Cookies developed with malted barley residue: nutritional composition and health benefits

Biscoitos desenvolvidos com resíduo de cevada maltada: composição nutricional e benefícios para a saúde

Received: 2023-11-15 | Accepted: 2023-12-18 | Published: 2023-12-22

Jaqueline Andrea Custódio Trevizan
ORCID: https://orcid.org/0000-0002-2702-4868
Universidade Unicesumar, Brasil
E-mail: jaqueline.trevizan@unicesumar.edu.br

Denise Bertin Carnevalli
ORCID: https://orcid.org/0000-0002-2971-0247
Universidade Unicesumar, Brasil
E-mail: debertin@hotmail.com

Ariana Ferrari
ORCID: https://orcid.org/0000-0001-7843-8019
Universidade Unicesumar, Brasil
E-mail: ariana.ferrari@unicesumar.edu.br

Daniele Fernanda Felipe
ORCID: https://orcid.org/0000-0001-9028-0728
Universidade Unicesumar, Brasil
E-mail: daniele.felipe@unicesumar.edu.br

ABSTRACT

Malted barley residue (malt bagasse) is obtained in the brewing process and due to its nutritional potential, can be an alternative ingredient for food composition. The objective of the present study was to develop cookies using malt bagasse bran as an ingredient. The cookies were produced and submitted to physicochemical analyses: moisture content, ash determination, minerals, protein, lipid, fiber, carbohydrate and energy value. The addition of malt bagasse bran in the cookie promoted an increase in the nutritional quality of the product, making the product rich in fiber, minerals (phosphorus, zinc and iron), and low in sodium. The cookie presented omega-9 monounsaturated fatty acid and considerable amount of proteins. Thus, malt bagasse bran has the potential to be used as a functional ingredient for products such as cookies.

Keywords: Malt Bagasse; Food Product; Fiber; Minerals.
RESUMO

O resíduo de cevada maltada (bagaço de malte) é obtido no processo de fabricação de cerveja e devido ao seu potencial nutricional, pode ser uma alternativa de ingrediente para composição de alimentos. O objetivo do presente estudo foi desenvolver biscoitos com farelo de bagaço de malte como ingrediente. Os biscoitos foram produzidos e submetidos às análises físico-químicas: teor de umidade, determinação de cinzas, minerais, proteínas, lipídios, fibras, carboidratos e valor energético. A adição de farelo de bagaço de malte no biscoito promoveu um aumento na qualidade nutricional do produto, tornando-o rico em fibras, minerais (fósforo, zinco e ferro), e com baixo teor de sódio. O biscoito apresentou ácido graxo monoinsaturado ômega-9 e quantidade considerável de proteínas. Assim, o farelo de bagaço de malte tem potencial para ser utilizado como ingrediente funcional para produtos como biscoitos.

Palavras-chave: Bagaço do Malte; Produto Alimentício; Fibras; Minerais.
INTRODUCTION

Malt bagasse, also called malted barley residue, is the main waste generated in the production process of the beer, and it is important to seek ways to reuse this waste. This residue has been discarded in nature causing damage to the environment, or used as animal feed due to its nutritional benefits and relatively low cost (Stefanello et al., 2014; Trujillo et al., 2018).

The generation of organic waste corresponds to about half of the total urban solid waste, most of which originates from the food sector. Among the various indirect environmental impacts of solid waste are the risks of contamination of groundwater and damage to the health of the population (Viana, 2021). Its disposal in the soil, in dumps or landfills, for example, constitutes an important source of human exposure to various toxic substances, such as exposure to organic compounds and heavy metals. Offering several risks to human health, such as increased risk of cancer, congenital anomalies, or even transmission of infectious diseases (Gouveia, 2012).

To avoid waste, there is a need to find new reuse techniques. Considered the malt bagasse, in the literature there are studies to replace wheat flour with malt bagasse flour. Research on the proximate composition indicated that there is a high content of fiber and protein in its composition, in addition to ash and lipids (Melo; Manfio; Rosa, 2016).

The partial or total replacement of wheat flour by malt bagasse flour is a viable alternative, due to its nutritional value. In bakery, industries are interested in this ingredient, mainly aiming at the environmental, economic and nutritional importance, mainly because it is a source of fiber (Mastanjević et al., 2019; Panzarini et al., 2014). In the research by Ktenioudaki et al. (2012), it was reported that with malt bagasse added in the preparation of a bakery product, an increase in fiber content can be verified when bagasse is added in relation to the product made only with wheat flour. A study carried out by Trevizan et al. (2021) reported that malt bagasse bran had a high content of fiber, proteins and minerals, mainly phosphorus, in addition to a significant amount of potassium, iron and calcium and low sodium content.

