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Physical and chemical characteristics of cheese bread, using fermented broken rice

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Abstract

Development of new food products, taking as raw material the subproducts obtained during industrial process become an economic and nutritious alternative, since these are usually discarded, caning be a significant nutritional source good. This research aimed to develop cheese bread using fermented broken rice instead of sour starch in four different concentrations (0%, 25%, 50%, 75% and 100%). After the development of formulations, was performed physics and chemicals characterization of products obtained, performing analysis of: proximate composition, dietary fiber, acidity, pH, °Brix, total soluble sugars, reducing and sucrose. The increased formulations didn't present significant differences, highlighting the average values of protein 7%, dietary fiber 9% and ash 1.9%. Broken rice, after fermentation process, becomes a profitable alternative instead of the sour starch on cheese breads, saving all the physical and chemical characteristics and being inexpensive.

Keywords: subproducts; fermentation; physical characteristics; rice.

Practical Application: Development of new food products with high added value has become a challenge for food industry, since the nutritional quality of the same, will depend on the raw material used. Thus, the knowledge of news raw material rich in bioactive compounds and high nutritional content, involving in this context the use of subproducts from agro-industrial processes is essential in the obtainment of new food products with a good source of nutrients with great importance in the daily alimentation, contributing in the aggregation value for the subproducts originated from food process.

1 Introduction

Cheese bread is a product from Brazilian culinary, originated in Minas Gerais State, Brazil, largely known and consumed worldwide, being exported for several countries in Europe, Latin America, Japan, United States, among others. Formulations variety of this product is given mainly to its commercial expansion, going by adaptations in each place which it is found. Therefore, "the true cheese bread from Minas Gerais" has several different formulations, having no identity, quality and product manufacturing standards (Pereira et al., 2010). Thus, it is possible to increase new ingredients or raw materials for the use of subproducts generated during food processing, it becomes a viable alternative, bringing economic alternatives as well as an improved nutritional quality of the product developed.

According to data released by the Foreign Agricultural Service of United States Department of Agriculture (2014) is provided for consumption, in 2014/15 harvest, the total of 2,143.3 million tons of grain in the world. Rice, on it processed form, will participate with 479.1 million tons, or 22.35% of the quantitative. Among products intended for human consumption, it is second in importance, behind only to wheat, and in some parts of the world, especially in Asia, it is the staple food of their population (Companhia Nacional de Abastecimento, 2014). This growing rice consumption, combined with its nutritional characteristics and functional properties such as the ability to deliver smooth flavor and hypoallergenicity, making a desirable grain to be used in enriched products (Bryant et al., 2001), which demonstrates its global importance as food source, representing a food with potential to fight world hunger. In Brazil, rice is consumed in the form of entire grains, preferably in polished white, polished parboiled and whole forms, being an excellent source of energy due to high starch concentration, providing also, protein, vitamins and minerals, containing a low content of lipids.

Main stages of rice processing include grain peeling (peel represents 20 to 22% of its total weight), the honing and polishing. The whole grain, as classified after peeling step, goes through honing and polishing steps, which are removed, partially or completely, the embryo and most of the film which covers the grain. This step, results the rice bran, representing, approximately, 8% of the volume of product in peel or 10% of the peeled product. Then there is a separating step of broken (14%) and entire (58%) grain fraction, being classified the broken grains in large, medium and broken rice (Zhai et al., 2001). Broken rice is rejected by the consumer market and, for the most part, is intended for animal feed, for brewing industry, fertilizer etc. Forms of use of this product generated during rice processing, aiming to add value to it, is necessary since incorporation of these in food formulations could solve the great waste arising rice processing, and become an alternative form of income. According to Tavares et al. (2016), broken rice is a high quality

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product having protein and metabolizable energy levels similar to corn, lysine and methionine levels slightly higher than this grain, besides having a good amount of starch, which provides nutritional and technological importance. Therefore, broken rice has good constitution in starch and could be better used in the form of flour for preparation of processed foods such as breads, cookies, simple extracts and compounds with fruit pulp, fermented beverages, desserts etc. One of the alternatives to add value to broken rice and minimize economic losses to rice industry is production of broken rice flour, modified for cheese bread production, since rice starch and broken rice is thin, non-allergenic and white, with smooth taste and, therefore, it may be used in bakery and confectionery (Carvalho et al., 2006).

Given the above, in order to use and add value to broken rice, this study aimed to develop cheese bread, corporate with fermented broken rice, replacing the flour starch at five different concentrations (0%, 25%, 50%, 75% and 100%), evaluating the physical and chemical characteristics.

