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Development of cassava cake enriched with its own bran and *Spirulina platensis*

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ABSTRACT. The cassava cake was developed enriching it with a biomass of *Spirulina platensis* and a type of bran made out of its own starch. This biomass, a part from being rich in protein, also contains vitamins, essential fatty acids and minerals. Around Umuarama, in the State of Paraná, there is an agricultural/industrial complex annually producing and processing tons of cassava. Baked goods can be elaborated based in cassava as a way to expand the use of this raw material and to produce food free of gluten to celiac people. In this complex a solid byproduct is generated, which is rich in starch and fibres, and because of its low commercial value it is used for animal feed or discarded. The bran was dehydrated and analysed microbiologically as well as physically and chemically so as to be used in applied research. Developed energetic food based on cassava lacks protein, but this can be supplied by adding the biomass of *Spirulina platensis*. Different formulations of this cassava cake were developed varying the concentration of *Spirulina platensis* and cassava bran. The formulation that presented the best features received chocolate before being submitted to sensory tests by children in the public education system. The results show an excellent acceptance which made viable the development of this product because of aspects like nutrition, technology and sensorial.

Keywords: bakery products, single cell protein, manioc, nutritional enrichment, sensorial acceptance.

Desenvolvimento de bolo de mandioca enriquecido com *Spirulina platensis* e farelo de fecularias

RESUMO. Desenvolveram-se bolos de mandioca com *Spirulina platensis* e farelo de fecularias. A *Spirulina platensis,* rica em proteínas, apresenta em sua composição vitaminas, ácidos graxos essenciais, minerais, baixo conteúdo de ácidos nucléicos sendo segura do ponto de vista alimentar, com comprovadas propriedades terapêuticas. Na região de Umuarama, Estado do Paraná, localiza-se um complexo agroindustrial que processa toneladas de mandioca. Nessas indústrias origina-se um subproduto sólido, o farelo, rico em amido e fibras, com baixo valor comercial. Os produtos de panificação podem ser elaborados à base de mandioca como uma forma de ampliar a aplicação dessa matéria-prima e produzir alimentos livres de glúten para celíacos. Estes alimentos são energéticos, mas apresentam deficiência em proteínas que pode ser suprida com a adição de *platensis*. Foram elaboradas formulações de bolos de mandioca variando concentrações de *S. platensis* e farelo de mandioca. Este farelo foi desidratado e submetido às análises microbiológicas e físico-químicas. Realizarem-se análises de composição centesimal e avaliação de parâmetros tecnológicos, sendo que o bolo que apresentou melhores características foi destinado, após adição de chocolate, a análise sensorial. Os resultados mostraram aceitação do bolo configurando a viabilidade de desenvolvimento do produto.

Palavras-chave: produtos de panificação, proteína unicelular, mandioca, enriquecimento nutricional, aceitação sensorial.

Introduction

A balanced diet is essential for the growth and good eating habits acquired during childhood and will reflect in adult life. The development of enriched foods for school lunch which are low cost and sensory attractive is an interesting research subject attached to the findings of new raw materials. The eating habits of an individual are acquired depending on one's environment or family experiences. Early and continuous interaction with food determines healthy eating habits (KIMMEL et al., 1994; KOIVISTO, 1999).

Manioc or cassava (*Manihot esculenta* Crantz) has a high productivity rate, with technological versatility at low cost, but it should be better utilised as an energetic source by the development of new products which will add value to its productive chain. As it can be grown in small properties and do not demand high technological investment, it can serve small producers in generating earnings and work. Such food development, especially in the baked goods field, is of the utmost importance to reduce the consumption of wheat flour in Brazil, and because these new foods do not contain gluten, they can be consumed by celiac people. Obedience to a diet free from wheat, rye, barley and oats is not an easily enforced practice, especially to children and because of the small offer at the markets of such types of food, not to mention in the school lunch (SDEPANIAN et al., 2001).

Baked goods can be advantageous to use as vehicles of nutrients due to the fact of their good sensory response, relative simplicity in both their processing and consumption. Receipts of cakes have been acquiring increased importance, and these are obtained through the mixing, blending and cooking of dough prepared with flours and other substances like milk, sugar, eggs and fat. However, the end appearance of the final product should be typical to ensure acceptance, specially its palatability (CHAVAN; KADAM, 1993).

