction

It can be observed the tendency of consumers for healthier products and ready for consumption. Among these, is the cookie, very significant part of the food industry in most countries (Giuberti et al., 2018; Sulieman et al., 2019), known worldwide for its practicality, long shelf life, and low cost, that are entering the world of functional foods by including ingredients that provide a better source of nutrients, such as nuts, seeds and flour obtained from tubers and roots tuberous (Jan, Panesar, & Singh, 2018).

Regardless of its origin, currently, the cookie is a product internationally consumed by all social classes. Each country has, of course, your preference for a particular class, which, when taken together, form an extensive selection of shapes, sizes, types, and flavors (de Moraes, Zavareze, de Miranda, & Salas-Mellado, 2010).

Recently, the cookies have being produced with the intention of improving its formulation with fiber or protein, due to the strong nutritional appeal that exists today regarding the food consumed (Kaur et al., 2018), which reflects directly on your sale that rose approximately 5,5% in 2018 and amounted R$ 0,703 billion, compared to R$ 0,690 billion in the previous year, according to the IBAPBI (2019) - Industries Brazilian Association of Cookies, Pasta and Bread & Cakes Industrialized. Aiming functionality and reducing plant waste observed worldwide, the production of new foods in this segment has become prosperous.

Traditionally cookies are made starting from ingredients such as sugar, wheat flour and fat (Jan et al., 2018). The substitution of wheat flour in order to obtain improved technological characteristics has been reported by other authors (Aquino, Móes, Leão, Figueiredo, & Castro, 2010; Capriles, Coelho, Matias, & Arêas, 2006; Kopper et al., 2009; Zhao, Liu, Bai, & Wang, 2019). Although this area is well studied and are proposed various foods, there are many types of potential substitutes for wheat flour which must be explored, as an example, the flour originating from potato and beet.

The potato, from the species Solanum tuberosum L., commonly known as English potato, is among the four most consumed vegetables in the world, along with rice, wheat and corn, and plays an important role in human nutrition (Cao, Zhang, Guo, Dong, & Li, 2019). In addition to carbohydrates, this vegetable contains high-quality protein, vitamins and minerals (superior to wheat flour), besides several phytochemicals such as polyphenolics and flavonoids (Liu, Mu, Sun, Zhang, & Chen, 2016).

The beet (*Beta vulgaris L.*) is an herbaceous vegetable rich in minerals, belonging to the family of Chenopodiaceae. It is a tuberous root, originally from the temperate regions of Europe and North Africa. Its root can be eaten raw, cooked, canned, dried or powdered (Filho, Eidam, Borsato, & Raupp, 2011). The red beet is a source of phenolic compounds including phenolic acids, flavonoids, and organic and inorganic acids (Vasconcellos et al., 2016), and it has a strong sensory appeal due to its intense red color.

The raw materials listed above (potato and beet) as well as several other plant origins, exhibit high production waste generated by different factors which may be genetic, related to the weather or soil, unsuitable storage and transportation, etc., leading to obtaining food that end up not being favorable for the fresh fruit market. The use of these, even if damaged by adverse conditions listed above, but with good technological characteristics in processing new types of food, is very important, from the perspective of increase of nutrition value and adding the commercial value of the product.

Faced with the facts presented, the choice of these two raw materials is mainly for these have different types of nutrients, an attractive pigment in the case of beet, and the ease in transportation and storage. The use of a mixture of flour obtained from potato and beet, replacing the wheat flour, for the production of the cookie, will allow the creation of a new technological product, with favorable physical-chemical, nutritional and organoleptic characteristics, making extremely attractive production, besides the fact that both materials have low cost and easy accessibility in Brazilian market.

Therefore, the aim of this research is to elaborate a cookie with flour derived from dehydrated pulp of beet and potatoes, by drying in a tray dryer

2. Material and Methods

This work consists of laboratory research, through physical-chemical analyzes based on the methodologies of the Adolf Lutz Institute (IAL, 2008), and field research, through sensory analysis following the methodology described in Peryam & Pilgrim (1957) and Meilgaard, Civille, & Carr (1991).