2 Material and methods

Was used the broken rice, acquired by donation of an rice processing industry located in Barreiras, Bahia, in the period February-March, 2014.

2.1 Broken rice preparation

The broken rice was ground in an industrial blender and allowed to steep in clear water at room temperature (30 °C), for five days. Then, filtered in mesh and allowed to dry in the sun, obtaining the fermented broken rice, which was stored for later chemical and physical analysis.

2.2 Development of cheese bread

Development of cheese breads was used the standard formulation for this type of product, containing 600 g of sour starch, 400g of milk, 150 ml of oil, 200 g of grated minas cheese and 4 large eggs (Silva et al., 2009). Five treatments were performed with following proportions of fermented broken rice, replacing the sour starch at 0%, 25%, 50%, 75% and 100%.

Oil was placed along with the milk to the fire until it boils. Then poured this emulsion on sour starch with fermented broken rice and scalded until complete cooling. Then, it was added the eggs one by one, and lastly the cheese and kneaded until complete homogeneity of paste. Cheese breads were wrapped in spherical form and taken to baking in a preheated oven for 45 minutes at 200 °C, then after developed, physical and chemical analysis were performed.

2.3 Physical and chemical analysis

Determination of moisture, ash, lipids, protein, dietary fiber, total titratable acidity contents were performed according to Association of Official Analytical Chemists (2010). Total carbohydrates were performed by difference and caloric value was estimated according to Atwater conversion values.

Total soluble solids and pH analysis were performed according to Association of Official Analytical Chemists (2010) techniques, and total soluble sugars, reducing and total sucrose contents determined by the method of Nelson (1944).

Determination of swelling capacity and solubility index were performed according to methodology described by Leach et al. (1959). Starch paste clarity was determined according to Whister & Paschall (1965) and expansion index according to the procedure proposed by Cereda (1983).

2.4 Statistical analysis

Experiment was conducted in a simple completely randomized design (Ferreira, 2010). Was evaluated the influence of four different proportions of replacement of sour starch for fermented broken rice (25%, 50%, 75% e 100%) with 0% being the control, in 3 replicates.

Results of analyzed variables were submitted to variance analysis. Treatment averages, when significant, were compared by Tukey test at 5% probability. Physical and chemical characteristics analyses of fermented broken rice were performed in 15 replicates with respective standard deviation (SD) and coefficient of variation (CV).

3 Results and discussion

Data obtained on chemical characteristics of fermented broken rice at room temperature is shown in Table 1.

Moisture content, carbohydrates, proteins, lipids, fibers, ashes and reducing sugar were respectively 12.4%, 78%, 1.1%, 0.6%, 0.5% e 0.14%. According to Leonel (2007), sour starch contains 14% of moisture content, 79% of carbohydrates, 0.14% of protein, 0.5% of lipid, 0.4% of fiber, 0.2% of ash and 0.4% of reducing sugars, which led to detect similar values among fermented broken rice, and moisture content, carbohydrates and sugars were slightly higher in sour starch, whereas proteins, ash, lipids and fibers values were higher in the product studied in this research.

Table 1. Chemical characteristics average of fermented broken rice with respective standard deviation (SD) and coefficient of variation (CV). Goiânia, GO.

Analysis	Average Results ± SD
Moisture (%)	12.4 ± 0.5
Ash (%)	0.5 ± 0.01
Proteins (%)	8.2 ± 0.2
Total Lipids (%)	1.12 ± 0.1
Total Carbohydrate (%)	78 ± 0.4
Energy Value (Kcal)	354 ± 2.5
Total Soluble Sugars (%)	1.55 ± 0.02
Reducing Soluble Sugars (%)	0.14 ± 0.04
Sucrose (%)	1.4 ± 0.02
Dietary Fiber (%)	0.6 ± 0.4
pH	8.9 ± 0.01
Titratable Acidity (%)	3.9 ± 0.6
Total Soluble Solids (°Brix)	2.3 ± 0.2

Ascheri et al. (2007) studying the broken rice, obtained values of 12.4% for moisture, 0.7% for lipids, 7.3% for protein, 0.5% for ash, 1.6% for total fiber and 79.08% for carbohydrates, generating calorie of 351.8 Kcal. Comparing these data with those obtained in this study, was noted similarities with exception of lipid content (1.1%), which were higher and fiber (0.6%) which was lower in fermented broken rice.