The high fiber content and some micronutrients brings nutritional and functional health benefits, making the cookie a healthier and more practical food option for human consumption. The high fiber content has benefits for intestinal health, which is related to metabolic regulation (Koh et al., 2016; Makki et al., 2018) and to the control of some chronic diseases, such as type 2 diabetes mellitus, neurodegenerative diseases and
cardiovascular diseases (Myhrstad et al., 2020; Needham; Kaddurah-Daouk; Mazmanian, 2020).

The execution of this study is important because the elaboration of a cookie with the residue obtained from the brewing production demonstrates that there can be better use of the residue with high nutritional value. Thus, considering the nutritional properties of malt bagasse, in addition to the need to find a sustainable way to reuse this residue, the present study aimed to develop a cookie using malt bagasse bran as an ingredient of the formulation.

MATERIALS AND METHODS

Malt Bagasse Processing

To carry out the research, the malt bagasse, which was obtained from the production of a Pilsen-type beer, was purchased at a specific craft brewery, located in the city of Maringá-PR-Brazil. The residue was sent to the laboratory of the university, where the malt bagasse was weighed and then dried. The drying process was carried out in a forced ventilation oven at 70°C for 38 hours, at the same temperature and time used by Rigo et al. (2017). After drying, the residue was passed through 2 mm sieve and then, packed in hermetically sealed containers, being called malt bagasse bran.

Development of cookie

The formulation of the developed cookie presented the following ingredients: malt bagasse bran (40%), refined sugar (14.5%), brown sugar (15.5%), unsalted butter (19.5%), eggs (9.5%), vanilla essence (0.4%), sodium bicarbonate (0.3%), salt (0.1%) and potassium sorbate (0.2%).

First, the butter and sugars were homogenized, after adding the eggs and then the vanilla essence. Afterwards, the other ingredients were added. The cookies were placed in containers and refrigerated for approximately 24 hours. After cooling, they were portioned and taken to a convection oven preheated to 175°C for approximately 10 minutes. Then they were transferred to a rack for complete cooling. After cooling, the
cookies were placed in hermetically sealed glass containers. The yield was 40 cookies of 30 g.

**Nutritional composition of cookie containing malt bagasse bran**

The analysis of the nutritional composition of the cookie containing the malt bagasse bran, which was previously crushed, was performed. All analyzes were performed in triplicate.

The moisture content was determined by the gravimetric method, based on the weight loss of the material submitted to heating in an oven at 105°C until constant weight. The ash content (fixed mineral residue) was determined by incinerating the material in muffle at 550°C until constant weight. The determination of mineral elements (zinc, sodium, iron, phosphorus, manganese, calcium and potassium) was performed using atomic emission spectrometry (spectrophotometer Varian®) with argon plasma inductively coupled with optical detection (ICP-OES), using the specific instrumental parameters for each mineral (Instituto Adolfo Lutz, 2008). To determine minerals in the sample by this method, it is necessary to make the analytes available in solution by means of prior mineralization of the sample, and subsequent dissolution of the residues with mineral acids.

The amount of dietary fibre was determined by the enzymatic-gravimetric method. The protein content of the cookie was calculated by determining the percentage of total nitrogen in the sample, according to the Kjeldahl method, considering 5.75 as a conversion factor for the calculation of crude protein. The Kjeldahl method is based on three stages: digestion, distillation and titration of the sample. The amount of nitrogen present in the sample is determined by titrating the excess of the acid used in the distillation with sodium hydroxide. The amount of carbohydrate was calculated by difference, subtracting from 100 the contents in percentage of humidity, ashes, total fats, protein and total dietary fibre (Instituto Adolfo Lutz, 2008).

The total fat content was determined by the Soxhlet method, using the Soxhlet extractor (Tecnal®) and petroleum ether as organic solvent to extract the lipids present in the sample, followed by removal of the solvent by evaporation (Instituto Adolfo Lutz, 2008). The composition of saturated and unsaturated fatty acids was determined by gas chromatography with a flame ionization detector, using instrumental parameters according to the methodology of Instituto Adolfo Lutz (2008).
The energy value was calculated by adding the percentages of protein and carbohydrates multiplied by factor 4 (Kcal/g) plus the total fat content multiplied by factor 9 (Kcal/g) (Brasil, 2003).