The drying of samples, cookie production, determination of centesimal composition and sensory analysis, were performed in laboratories of Unit Operations, Cereals, Chemical Food and Sensory Analysis, respectively, of the Food Engineering Department of the Federal University of

Maranhão - Center of science, social, health and technology. The raw materials were obtained from producers in Imperatriz, Maranhão.

2.1 Material

For the preparation of flour, the raw materials were purchased in the local market, dried in a tray dryer, produced by researchers at the University Santa Cecilia. The reagents used in the determination of the chemical composition were: sulfuric acid, sodium hydroxide, hydrochloric acid, methyl red indicator, copper sulfate and hexane. For cookie production, were used ingredients: wheat flour, refined crystal sugar, baking powder, margarine, mineral water, salt.

2.2 Methods

2.2.1. Drying kinetics curve and flour obtainment

Samples were washed in running water for removal of coarse dirt, soaked in sodium hypochlorite solution (0,02ml/L) for 30 minutes and then washed in running water to remove excess chlorine. After sanitization, the samples were washed in water and bleached (100°C for 15 min), then peeled and cut manually with stainless knives, and a vegetable slicer, respectively, in a standard thickness of approximately 1.3 mm, with variable area according to the size of the tuber.

Slices were distributed uniformly on trays, and the drying conducted in a tray dryer with forced air circulation, where the heat is transferred from the equipment to the product by convection mechanism (hot air). Operating variables measured were: temperature of the dryer, dry and wet mass, measured in a 15 minutes sampling interval, until it reached constant weight, with conditions airflow equal to 2.6 ms-1 and temperature wet bulb T_{wb} = 61°C and dry bulb T_{db} = 58°C. After drying, the material was triturated in a high shear blender (BM 43) for reduction of particulates, to a granulometry lower than 700 micrometers.

2.2.2. Mathematical modeling for drying kinetics curve

Armed with the data, were built the drying curves and drying rate (Charmongkolpradit & Luampon, 2017). The moisture content of the sample is calculated by the following equation 1:

$$MR_{drybasis} = \frac{M - M_{dry}}{M_{wet} - M_{dry}} \tag{1}$$

Where:

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$MR_{drybasis}$ is the ratio between the mass of water present in the sample (M) and this solid moisture-free mass (M_{dry}) at any level and at any given time. M_{wet} is the sample weight before drying (g) and M_{dry} is the dry mass obtained after drying (g).

Various mathematical and semi-empirical models have been reported to study the mathematical modeling of thin layer drying kinetics (Park, Park, Alonso, Cornejo & Fabbro, 2014). The Midilli model (Midilli, Kucuk, & ZA, 2002) is a semi-empirical method used with success to describe the drying characteristics of a variety of food. Therefore, the semi-empirical Midilli, equation 2, was used to describe the drying kinetics of samples:

$$MR = ae^{(-kt^n)} + bt \tag{2}$$

Where:

a, k, n and b are model constants. The terms used to evaluate the goodness of fit of the tested models to the experimental data were the coefficient of determination (R^2); root mean square error (RMSE) and the reduced chi-square (χ^2) between the experimental and predicted moisture ratio values. The statistical parameters were calculated using equations 3 -5.

$$R^2 = 1 - \frac{\sum_{i=1}^{N}\left(MR_{\exp,i} - MR_{pre,i}\right)^2}{\sum_{i=1}^{N}\left(\overline{MR_{\exp,i}} - MR_{\exp,i}\right)^2} \tag{3}$$

$$RMSE = \left[\frac{1}{N}\sum_{i=1}^{N}\left(MR_{pre,i} - MR_{\exp,i}\right)^2\right]^{1/2} \tag{4}$$

$$\chi^2 = \frac{\sum_{i=1}^{N}\left(MR_{\exp,i} - MR_{pre,i}\right)^2}{N - Z} \tag{5}$$

Where:

$MR_{exp,i}$ is the experimental moisture ratio found in any measurement, $MR_{pre,i}$ is predicted moisture ratio for this measurement, N is the number of observations, Z is the number of model constants, $MR_{exp,i}$ (with dash above) is the total average data, and i is i^{th} data.