Regarding to pH, fermented broken rice obtained average value of 8.9, total titratable acidity of 3.9%, which are different for those presented by Anjos et al. (2014), in samples of modified starches or stabilizers in preparation of cheese bread which the pH was 5.60 and total titratable acidity was 5.8%. This observed difference in pH and acidity may be related to fermentation time of different products, since broken rice was fermented (five days) in shorter time compared to sour starch fermentation which was 40 days.

For total soluble sugar, the content found was 1.5%, and most of these sugars were comprised of sucrose, which obtained value of 1.4%. Total soluble solids detected were 2.3% and caloric value of fermented broken rice was 354 kcal per 100 g of product.

Data on physical characterization of starch of fermented broken rice are shown in Table 2.

According to Pereira et al. (2004), expansion index of sour starch has an average value of 1.9 mL/g, characterizing expansion of sour starch as slightly higher than fermented broken rice, which was equal to 1.4 mL/g. This may be due to structural difference of starch granules, as well as sour starch fermentation time. According to Silva et al. (1998), the expansion power is highly dependent on gelatinization of the starch, being favored by the water content provided in the formulation. Swelling capacity of fermented broken rice reached value of 11 g/g, with solubilization index of 17% and clarity of 0.44% of transmittance.

Table 2. Physical characteristics of starch on fermented broken rice, with respective standard deviation (SD) and coefficient of variation (CV). Goiânia, GO.

Analysis	Average Results
Swelling Capacity (g/g)	11 ± 0.3
Solubility Index (%)	17 ± 0.9
Paste Clarity (%T)	0.4 ± 0.02
Expansion Index (mL/g)	1.4 ± 0.04

Dufour et al. (1996), evaluated the expansion, in the oven, of Colombian cassava starch with samples submitted to following treatments: sweet starch flour dried in shade, kiln-dried and sun-dried. Expansion index of sun-dried sour starch was two times higher than the other drying conditions. Results were 6.3 mL/g for sweet starch flour, 7.0mL/g for kiln-dried sour starch and 14.9 mL/g for sun-dried sour starch. The authors concluded that fermentation (by 3 to 4 months a year) and sun drying are important to give the cassava starch the expansion ability in the oven. Note that expansion values found by these authors are much larger than fermented broken rice, demonstrating that fermentation time is important for expansion. According to Esteller & Lannes (2005), these two parameters show the relationship between the solids content and the air fraction in the roasted mass. Masses with high specific gravity or low specific volume present a disagreeable appearance to the consumer, associated with high moisture content, failure in cooking and cooking, poor aeration, difficult chewing, improper taste and low conservation.

Cereda & Maeda (2001), after evaluation of two expanding methods of sour starch in the oven, proposed a classification, at national level, expansion indexes of sour starch in the oven. Type A would be sour starch with extra quality in expansion index, valued at more than 16mL/g; type B with an average quality, with expansion index in the oven among 12 mL/g and 16mL/g and type C, the sour starch with expansion index in the oven lower to 12 mL/g. Therefore, the researched product would be classified as type C.

Data referring to chemical characterization of cheese breads with different concentration of fermented broken rice on it formulation, are shown in Table 3.

According to Table 3, is notable that total carbohydrates variables, total soluble sugars, sucrose, energy value, fibers and pH were rising as replaced the sour starch for fermented

Table 3. Chemical characteristics of cheese bread, made with different concentrations of fermented broken rice, with respective standard deviation (SD) and coefficient of variation (CV). Goiânia, GO.