It is generated considerable quantities of solid and liquid residues during cassava processing which should be entirely used to contribute to the sustainability of this industry. The bran generated in this industry are solid by-products originated at the time of separating the starch and which has 85% humidity rate, and when partially dried its main feature being a 70% starch residual rate and 16% of fibre content (CEREDA, 2001).

Fibre intake for medicinal purposes has been greatly researched, because it exerts a series of actions upon the digestive system. Modern eating habits are being responsible for diminishing the consumption of fibres, types of food that include fibre into children's diet is important. Fibres contained in food are macro molecules which are resistant to digestion by digestive enzymes in the human digestive system, their cellular walls are primarily made of pectin, lignin, cellulose and hemi cellulose. Therefore, their physiological properties are related to the chemical components that form them, which have a prominent effect in increasing the weight of the faecal matter which help to avoid *Diabetes Mellitus*, cardio-vascular diseases, obesity and colon cancer (THARANATHAN; MAHADEVAMMA, 2003; SANTOS et al., 2011). Other agro-industrial byproducts besides cassava are rich in fibre and many studies report their utilisation in baked goods, revealing a trend to correct these problems in the western diet (DUTCOSKY et al., 2006; PROTZEK et al., 1998; SUROJANAMETHAKUL et al., 1999; ZAVAREZE et al., 2010).

The cyanobacterium *S. platensis* has been widely used in several countries, it is considered *GRAS* (*generally recognized as safe*), without toxicological effects, and it is approved by the FDA (U.S.A.) and ANVISA (BRASIL, 1998). Countless beneficial effects are attributed to this microorganism, because of its high nutritional value and bioactive compounds, mainly anti-oxidants (CHAMORRO-CEVALLOS et al., 2008; IYER et al., 2008). It is worth mentioning that when compared to other bacteria biomasses it has a reduced content of nucleic acids, which in excess cause problems like the built up of uric acid in the body, it is easily cultivated and separated from its culture medium due to its size. Its protein content is 50-70%, the amino acid spectra is compatible with FAO standard, excellent digestibility due to its mucopolysaccharidic cellular wall, which is different from other non-conventional protein sources (MORAIS et al., 2006; SPOLAORE et al., 2006). *Spirulina* sp. is rich in vitamins like Cyanocobalamin (B12), Pyridoxine (B6), Riboflavin (B2), Thiamin (B1), Tocopherol (E) and Phylloquinone or phytonadione (K) (BRANGER et al., 2003). Vitamin B12 which practically only exists in animal sources, is found in *Spirulina* spp. at about 0.11 mg 100 g^{-1} of the biomass (SHIMAMATSU, 2004).

Experiments with children showing third stage malnutrition were performed in Mexico City. After 320 days of administering *S. platensis* results revealed that the absorption rate of nitrogen was lower than in comparison with milk and soya, but the nitrogen retained in this absorbed quantity was slightly lower than milk but better than soya (BRANGER et al., 2003).

As the sensory qualities of foods are of decisive importance in their acceptance, their modification resulted through adding or replacing components should be carefully studied to access the consumer's reaction to the alterations in flavour, texture and colour of the product.

The addition of sugar in the development of baked goods is being used to sweeten, increase softness and volume, to develop the flavor and colour (AIKAR et al., 1993). The main type of sugar used is sucrose from sugar cane.

The addition of *S. platensis* to the cassava cake's dough can imprint a nutritional enrichment; also the use of hydrolysed sugars may contribute to mask the possible negative effects about the colour of the product, ensuring a better sensory acceptance with higher reaction rates of Maillard. Protein can positively contribute to the dough (CHUN et al., 2004; IYER et al., 2008).

A proposal of enrichment of cassava cake with fibres of its own starchy bran and biomass of *S. platensis* was the objective of this study. Food based on cassava lacks in protein. Therefore it is justified to study sources of enrichment such as the biomass of *Spirulina platensis*. The product thus developed can be an interesting alternative to availability of nutritional low cost food, resulting in a functional food with possible destination to school lunch.