2.2.3 Development of formulations

The formulations were developed through laboratory tests, therefore, was used as a base one cookie preparation methodology, with some modifications in the type and percentage of flour, fat and water content (Aquino et al., 2010).

Formulations of the cookies were prepared using different proportions of wheat flour and mixed flour, according to Table 1. To prepare the mass, quantities of each ingredient were blended and kneaded by hand, sufficiently to homogenize.

Table 1 - Formulations used to prepare the cookie with and without mixed flour.

Ingredients	Standard		Type I (10%)		Type II (20%)	
	g	%	g	%	g	%
Wheat flour (g)	223.20	100.00	200.88	90.00	178.56	80.00
Mixed flour (g)	-	-	22.32	10.00	44.64	20.00
Refined sugar (g) *	100.00	44.80	100.00	44.80	100.00	44.80
Margarine (g) *	84.81	38.00	84.81	38.00	84.81	38.00
Mineral water (ml) *	-	-	-	-	20.00	8.96
Baking powder (g) *	5.00	2.24	5.00	2.24	5.00	2.24

Source: Adapted from Aquino et al. 2010.
* Proportion of ingredients based on the flour mass.

Cookie was made with 38% fat, because, according to authors, this level provides cookies with a low breaking factor (de Moraes et al., 2010). After adequate mixing of the ingredients, mass was molded with a roll and cut with a plastic form, obtaining cookies with 6 mm thickness and 22 mm diameter, and brought to the industrial furnace (Progás PRP5000) preheated to 120°C, for 1h. After the baking time, the samples were removed and allowed to cool at room temperature.

2.2.4 Physical-chemical analysis

Flours and cookies were evaluated for moisture content, using a moisture analyzer with infrared balance (RADWAG - Model MAC 210), and water activity using Aqualab equipment. The total nitrogen content was determined by the Kjeldahl method (IAL, 2008). The ash content was analyzed using a muffle furnace at 550 °C to constant weight (IAL, 2008). The lipid content was determined by Soxhlet direct extraction method (IAL, 2008). The total carbohydrates were calculated by difference (100g - total grams of moisture, protein, fat, and ash), including alimentary fiber fraction.

2.2.5 Sensory analysis

Sensory acceptance tests were performed for color, smell, flavor, texture, appearance, and overall acceptance attributes, by hedonic scale of nine points, where nine equals the highest score "liked very much" and the minimum grade "most disliked", evaluated by 60 untrained tasters (Peryam & Pilgrim, 1957). For evaluation of purchase intent, was used structured five-point scale, where five matches "certainly buy", and one, "certainly would not buy" (Meilgaard et al., 1991). Data were submitted to analysis of variance and the averages compared by Friedman test with $P < 0.05$.

3. Results and Discussion

3.1 Physical-chemical analysis and drying kinetics curve

After drying, the flour obtained from potato present an intense yellow color, and that obtained from beets, an intense violet color, similar to the natural tone. The results of the physical-chemical parameters of potato and beet, before dried (in nature), are 87.17 and 89.21 for moisture, and 0,996 and 0,989 for Aw, respectively. After drying, the values obtaining were 3.88 and 3.78 for moisture, and 0.6766 and 0.3838 for Aw, for potato and beet respectively. Both sample's moisture content obtained is within the maximum stipulated by Resolution - CNNPA nº 12, 1978 ANVISA (Brasil, 2001), which is 14%.

It is observed that the Aw value of both samples in nature is very close. However, after drying, the beet has a lower Aw towards the potato. Even though, the possibility of creating a mixed flour of potatoes and beets indicates a significant technological potential because of these characteristics.

It can also say that the flour produced can be considered microbiologically stable because it has water activity about 0,6 or less, which is the threshold capable of permitting the growth of microorganisms (Cheng & Bhat, 2016). From the data obtained experimentally, it was possible to construct a kinetic curve for drying beet and potato, where the amount of water lost, due to the dry sample mass, is related to the time taken to dehydrate (Figure 1).