Analysis (%)	Different concentration of fermented broken rice in cheese breads formulation				
	0%	25%	50%	75%	100%
Moisture	26 ± 0.4^{A}	25.5 ± 0.3 ^{A}	25.05 ± 0.5^{B}	24.7 ± 0.7^{B}	24.3 ± 0.8^{B}
Ash	1.7 ± 0.01^{A}	2.1 ± 0.01^{A}	1.8 ± 0.1^{A}	1.8 ± 0.1^{A}	1.9 ± 0.1^{A}
Proteins	6.8 ± 0.24^{A}	7.03 ± 0.3^{A}	6.9 ± 0.2^{A}	6.9 ± 0.25^{A}	7 ± 0.2^{A}
Lipids	14.7 ± 0.5^{A}	14.8 ± 0.5^{A}	15 ± 0.5^{A}	15.2 ± 0.6^{A}	15.3 ± 0.6^{B}
Total CHO	44.5 ± 0.4^{A}	50.5 ± 0.8^{A}	51.2 ± 0.9^{A}	52.6 ± 0.1^{A}	51.4 ± 0.9^{A}
T Sol. Sugar	0.3 ± 0.1^{A}	0.4 ± 0.1^{A}	0.5 ± 0.1^{A}	0.6 ± 0.1^{B}	0.6 ± 0.1^{B}
Reducing S.	0.03 ± 0.0^{A}	0.03 ± 0.01^{B}	0.04 ± 0.01^{B}	0.02 ± 0.0^{B}	0.01 ± 0.01^{B}
Sucrose	0.3 ± 0.1^{A}	0.4 ± 0.1^{A}	0.4 ± 0.03^{B}	0.5 ± 0.01^{A}	0.6 ± 0.02^{A}
(Kcal)	393 ± 2.2^{A}	403 ± 0.2^{A}	424 ± 0.2^{B}	432 ± 0.2^{B}	439 ± 0.4^{B}
Dietary F.	8.5 ± 0.3^{A}	8.7 ± 0.5^{A}	9.1 ± 0.4^{A}	9.2 ± 0.4^{B}	9.6 ± 0.2^{A}
pH	6.1 ± 0.2^{A}	7 ± 0.2^{A}	7.2 ± 0.2^{A}	7.8 ± 0.2^{A}	8.4 ± 0.4^{B}
% TA	4.6 ± 0.1^{A}	5.3 ± 0.01^{A}	6.1 ± 0.2^{B}	6.8 ± 0.4^{B}	7.5 ± 0.5^{B}

Averages followed by the same letter in the lines, do not differ at the 5% level.

broken rice; while moisture, reducing sugars and titratable acidity contents had a contrary behavior; ash, proteins and lipids contents remained the same, even increasing the concentration of fermented broken rice, with an average of 1.8%, 6.9% and 15% respectively.

Average moisture values only differed statistically at concentrations above 75% of fermented broken rice. Cheese bread, using 100% of fermented broken rice, obtained moisture content of 24.34%, while the control cheese bread obtained moisture of 26%. This factor also may be considered when evaluating parameters such as titratable acidity and pH, after all, both obtained contrary behavior, according to concentration increase of fermented broken rice, the pH only differed statistically in treatment with 100% of fermented broken rice with an average of 8.4. Titratable acidity had a decreasing behavior, as lower the sour starch content in cheese bread paste, lower will be the acidity of the product. Higher values for moisture were found by Pereira (2001) and Silva et al. (2009), average values of 42%, when characterized different formulations of cheese bread available in the market and the effect of freezing on chemical characteristics of product. Regarding pH value and acidity, these same authors found values respectively, ranging from 5.73 to 5.91 for pH, and 0.74 to 1.2 for titratable acidity, being different from those detected in this experiment. Also an important factor to be observed is that fiber content of product increased according to increase of fermented broken rice content in formulation of cheese bread, introducing the control 8.5% and 9.6% in cheese bread with 100% of fermented broken rice, enriching nutritionally the product. Silva et al. (2009), studying effect of freezing on cheese bread characteristics, has reported average values of 5% and lower than those found in this research.

Total carbohydrate content was the same for all cheese breads with fermented broken rice, with an average of 50.05%, differing statistically from control with an average of 44.5%. Leal et al. (2013), comparing chemical and physical characteristics of cheese bread with cow, goat and sheep milk, found carbohydrate average values (58.25%, 57.42% and 57.36% respectively) higher than those found in this research. Energy value of new product increased from incorporation of 50% of fermented broken rice, not statistically different from each other, with an average of 431.48 Kcal. Treatments control and 25% were equal, statistically, averaging 398 Kcal. Similar values for energy were found by Pereira et al. (2005), evaluating specific pastes of cheese bread.

Regarding soluble sugars, total and sucrose content, had the same behavior, treatments above 50% of broken rice were statistically equal, differing from control treatment and with 25%, averaging 0.3% and 0.6% for total sugar and 0.4% and 0.5% for sucrose respectively. Reducing sugars contents were similar in treatments with 75% and 100%, differing from the others, which were also statistically equal, averaging 0.016% and 0.035% respectively. Is remarkable, even while the sucrose content increased with incorporation of fermented broken rice, reducing sugars reduced, showing that with increasing pH and high temperature on cheese bread baking, total sugars, represented by 90% of sucrose, were not hydrolyzed and remained intact sucrose.

Characteristics of different pastes of cheese breads with varying concentrations of fermented broken are shown in Figure 1.