Material and methods

The cassava bran was supplied by Lorenz Starch Company in Umuarama, State of Paraná. Before this material had been was utilised it was submitted to dehydration in a dryer with forced air circulation (MA 035 Marconi, Piracicaba, São Paulo State, Brazil), at 55°C for 12h. The bran showed an irregular granulometry and it was ground with a horizontal blade (MA 021/CFIT, Marconi, Piracicaba, São Paulo State, Brazil).

The humidity rate was analysed at 105°C. The pH was measured with a digital potentiometer (PG 2000 Gehaka São Paulo, Brazil) and the acidity was determined by titration with NaOH 0.025 mol L^{-1}. To determine the starch content, samples of bran were submitted to acid hydrolysis in an autoclave (CS Logen Scientific, Diadema, São Paulo State, Brazil), at 1 atm for 1h, neutralized with NaOH at 10% and at the end a titration in Redutec (MA 087 Marconi, Piracicaba, São Paulo State, Brazil). The fibre content was determined in a fibre digester apparatus (MA 455 Marconi, Piracicaba, São Paulo State, Brazil). Analyses were done in triplicates according to the standards of the Adolfo Lutz Institute (AACC, 2000; AOAC, 1995; IAL, 2008).

The microorganisms analysed in the bran were the ones indicated in the RDC No. 12 of January, 2nd 2001 (BRASIL, 2001). For roots and similar, the standard is to search for: bacteria of the coliform group from faecal origin, as well as other microorganisms whenever it is necessary to obtain data about the hygienic condition of these products. Analysis of spores was also undertaken to obtain a more rigorous assessment of the condition of microbiological contamination of the bran (APHA, 1992). The analysis was made using method developed by Silva et al. (1997).

The *S. platensis* strain utilized was UTEX 1926 (acquired from UTEX - The Culture Collection of Algae of the University of Texas at Austin, USA). The culture was done using Paoletti culture medium (DANESI et al., 2002, 2004). The source of light used were fluorescent lamps put at a certain distance so that 40 μmol photons m^{-2} s of light were supplied, this was measured by a lux meter (LX 1010B Kalibrasil, São Paulo State, Brazil). To maintain the strain, it was used a shaker (MA 830/A Marconi, Piracicaba, São Paulo State, Brazil) until cell concentration sufficient to cultivates. The cultives was conducted in open mini tanks equipped with rotating paddles to blend and homogenise, also heaters were used to keep the temperature at 30°C. The initial inoculum concentration was 50 mg L^{-1} of cells (PELIZER et al., 2002). The nitrogen source utilised was urea, replacing KNO_3 used in the culture medium of Paoletti. This was daily added by a fed batch process to avoid toxicity levels. The urea flow was determined as previous studies by Danesi et al. (2002, 2004), which was added to a water solution and a constant volume of 5 L was maintained throughout the entire cultivation process avoiding natural evaporation. The biomass was harvest by centrifugation after 14 days (centrifuge MTD III Plus, Metroterm, Porto Alegre, Rio Grande do Sul State, Brazil) and the sediment was taken to a dryer (MA 035, Marconi, Piracicaba, São Paulo State, Brazil), at 55°C for 24h.

For the manufacturing of the cassava cake, the raw material and formulation utilised are shown on Table 1. White Manioc roots were donated by Prof. Dr. Genildo Manoel Pequeno, from the State University of Maringá - Umuarama Campus, and were ground with a processor (PA - 7C, Skymsen, Brusque, Santa Catarina State, Brazil), with 1.5 e 3 mm diameter blades. In the mixer (Britania Pérola/Plus, Brazil), were put the other ingredients like eggs, sugar, shredded cassava, coconut, margarine, *S. platensis* and cassava bran. The speed and power 4 of the mixer were used and controlled for 5 minutes to obtain homogeneous dough.

The dough was divided in 1 kg portions that were placed in aluminium rectangular baking trays measuring (10 x 6 x 24 cm) and were baked at de 150 to 170°C temperature for 50 minutes in an electric oven (Turbo Power Expert FTT 240E Tedesco, State of Rio Grande do Sul, Brazil), which was previously heated.