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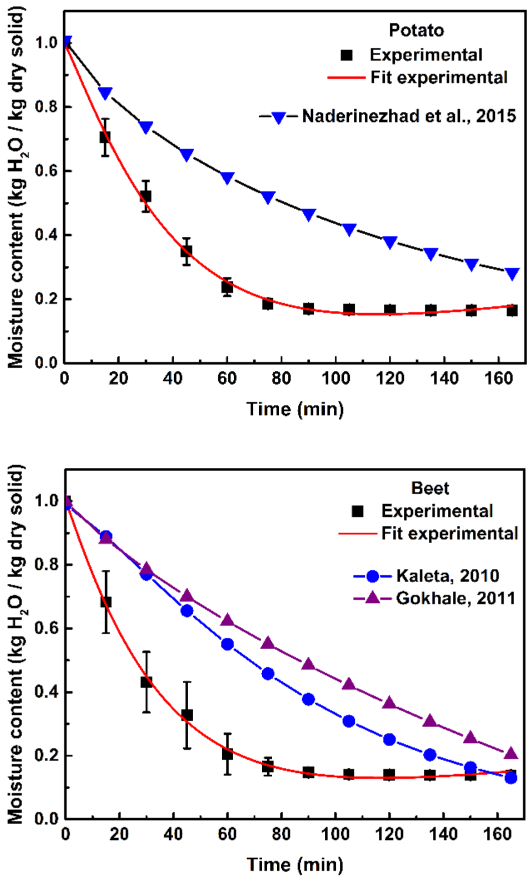
Figure 1. Drying kinetics of beet and potato in closed trays.



Source: author

As observed in Figure 1, the samples exhibited similar profiles drying, although they present different chemical constitutions. This is mainly caused by the drying conditions, where the slices are not used in the drying thick, and the high rate of convection. The samples don't exhibit an initial period corresponding to the steady-state period in which the material adapts to the drying conditions, because of little thickness of the slices, so the surface quickly reaches the humid bulb temperature, and so quickly is moisture loss. This shows that diffusion in dominant physical mechanism, governing moisture movement in the samples.

It was observed that there was a constant drying rate from 0 to 30 min (potato and beet), which is characterized by the fact that the drying speed is independent of the total moisture of the material at each instant. From time 30 to 90 min, for both samples, was showed a slow dehydration behavior, where the material reaches the critical moisture point, that is the moment when the movement of liquid inside the solid to the surface is insufficient to maintain a continuous film on the solid surface (Gokhale & Lele, 2011). Thus, the surface of the material becomes dry. Finally, the samples start the last period when the entire vapor, which is removed from the solid, shall diffuse through the solid to the surface and then through the gas stream. The data obtained in the drying process show that the loss of moisture from the potato and beet was around 83.5 and 86.2%, respectively.

The result of the regression analysis performed, to fit the experimental data, to the selected thin-layer drying model are shown in Table 2.

Table 2 - Regression analysis and fitting of experimental data to drying models.

Sample	**V m sec^{-1}**	**T °C**	***a***	***b* x10^{-3}**	***N***	***k* x10^{-2}**	***R^2***	**χ^2 x10^{-3}**	***RMSE* x10^{-2}**	**Ref.**
Potato	2.6	61	0.9978	1.05	1.12056	1.679	0.997	0.02	0.173	This paper
Potato	1.8	60	1.0080	-0.1	0.82340	1.873	0.999	0.01	0.245	(Naderinezhad, Etesami, Najafabady, & Falavarjani, 2016)
Beet	2.6	61	1.0016	0.08	1.05230	2.408	0.998	0.01	0.148	This paper
beet	1.0	60	0.9896	0.0	1.22684	0.386	0.993	1.10	3.275	(Kaleta & Górnicki, 2010)
beet	2.0	65	0.998	-13.5	0.878	0.960	0.998	0.02	0.4	(Gokhale & Lele, 2011)

Source: author

The mathematical model of Midilli gave a good correlation between the moisture ratio and drying time of sweet potato slices under the conditions of the experiments, based on parameters R^2, the lowest $\chi2$, and lowest RMSE. The results were similar to some of the literature on the drying of various food (Demiray & Tulek, 2016; Gokhale & Lele, 2011), differing only in speed that reaches the equilibrium point, because of the high rate convection.