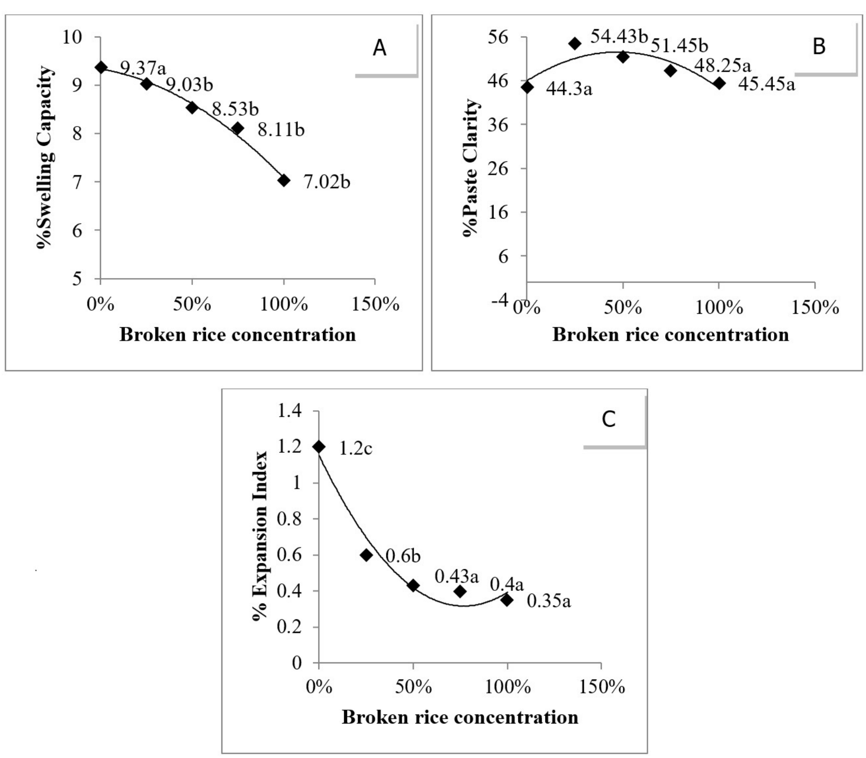

Figure 1. Characteristics of different cheese breads pastes with varying concentrations of fermented broken rice, (A) % swelling capacity, (B) % paste clarity and (C) % expansion index, Goiânia, GO. Averages followed by the same letter, do not differ at the 5% level.

Regarding analysis of swelling capacity, paste clarity and expansion index, was observed that these variables have statistically difference among studied treatments.

Swelling capacity suffered decrease with incorporation of fermented broken rice, ranging from 9.37 g/g to 7.02 g/g. Treatments with 25, 50 and 75% of fermented broken rice were statistically similar, differing from control treatments of 100%. It may be seen in visualization of products after baked, since cheese bread made with no starch flour showed smaller size compared to other formulations. Paste clarity before baked, was equal to control treatments with 75 and 100% of fermented broken rice, differing from treatments with 25 and 50%. If we compare these results with starch paste clarity of pure broken rice, is verified that there was a significant increase, from 0.44%T to 54.43%T, which may be explained by incorporation of other ingredients in cheese bread paste. Color is one of the main attributes that affect consumption through the perception of product quality and may even be used as an estimate of nutritional components for quality indices also influencing consumer to make the purchase decision (Fiates et al., 2008).

Expansion index of final product did not differ among treatments which had broken rice on it formulation, obtaining an average of 0.44 mL/g. Only the control treatment had the high expansion capacity, with an average of 1.2 mL/g, however value less than the expansion index of pure fermented broken rice starch, which had an average of 1.43 mL/g. Higher values were observed by Pereira et al. (2005), with contents among 187% to 317% for expansion and Leal et al. (2013), with average values of 49.40% on three evaluated cheese bread formulations.

Analyzing the results, in general, is reported the incorporation of up to 75% of fermented broken rice replacing the sour starch, regarding chemical and physical characteristics evaluated, proved extremely viable, adding nutritional value to the product with no profound changes of their characteristics relative to the standard. However, it is emphasized the necessity of sensory and microbiological study to complement the research and viability of the product.

4 Conclusion

The cheese bread, when enriched with fermented broken rice, becomes a viable possibility to do not waste the broken rice, since it is a by-product of this process and not used as much on the human alimentation. Broken rice flour, after fermentation process, becomes a profitable alternative instead of the sour starch on cheese breads, saving all the physical and chemical characteristics and being inexpensive.

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