Analyses of proteins, fat, ashes, humidity, fibres contents, of the manufactured cakes were done following official methodology (AOAC, 1995; IAL, 2008). The caloric value was calculated to its centesimal digits, using conversion factors of *Atwater* of 4 kcal g^{-1} for proteins, 9 kcal g^{-1} for fats and 4 kcal g^{-1} for carbohydrates (PEREIRA et al., 2005).

The analyses were done in triplicates and their averages submitted to the Tukey test of 5% of probability ($p \leq 0.05$) to verify any significant variance.

Table 1. Cake formulation of standard cassava cake and with the addition of *S. platensis* and cassava bran - Formulation 1 and Formulation 2.

Ingredients (%)	Standard	Formulation 1	Formulation 2
Cassava	100	100	100
Eggs from Harmonia® brand	6	6	6
BÜNGE® Margarine	15	15	15
UNIÃO® sucrose	80	80	80
MAIS COCO® Shredded coconut	18	18	18
ROYAL® baking powder	5	5	5
Inverted sugar	-	7	15
Cassava bran	-	2	4
S. platensis	-	1	2

The measurement of the volume of the cakes was done according to AACC (2000) with adaptations to the conditions of the product (ZAVAREZE et al., 2010). Shape dimensions were taken with the help of a calliper, and the weight was determined using a semi-analytical scale (BG 440, Gehaka, São Paulo State, Brazil). These measurements were taken with unbaked dough and baked cakes.

To obtain the dough volume the following equation was used:

$$V = b \times h \times c \quad (1)$$

where:

V = volume (cm^3);
b = base (cm);
h = height (cm);
c = length (cm).

Through this data (volume and weight), it was determined the expansion rate calculated by the following equation:

$$ER = \frac{V_2 - V_1}{V_1} \times 100\% \quad (2)$$

where:

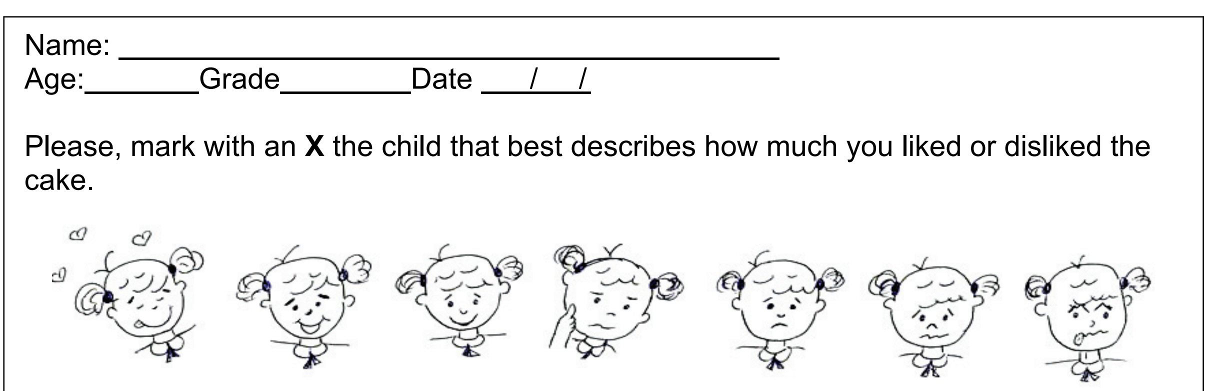
ER = expansion rate;
V_1 = Volume of the dough (before baked cake);
V_2 = Volume of the baked cake.

The specific volume was calculated dividing the value of the volume (cm^3) by the weight (g) of each sample. The density was calculated by dividing the weight (g) by the volume (cm^3).

From the analyses of the centesimal compositions and technological characteristics the best formulation was chosen to be added with 10% of powdered chocolate and submitted to sensory tests in order to verify the acceptance of the product.

The general acceptance test it was used a hedonic facial scale which Figure 1, where the first children of picture corresponds to “super bad” and the last children corresponds to “super good”. The analyses was conducted with 38 subjects, these were children from 7 to 10 years old, students of the Jardim União School, a public school in the city of Umuarama, State of Paraná, and also consumers of the school’s lunch. The samples were served in individual booths, illuminated with white light, the tasters received a tray containing a 30 g piece of cake, a glass of water and an evaluation form. The form used in this analysis can be observed as follows (IYER et al., 2008; KOIVISTO, 1999; MEILGAARD et al., 1991).