3.2 Cookie's physical-chemical analysis

The average chemical composition of the formulations was 70.76% carbohydrates, 4.24% proteins, 22.57% fats and 1.69% minerals, with an average caloric value of 505 kcal g-1 for Type I, and Type II showed values of 70.15% carbohydrates, 6.72% proteins, 20.54% fats, and 1.86% minerals, having an average calorific value of 491 kcal g^{-1}. The results were consistent with values reported for the same type of commercially available cookies, that are 74.50% carbohydrates, 4.24% proteins, 19.04% fats and 1.64% minerals, with an average caloric value of 486 kcal g^{-1}.

The average moisture content was 0.33% and 0.73% for the formulations Type I and II, respectively, appearing close to Standard (0.58%), within the limits established by ANVISA (Brasil, 2001) with maximum humidity value 14%. Type II presented the highest moisture content since the water was added to the recipe, which is not common to other cookies. Standard cookie has moisture higher than the Type I, once in this formulation has used a greater amount of wheat flour. These results indicate that there is a greater demand for water in the mass, to hold formable characteristics when added to mixed flour.

It is observed that the number of minerals and the amount of mixed flour are directly proportional, that is, the more mixed flour, the greater the number of minerals. The same result was found by authors, in the study of cookies produced by utilizing underutilized jering (*Pithecellobium jiringa Jack.*) legume flour (Cheng & Bhat, 2016). The content of ash was shown within which determines the legislation (Resolution – Nº CNNPA 12, 1978), that is, at most 3%. About the protein content, it can be observed a gradual increase in direct proportion to the increase in the mixed flour content. For the carbohydrate content, there was a significant difference between the Standard and Type I and Type II formulations. It is believed that this result is due to the introduction of wheat flour (composed primarily of carbohydrates). It is worth emphasizing that the amount of added sugar was the same for the three formulations.

The Type I and II formulations have a caloric value significantly higher than the standard formulation, even with a smaller amount of carbohydrates, as expected, since the raw materials used have a high carbohydrate value. It's also worth mentioning that the amount of added fat was the same for the three formulations.

3.3. Sensory Analysis

3.3.1. Acceptance Testing

The results of cookie acceptance related to color, smell, flavor, texture, sweetness and overall acceptance are shown in Table 3. In general, all three formulations showed good acceptability, since obtained percentages above 70% in the acceptance region (over 6) for all the sensory attributes evaluated.

For the color attribute, Standard and Type II formulations had a percentage in acceptance region equal to or greater than 7.0 while the Type I had values slightly below 7.0. However, it demonstrates that the product different shades, due to the mixed flour percentages, not harmed significantly the consumer acceptance. However, it can be seen greater acceptance for the Standard formulation (7.32) for having a yellowish color, common of cookie, which differs from that contained mixed flour, because they had a darker color near purple, from the betacyanin - aromatic compound present in the beet. Factor also observed in the cookies made of acerola residue flour, where most of the tasters evaluated negatively the color of cookies that contained flour residue (Aquino et al., 2010).

Table 3 - Results obtained by sensory analysis of cookies

Attributes	Standard	Type I	Type II
Color	7.32 ± 1.316[a]	6.8 ± 1.424[a]	7.08 ± 1.587[a]
Smell	7.11 ± 1.473[a]	7.3 ± 1.369[a]	7.35 ± 1.459[a]
Flavor	7.36 ± 1.583[a]	7.08 ± 1.816[a]	7.05 ± 1.620[a]
Texture	7.18 ± 1.545[a]	7.18 ± 1.512[a]	7.16 ± 1.451[a]
Sweetness	7.16 ± 1.648[a]	6.9 ± 1.892[a]	7.23 ± 1.544[a]
Overall impression	7.38 ± 1.136[a]	7.08 ± 1.521[a]	7.36 ± 1.163[a]

Source: author

* Averaged ±Standard deviation

** Standard (100% wheat flour / 0% mixed flour); Type I (90% Wheat flour / 10% mixed flour); Type II (80% Wheat flour / 20% mixed flour). Different letters between the lines indicate significant difference between the samples by Friedman test.