Statistical analysis

All of the experiments were performed in triplicate, and mean values and standard deviations were calculated using GraphPad Prism v. 5.0 software (GraphPad, San Diego, CA, USA).

RESULTS AND DISCUSSION

Development of cookie

The traditional cookie formulation consists of the ingredients wheat flour, refined sugar, vegetable fat, eggs, salt, chemical yeast, chocolate and sodium bicarbonate (Weege et al., 2017). In the present study, some traditional ingredients were replaced, such as wheat flour, which was replaced by malt bagasse bran because it had the nutritional benefits mentioned above. In addition, some ingredients were added, such as brown sugar, which is rich in nutrients such as minerals and vitamins, in addition to not having the addition of chemical agents (Rojas; Perez, 2014). Potassium sorbate was used because it is an antimicrobial preservative (Rebonatto et al., 2018).

Nutritional composition of cookie containing malt bagasse bran

The results of the analysis of the nutritional composition of cookies prepared with malt bagasse bran are presented in Table 1.
Table 1 – Nutritional composition of cookies containing malt bagasse bran.

<table>
<thead>
<tr>
<th>Centesimal composition</th>
<th>Values g/100 g of sample</th>
<th>Values g/portion of 30 g of sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>11.70±0.11ª</td>
<td>3.51</td>
</tr>
<tr>
<td>Ashes</td>
<td>1.15±0.00ª</td>
<td>0.35</td>
</tr>
<tr>
<td>Dietary Fiber</td>
<td>10.12±0.07ª</td>
<td>3.04</td>
</tr>
<tr>
<td>Proteins</td>
<td>4.74±0.15ª</td>
<td>1.42</td>
</tr>
<tr>
<td>Total fat</td>
<td>24.26±0.26ª</td>
<td>7.28</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>48.03b</td>
<td>14.41</td>
</tr>
<tr>
<td>Energy value (kcal)</td>
<td>429c</td>
<td>129</td>
</tr>
</tbody>
</table>

ª Mean ± standard deviation; b Calculation by difference: 100 – (g/100g moisture + g/100g ashes + g/100g total fat + g/100g protein + g/100g total dietary fiber); c The energy value of the sample was calculated by adding the percentages of protein and carbohydrates multiplied by factor 4 (kcal/g) added to the total fat content multiplied by the factor 9 (kcal/g).

Considering the moisture content, the value was 11.70%, within the value established in Resolution RDC nº 263 (Brasil, 2005), which recommends that the moisture content of cookies and crackers should be at most 15%. The adequate moisture content of the cookie developed can be considered of great importance, since the water content in a food favors the proliferation of microorganisms. Products that contain lower moisture content may have a longer shelf life compared to those with high moisture (Silva, 2019). The moisture content of the food must be analyzed as it can serve as evidence of product quality, thus ensuring an increase in the storage and conservation time of this product (Raschen et al., 2014).

In a study carried out with the addition of malt bagasse in the preparation of cake, Panzarini et al. (2014) observed that the greater amount of this ingredient in the formulation, greater moisture content is observed in the elaborated product. This is because, the greater amount of fibers in a formulation, increases the water retention, because during the cooking process they retain water in their structure.

As for the ash content, the cookies presented a value of 1.15%, which is close to the value of 1.97% described by Rigo et al. (2017), when making cookies with 30% malt bagasse flour. Part of this mineral content is due to the presence of malt bagasse, which has a considerable amount of these.

The analysis of the mineral components of the cookie developed (Table 2) showed the presence of zinc, sodium, iron, phosphorus, manganese, calcium and potassium, with phosphorus being the mineral in the highest concentration (147 mg/100 g). The considerable increase in sodium (136 mg/100 g) and potassium (125 mg/100 g) minerals...
was probably due to the use of sodium bicarbonate (used to give volume and lightness to the dough) and potassium sorbate in the formulation of cookie developed.