This Project was approved by the State University of Maringá Ethics Research Committee (CAAE No. 0477.0.093.000-10) and it was carried out in the same Institution.



Name: ______________________________
Age:_______Grade________Date ___/___/

Please, mark with an **X** the child that best describes how much you liked or disliked the cake.

Figure 1. Form with hedonic facial scale of 7 points used in the sensory analysis (general preference), of the cassava cake with chocolate - formulation 2 enriched with *S. platensis.*

Results and discussion

The results of the microbiological analysis of the bran are shown on Table 2 and Table 3 shows the physical and chemical analyses before and after drying. It can be verified that the bran's pH was 5, below 7, where the food is considered as acid or low acidity food. It is at this point where moulds and yeasts show optimum growth, presenting great resistance and when bacterium development can also occur. The bran's pH and acidity vary a lot due to natural fermentation of the raw material. The low bran's humidity rate of 4.4% after drying allows an extended shelf life and it can be considered safe (JAY, 2008). The results present on Table 2 are well below the permitted by Brazilians Law and so it is possible to eat this cassava bran without risk to people health (BRASIL, 2001).

The starch content (76.25%) is comparable to the one reported by Leonel (2001), although the fibre content (10.63%) is a little below, however this small variation can be attributed to manioc's cultivar utilised at the time of harvest and processing.

A natural food can be considered functional or become functional by increasing the concentration, adding or replacing a component (HASLER, 1998). When analysing the data shown on Table 4 it can be verified that formulations 1 e 2 have shown a significant increase of fibre content in relation to the standard formulation. The specifications of the Directive No. 27, of January 13, 1998 (BRASIL, 1998) state that for a solid food to be considered a source of fibres it must contain a minimum of 3 g of fibres 100 g^{-1} and a maximum of 6 g fibres 100 g^{-1} to be considered a high fibre content food. So, cakes 1 e 2 can be considered food as a source of fibre besides its functionality indications when considering the many bioactive components present in the biomass of *S. platensis*, which confers it therapeutic properties (IYER et al., 2008).

Table 2. Results of the microbiological analyses of the cassava bran.

Analyses	Bran after drying	Recommendations RDC 12 (BRASIL, 2001)
Coliform at 45°C (MPN*** g^{-1})	< 0,3	10^3 MPN
Spores (CFU** g^{-1})	Absence	ND*
Fungi (CFU g^{-1})	1	ND*
Bacillus cereus (CFU g^{-1})	3.10^2	10^3

*ND – not demanded in the legislation; **CFU - Colony Forming Unit; ***MPN - Most Probable Number.

The standard cake presented the highest humidity rate followed by the enriched formulations 1 (2% bran, 1% *S. platensis*) and 2 (4% bran, 2% *S. platensis*), both of these had close humidity rate. This difference can be explained by the addition of other ingredients (fibres and proteins). The main function of starch in baked goods is to absorb water and in this way establish the structure and humidity of the product (CHAVAN; KADAM, 1993). The addition of fibres in baked goods influences the humidity; however the starch content of the manioc had a more prominent effect than the fibres (SUROJANAMETHAKUL et al. 1999, SANTOS et al., 2011).

The composition of *S. platensis* showed 60% of proteins (DANESI et al., 2002, 2004). The protein enrichment was thus proved by the addition of this biomass, because there was a significant variance of 0.05 between formulations 1 and 2 to the standard cake.

Table 3. Results of the physical and chemical analysed of the bran before and after drying.

Component (%)	Bran before drying	Bran after drying
pH	5.00	5.00
Humidity	84.90 ± 0.02	4.40 ± 0.02
Acidity	5.72 ± 0.13	4.45 ± 0.02
*Starch	**	76.25 ± 0.11
*Fibres	**	10.63 ± 0.32

*dried; ** not evaluated.

This biomass contains lipids, including fatty acids and other liposoluble substances that contributed to increase this content in the formulation to which they were added. Formulation 1 presented the highest lipid content, but it probably could have had an irregular distribution when the fat was mixed with the cassava during the mixing process of the cake. It is worth mentioning that the manioc utilised on the development of the cakes was ground and the *S. platensis* biomass was milled, which might have caused differences in the components granulometry and made it difficult to get uniform samples which in turn may have led to problems in the analyses to determine this rates of composition.