Regarding the smell of cookies, Type II obtained the highest score (7.35), followed by Type I (7.30) and Standard (7.11). This demonstrates that the highest proportion of mixed flour in the formulation was directly involved in the acceptance of cookie smell, making the product more accepted concerning this attribute. As for the texture attribute, type II had the smallest note in the acceptance region (7.16) behind the type I and Standard, with the same note (7.18). This can be evidenced by the increased amount of mixed flour in Type II formulation, which may have compromised the crispness of the product.

As for flavor, the highest proportion of mixed flour, made the product less accepted, with notes of 7.36; 7.08 and 7.05 for Standard, Type I and Type II formulations, respectively. This result can be attributed to low consumer acceptance by one of the components of the mixed flour (beet), where 23.34% of the tasters said they never consumed. However, the three formulations showed in the area of acceptance.

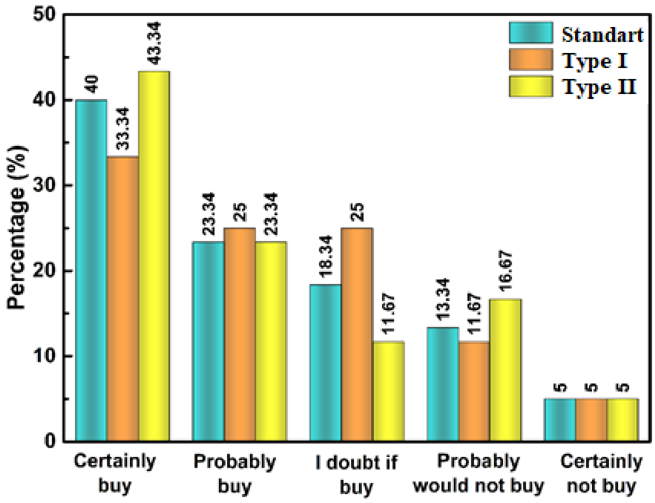
As to the sweetness attribute, the Standard and Type II formulations presented with higher scores, 7.16 and 7.23 respectively, which didn’t happen with type I, which obtained an average score of 6.9. This result is contradictory when it calls attention to the fact that the raw materials that compose the mixed flour are naturally sweet. One possible explanation for this result is the fact that non-acceptance of Type I cookie due to small amount of mixed flour. However, Type II showed as expected, in which the amount of sugar present in the raw materials adds sweetness to the final product.

The overall impression is the general perception of the tasters about this product. According to the data, the Standard and the Type II formulations showed very close scores of 7.38 and 7.36 respectively, while the Type I formulation was obtained 7.08. Taking into account that 23.34% of the tasters dislike beets, the acceptance of the cookie was satisfactory, since all formulations presented more than 70.00% of the notes in the acceptance region for this attribute. A similar result was found in the study of gluten-free cookies made from whole Indian quinoa flour (Jan et al., 2018) and cookies with almond cold-pressed oil by-product (Barreira et al., 2019), where the acceptance of cookies produced, were satisfactory.

3.3.2. Buy intention

The results for the intention of buying the cookie made from flour mixed potato and beets are shown in Figure 2.

Figure 2. The tasters purchase intent for three cookie formulations.



Source: author

The assessment shows that the three formulations showed good purchase intent, that’s it, that consumers would buy the product, confirming the acceptance percentages presented in the sensory attributes analyzed. The Type II formulation obtained the least intention of purchase, between samples, in "definitely buy", followed by the standard formulation, and the item "probably buy", the sample type I stood out, with 25% acceptance. Standard and Type II cookies were better evaluated in the overall impression attribute and are accepting reflected in the purchase intent of the two formulations (Figure 2).