**Table 2** – Minerals analyzed in cookies containing malt bagasse bran.

<table>
<thead>
<tr>
<th>Minerals</th>
<th>Content (mg/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphor</td>
<td>147</td>
</tr>
<tr>
<td>Sodium</td>
<td>136</td>
</tr>
<tr>
<td>Potassium</td>
<td>125</td>
</tr>
<tr>
<td>Calcium</td>
<td>59.1</td>
</tr>
<tr>
<td>Iron</td>
<td>10.3</td>
</tr>
<tr>
<td>Zinc</td>
<td>4.38</td>
</tr>
<tr>
<td>Manganese</td>
<td>1.36</td>
</tr>
</tbody>
</table>

In the study carried out with breads containing malt bagasse, Ktenioudaki et al. (2015) found the levels of potassium 98.9 mg/100 g, iron 1.6 mg/100 g and zinc 0.6 mg/100 g, which were lower than the values of the present research, with levels of 125 mg/100 g, 10.3 mg/100 g and 4.38 mg/100 g, respectively.

According to Resolution RDC nº54 (Brasil, 2012), the cookie containing malt bagasse bran is considered a food rich in iron, zinc and manganese minerals, since it provides more than 30% of the recommended daily intake values for these nutrients, described in Resolution nº360 (Brasil, 2003). With regard to phosphorus, the prepared cookie is considered a food that is a source of this mineral, as it provides a value of 21% of the recommended daily intake value for this nutrient, being greater than the minimum value of 15% recommended (Brasil, 2003). Considering the minerals calcium and potassium, these are present in low amounts in the cookie, with values of 5.91% and 3.57%, respectively, below the minimum value of 15%.

As for the sodium content, a value of 136 mg/100 g was found, which corresponds to 40.8 mg per serving, being classified the cookie containing malt bagasse as a food with low sodium content, according to Resolution RDC nº54 (Brasil, 2012), since it was lower than the value of 80 mg per serving. It is only mandatory to declare sodium on the nutritional labeling of foods and the declaration of other minerals can only be made optionally if they are present in amounts equal to or greater than 5% of the Recommended Daily Intake per serving indicated on the label (Brasil, 2003).

Regarding the fiber content, the cookie developed with malt bagasse bran presented a value of 10.12%, which corresponds to 12% of the recommended daily value, being classified as a food rich in fiber, according to Resolution RDC nº 54 (Brasil, 2012),
as it is a value greater than 6%. A similar result was found by Panzarini et al. (2014), in which the fiber content of the cake containing 10.5% of malt bagasse was 11%.

Kteniudaki et al. (2015) in a study carried out with malt bagasse flour added to bread formulations in different percentages, it was observed that as malt bagasse flour is a material considered rich in fiber, it consequently improved the fiber content of breads produced. In the study carried out by these researchers, the value of fiber found in breads with 15% addition of malt flour was 11.9%. According to Kteniudaki et al. (2013), the addition of malt bagasse increases both the fiber content and the protein content of foods. Therefore, the addition of malt bagasse bran in the cookies developed justifies the high fiber content found.

Fiber consumption is recognized for its benefit on intestinal health. Diet components, including fiber, can influence the bacterial composition of the intestinal microbiota and the metabolites derived from microorganisms. Thus, also influencing the body metabolic regulation (Koh et al., 2016; Makki et al., 2018). Some chronic diseases of great public health importance, such as type 2 diabetes mellitus, neurodegenerative diseases and cardiovascular diseases have been associated with intestinal dysbiosis (Myhrstad et al., 2020; Needham; Kaddurah-Daouk; Mazmanian, 2020). The cookie developed can then be a healthier option that can be included in the diet of these patients, in view of its functional and nutritional benefits.

Considering the protein content, the cookie containing the malt bagasse bran presented the value of 4.74%, and can be classified as a food with low protein content, as it would have to present a content of at least 6 g/100 g, to be a protein source, according to Resolution RDC nº 54 (Brasil, 2012). In a study carried out by Weege et al. (2017), in which the cookies were developed with 20% malt bagasse, the protein content was 2.35 g per serving of 30 g of cookie, while in the present study the value of 1.42 g was found per serving.

In relation to carbohydrate content, the value found in cookies developed was 48.03%, corresponding to 14.41 g per serving. According to Resolution RDC nº 54 (Brasil, 2012), it can be considered that the cookie with malt bagasse bran has a high carbohydrate content, as a value higher than 5 g/100 g was found. The addition of refined sugar and brown sugar, in addition to malt bagasse, contributed to this high content, which corresponds to 5% of the recommended daily value. The value found was lower than the value found by Rigo et al. (2017), which was 53.39%. Weege et al. (2017), reported a
content of 10.29 g per serving of 30 g of cookie, which is a lower value than that found in the present study.