The ash content in formulations 1 e 2 were benefited due to the enrichment with the *S. platensis* biomass, which is rich in iron, calcium, potassium, phosphorus, manganese, copper, zinc, magnesium, boron, molybdenum and selenium (BRANGER et al., 2003). According to Leonel (2001) cassava bran is rich in minerals content like phosphorus, potassium, calcium, magnesium, sulphur, iron, zinc, copper, boron, compared to the standard formulation. The minerals and vitamins are essential for a child's growth and normal development. Insufficient ingestion of these elements may result in growth delay and diseases like rickets, anaemia, infections, depression among others.

Table 4. Results of the analyses of humidity, proteins, lipids, carbohydrates, fibre content, ash and caloric value of the standard, formulation 1 e formulation 2 cassava cakes.

Components (%)	Standard	Formulation 1	Formulation 2
Humidity	$31.5^{a} \pm 0.91$	$29.7^{ab} \pm 0.7$	$29.0^{b} \pm 1.3$
Proteins (Nx6,25)	$2.8^{b} \pm 0{,}2$	$3.9^{a} \pm 0.3$	$4.3^{a} \pm 0.3$
Total Lipids	$10.6^{a} \pm 0.3$	$11.3^{a} \pm 0.8$	$11.0^{a} \pm 1.2$
Carbohydrates*	53.4^{a}	50.1^{b}	50.5^{ab}
Total Fibre content	$1.1^{b} \pm 0.03$	$3.8^{a} \pm 0.95$	$3.8^{a} \pm 0.6$
Ash	$0.6^{a} \pm 0.15$	$0.9^{b} \pm 0.2$	$1.1^{b} \pm 0.1$
Caloric value (100 g)	320.2 kcal or 3.2 kj	317.7 kcal or 1.334 kj	319.0 kcal or 1.337 kj

Carbohydrate value was calculated as such: 100 – (g 100 g^{-1} humidity + g 100 g^{-1} ash + g 100 g^{-1} brute protein + g 100 g^{-1} total lipid + g 100 g^{-1} total fibre content). Averages followed by different letters in the columns differ significantly as shown by Tukey test at de 5% probability ($p \pm 0{,}05$).

Sources of fibre derived from wheat added to food were associated to the decrease of zinc and copper which was not confirmed with other sources, this represents an extra advantage in replacing wheat derivates by cassava bran in baked goods (RIAZ, 2001).

According to Weis et al. (2005), a school lunch should supply a minimum of 15% of the nutritional needs, encouraging good eating habits and ensuring a 350 kcal meal and 9 g of proteins. The 100 g standard manioc cake portion ensures 40% of the protein needs and 91.2% of the daily caloric intake. These percentages for Formulation 1 were 43.3 and 90.7%, whereas Formulation 2 contributed with 53.3 and 91.1%. These formulations are adequate to a school lunch. Well nourished children have better disposition, better mental and physical health, are able to learn more easily and can improve their quality of life.

The products: standard, formulations 1 and 2 were analysed in relation to technological weight characteristics, specific volume and expansion rate. The results are shown on Table 5.

The doughs of baked goods are generated by the action of the proteins that form the gluten present in wheat. The necessary characteristics to the wheat flour for cake doughs are more flexible than other products. In this way it is very important to perform a study using flour mixed derived from manioc or other type of flour in the preparation of special cakes, without compromising the typical structure of the product, with economical and nutritional advantages. Starchy carbohydrates which are also full of fibre that composed this study's cakes interacted with the other ingredients and made possible obtaining cakes compatible with what was expected, which can be confirmed by the expansion rate and dough appearance.

Eggs due to their coagulation, emulsification and foam formation take part in the structure of the ready cake. It is also important the role played by lipids in the cake's structure, which is affected by its quality and type used. Elevated lipid content improve softness and flavor, producing a thinner and more uniform granulation, besides a more humid and silky texture. This could probably be explained by its ability of holding air, therefore viscosity increases with increments of fat content.