4. Final considerations

The Midilli model describes the drying kinetics with a good adjustment parameter. An average calorific value was found consistent with the calorific values of cookies on the market. Regarding the sensory characteristics evaluated, it was observed that the form of insertion of mixed flour positively influenced the sensory characteristics of the cookies, presenting values within the area of consumer acceptance. This factor directly influenced the purchase intention, which presented scores above 7.0. Concerning the two formulations containing mixed flour,

Type II was better evaluated sensorially and nutritionally, due to the higher percentage of potatoes and beets present in the formulation. Thus, it can be noted that a cookie made with mixed potato and beet flour is very promising, taking into account the variety of additional nutrients in the raw materials (mainly minerals) and consumer acceptance for this new product. For the future, rheology analyzes could be carried out, with the aim of improving the texture of the cookie or even replacing the sugar with a sweetener, aiming at a light product.

Conflicts of interest
All authors declare no competing interests.

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Referências

Aquino, A. C. M. de S., Móes, R. S., Leão, K. M. Ma., Figueiredo, A. V. D., & Castro, A. A. (2010). Avaliação físico-química e aceitação sensorial de biscoitos tipo cookies elaborados com farinha de resíduos de acerola Physical-chemical and sensory characteristics of cookies formulated with acerola (Malpighia emarginata D.C.) residues flour. *Rev Inst Adolfo Lutz*, *69*(3), 379–86.

Barreira, J. C. M., Nunes, M. A., da Silva, B. V., Pimentel, F. B., Costa, A. S. G., Alvarez-Ortí, M., Pardo, J. E., et al. (2019). Almond cold-pressed oil by-product as ingredient for cookies with potential health benefits: Chemical and sensory evaluation. *Food Science and Human Wellness*.

Brasil. (2001). *RESOLUÇÃO-RDC Nº 12, DE 02 DE JANEIRO DE 2001*. *ANVISA - Agência*

Nacional de Vigilância Sanitária. Retrieved August 29, 2017, from http://portal.anvisa.gov.br/documents/33880/2568070/RDC_12_2001.pdf/15ffddf6-3767-4527-bfac-740a0400829b

Cao, Y., Zhang, F., Guo, P., Dong, S., & Li, H. (2019). Effect of wheat flour substitution with potato pulp on dough rheology, the quality of steamed bread and in vitro starch digestibility. *LWT - Food Science and Technology*, *111*(October 2018), 527–533. Elsevier. Retrieved from https://doi.org/10.1016/j.lwt.2019.01.034

Capriles, V. D., Coelho, K. D., Matias, A. C. G., & Arêas, J. A. G. (2006). Efeito Da Adição De Amaranto Na Composição E Na Aceitabilidade Do Biscoito Tipo Cookie E Do Pão De Forma. *Alimentos e Nutrição*, *17*(3), 269–274.

Charmongkolpradit, S., & Luampon, R. (2017). Study of Thin Layer Drying Model for Cassava Pulp. *Energy Procedia*, *138*, 354–359. Elsevier B.V. Retrieved from https://doi.org/10.1016/j.egypro.2017.10.138

Cheng, Y. F., & Bhat, R. (2016). Functional, physicochemical and sensory properties of novel cookies produced by utilizing underutilized jering (Pithecellobium jiringa Jack.) legume flour. *Food Bioscience*, *14*, 54–61. Elsevier. Retrieved from http://dx.doi.org/10.1016/j.fbio.2016.03.002

Demiray, E., & Tulek, Y. (2016). Degradation kinetics of β-carotene in carrot slices during convective drying. *International Journal of Food Properties*, *20*(1), 151–156.

Filho, D. G. de A., Eidam, T., Borsato, A. V., & Raupp, D. da S. (2011). Processamento de produto farináceo a partir de beterrabas submetidas à secagem estacionária. *Acta Scientiarum. Agronomy*, *33*(2), 207–214.

Giuberti, G., Rocchetti, G., Sigolo, S., Fortunati, P., Lucini, L., & Gallo, A. (2018). Exploitation of alfalfa seed (Medicago sativa L.) flour into gluten-free rice cookies: Nutritional, antioxidant and quality characteristics. *Food Chemistry*, *239*, 679–687. Retrieved from http://dx.doi.org/10.1016/j.foodchem.2017.07.004

Gokhale, S. V., & Lele, S. S. (2011). Dehydration of red beet root (Beta vulgaris) by hot air drying: Process optimization and mathematical modeling. *Food Science and Biotechnology*, *20*(4), 955–964.