The total fat content of the cookie developed with malt bagasse bran was 24.26% and considering the value per serving of 30 g of cookie, the value was 7.28 g. In this way, the cookie developed in the present study can be classified, according to Resolution RDC nº54 (Brasil, 2012), as a food with a high content of total fat, as it has a content higher than 3g/100 g, corresponding to 13% of recommended daily value. The value found was higher than that found by Rigo et al. (2017), which was 21.03% and the value was higher than the content of 6 g per serving of cookie developed in the study by Weege et al. (2017). Ktenioudaki et al. (2012) reported that the use of malt bagasse as an ingredient increases the fat content of foods.

Considering the analysis of total fat, the value of 13.90% (4.17 g per serving of 30 g) of saturated fats (19% of the recommended daily value) was identified, corresponding mainly to palmitic acid fatty acids (6.90%), stearic acid (2.51%) and myristic acid (2.28%). This value found allows the cookie developed not to be considered a food with low content of saturated fats, because according to Resolution RDC nº54 (Brasil, 2012), it would have to present a maximum value of 1.5 g of the sum of saturated fats and trans per serving.

As for unsaturated fats, 6.06% of monounsaturated fatty acids were found, mainly oleic acid (5.48%), called omega 9. According to Resolution RDC nº54 (Brasil, 2012), a food can be considered a source of omega 9 when it has at least 2 g per serving, which is close to the value found of 1.64 g per serving of the cookie developed, thus contributing to the daily intake of omega 9.

Regarding polyunsaturated fatty acids, they are in a smaller amount in the cookie, being identified linolenic acid (0.17%), which is omega 3 and linoleic acid (1.41%), which is omega 6. Considering the amount of trans fats, 0.88% (0.26 g per serving) was found, a value higher than that described in Resolution RDC nº54 (Brasil, 2012), which establishes the amount of up to 0.1 g per serving to be considered as a product that does not contain trans fats.

In a study carried out by Waters et al. (2012), the total fats of malt bagasse were analyzed and saturated fats were found in high concentration, especially the saturated fatty acids that were identified in the present study (palmitic acid, stearic acid and myristic acid). In addition, it showed a high concentration of monounsaturated fatty acid, oleic acid, and also found polyunsaturated fatty acids, linolenic acid and linoleic acid. This
shows that most of the fat found in the developed cookie was due to the presence of malt bagasse bran, being one of the main ingredients that contributed to the high content of total fat, saturated and unsaturated fats.

As for the energy value of cookies with malt bagasse bran, it was found that 100 g of the product has 429 Kcal and, in 30 g per serving, this value is equal to 129 Kcal, representing 6% of the recommended daily value. According to Resolution RDC nº54 (Brasil, 2012), a food has a low energy value when it has a value lower than 40 Kcal per serving. The value found was higher than the value found by Weege et al. (2017), which was 72 Kcal per serving of 30 g of cookie developed with 20% of malt bagasse. According to Rigo et al. (2017), one of the ingredients that increases the energy value of cookies is fat.

Thus, the cookies developed present nutritional benefits, as they are considered a product rich in fiber and in some micronutrients such as iron, zinc and manganese, which are essential for health, in addition to having other important nutrients. The literature has increasingly demonstrated the low intake of healthy foods by the general population (Batista et al., 2020). Consequently, leading to an insufficient daily intake by the population, given the importance mainly in pregnant women, children and the elderly. Therefore, the importance of thinking about healthier food alternatives and naturally enriched with essential nutrients for human health (Popkin; Corvalan; Grummer-Strawn, 2020).

Therefore, the use of malt bagasse bran in the formulation of cookie developed, promoted an increase in the nutritional quality of the product. This demonstrates that it is a raw material of interest to the food industry, and may even partially or totally replace the traditional flours used. With methods that preserve nutritional characteristics, malted barley residue can be an important ingredient in the production of breads, cakes and cookies, among other preparations, as reported by Trevizan et al. (2021).

**FINAL CONSIDERATIONS**

In view of the above, the addition of malt bagasse bran in the cookie developed, promoted an increase in the nutritional quality of the product, making the product rich in fiber, also in important minerals for our body, such as phosphorus, zinc and iron, low sodium content, in addition to having omega 9 monounsaturated fatty acid, and a considerable amount of protein. In addition, the product showed microbiological quality
Thus, malt bagasse has the potential to be used as a functional ingredient for products such as cookies.

REFERENCES