Cake formulations 1 e 2 produced with cassava bran were heavier. It can be verified that the loss of water in foods that contain fibre is lower because these interact with the water molecules inside the medium, which turns the end product heavier. High ability to absorb water is an important characteristic that has been explored by the food industry (SUROJANAMETHAKUL et al., 1999).

As a consequence the standard cake presented a lower density than formulations 1 e 2 due to their higher fibre content because of the addition of bran. In relation to the specific volume of the cakes it was verified that formulations 1 e 2 presented lower volumes compared to the standard cake.

The expansion rate of formulations 1 e 2 differed from the standard due to the starch in the bran, an agent of volume which is an essential feature to obtain cakes of good quality.

It was observed the time of baking for all different cakes occurred was very similar. With the heat transfer inside the oven, the temperature increases in the centre of the dough, at 15 minutes after the start of the baking process the definite volume of the cake was observed. At this stage the internal temperature in the oven was 170°C, which promoted gelatinization of the starch and the modification of the protein added to the doughs. A golden brown crust was formed at a later stage, due to the caramelisation of the sugar and Maillard's reaction (HUG-ITEN et al., 2001).

After observing the cakes in the developed formulations, in relation to technological characteristics, it can be said that the used components formed a typical and satisfactory structure which makes viable the utilization of cassava as the main ingredient to replace wheat (CHAVAN; KADAM, 1993).

Table 6 shows the sensory acceptance average results of formulation 2 which was the cake with chocolate added, demonstrating that the average grade given by the children was 6.92 (close the 7), which corresponds to "super good" in the hedonic facial scale. The acceptability index was calculated considering 100% the grade 7 of this scale, therefore the maximum grade given to the samples was 98.8% of acceptability. For a product to be considered approved in relation to its sensory characteristics, it is necessary that the acceptability index be at least 70%, adequate for consumption, with a good marketability (MEILGAARD et al., 1991, SANTOS et al., 2011).

Table 5. Specific volumes ($cm^3\ g^{-1}$), densities of the raw and baked cakes ($g\ cm^{-3}$), expansion rate (%) of the cakes: standard, formulations 1 e 2.

Technological Parameters	Standard	Formulation 1	Formulation 2
Specific volume of the raw dough ($cm^3\ g^{-1}$)	1.08	0.89	0.82
Specific volume of the baked cake ($cm^3\ g^{-1}$)	1.83	1.60	1.50
Density of the raw dough ($g\ cm^{-3}$)	0.92	1.125	1.215
Density of the baked cake ($g\ cm^{-3}$)	0.54	0.62	0.66
Expansion rate (%)	69.4 ± 1.91^a	79.7 ± 2.51^b	82.9 ± 1.56^b

Averages followed by different letters in the columns differ significantly as shown by Tukey test at de 5% probability ($p \leq 0,05$).

Table 6. Average Sensory acceptability of formulation 2 of the cassava cake with chocolate added.

Cassava cake formulation 2 with powdered chocolate				
Average	Rejection (%)	Indifference (%)	Approval (%)	Acceptability (%)
6.92	0	0	100	98.8

Rejection - percentage of grades from 1 to 3; indifference - percentage of grades 4; approval - percentage of grades from 5 to 7; acceptability - 100% grade 7.

In another study testing 22 dishes of Indian recipes cuisine that were added with *Spirulina* sp. it was demonstrated a good acceptability in relation to appearance, color, texture, taste and overall acceptance with concentrations of 1 to 2.5 g, when compared to the standard dish (IYER et al., 2008). Therefore it can be confirmed that the addition of biomass in food products does not compromise sensory acceptance.

The addition of chocolate, a component of great acceptance by children enables an alternative use of manioc in baked goods, which have considerable nutritional value. This strategy also ensures the manufacturing of adequate dough with typical characteristics and pleasant taste.

Conclusion

The production of a cassava cake enriched make the product more nutritious and with satisfactory technological and sensory characteristics.

The increase in protein, fibre and ash content in the formulations showed qualitative and quantitative advantages when compared to the standard recipe.

The sensory acceptability rate reached 98.8%, which refers to "super good" in the hedonic facial scale, which is considered good acceptability.

The results demonstrate production viability for this alternative food due to its low cost and easy preparation but more importantly, it can be destined to school lunch because it can improve the children's nutritional life.

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