IAL, I. A. L.-. (2008). *Métodos físicos-químicos para análise de alimentos* (IV.). São Paulo.

Jan, K. N., Panesar, P. S., & Singh, S. (2018). Optimization of antioxidant activity, textural and sensory characteristics of gluten-free cookies made from whole indian quinoa flour. *Lwt*, *93*, 573–582. Elsevier Ltd. Retrieved from https://doi.org/10.1016/j.lwt.2018.04.013

Kaleta, A., & Górnicki, K. (2010). Some remarks on evaluation of drying models of red beet particles. *Energy Conversion and Management*, *51*(12), 2967–2978. Elsevier Ltd. Retrieved from http://dx.doi.org/10.1016/j.enconman.2010.06.040

Kaur, P., Sharma, P., Kumar, V., Panghal, A., Kaur, J., & Gat, Y. (2018). Effect of addition of flaxseed flour on phytochemical, physicochemical, nutritional, and textural properties of cookies. *Journal of the Saudi Society of Agricultural Sciences*. King Saud University. Retrieved from https://doi.org/10.1016/j.jssas.2017.12.004

Kopper, A. C., Paola, A., Saravia, K., Ribani, R. H., Maria, G., Caldas, A., Acrocomia, R. A., et al. (2009). Utilização tecnológica de farinha de bocaiuva na elaboração de biscoitos tipo cookie. *Alim. Nutr. v. 20, n. 3, p. 463-469*, (March 2015), 463–469.

Liu, X. li, Mu, T. hua, Sun, H. nan, Zhang, M., & Chen, J. wang. (2016). Influence of potato flour on dough rheological properties and quality of steamed bread. *Journal of Integrative Agriculture*, *15*(11), 2666–2676. Chinese Academy of Agricultural Sciences. Retrieved from http://dx.doi.org/10.1016/S2095-3119(16)61388-6

Meilgaard, M., Civille, G. V., & Carr, B. T. (1991). *Sensory evaluation techniques* (2nd ed.). Flórida: CRC Press.

Midilli, A., Kucuk, H., & ZA, Y. (2002). A new model for single-layer drying. *DRYING TECHNOLOGY*, *20(7)*, 1503–1513.

de Moraes, K. S., Zavareze, E. da R., de Miranda, M. Z., & Salas-Mellado, M. de las M. (2010). Avaliação tecnológica de biscoitos tipo cookie com variações nos teores de lipídio e de açúcar. *Ciencia e Tecnologia de Alimentos*, *30*(SUPPL. 1), 233–242.

Naderinezhad, S., Etesami, N., Najafabady, A. P., & Falavarjani, M. G. (2016). Mathematical modeling of drying of potato slices in a forced convective dryer based on important parameters. *Food Science and Nutrition*, *4*(1), 110–118.

Peryam, D. R., & Pilgrim, F. J. (1957). Hedonic scale method of measuring food preferences. *Food Technology*, *11*, *Suppl.*, 9–14.

Sulieman, A. A., Zhu, K. X., Peng, W., Hassan, H. A., Mahdi, A. A., & Zhou, H. M. (2019). Influence of fermented and unfermented Agaricus bisporus polysaccharide flours on the antioxidant and structural properties of composite gluten-free cookies. *Lwt*, *101*, 835–846. Elsevier Ltd. Retrieved from https://doi.org/10.1016/j.lwt.2018.11.007

Vasconcellos, J., Conte-Junior, C., Silva, D., Pierucci, A. P., Paschoalin, V., & Alvares, T. S. (2016). Comparison of total antioxidant potential, and total phenolic, nitrate, sugar, and organic acid contents in beetroot juice, chips, powder, and cooked beetroot. *Food Science and Biotechnology*, *25*(1), 79–84.

Zhao, J., Liu, X., Bai, X., & Wang, F. (2019). Production of biscuits by substitution with different ratios of yellow pea flour. *Grain & Oil Science and Technology*, 101770. Retrieved from https://doi.org/10.1016/j.scs.2019.101770

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