

Inulin addition on flavored homemade bread: physico-chemical composition and sensory acceptance among schoolchildren

Adição de inulina em pão caseiro saborizado: composição físico-química e aceitação sensorial entre escolares

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Abstract

The study assessed the sensory acceptability of homemade bread flavored with pineapple rind tea added with inulin well as tried to determine the physico-chemical composition of the traditional formulation and also verified the formulation that contains the highest inulin level and sensory acceptance similar to the standard. It was used the following five bread formulations: standard (F1) and others added 20% (F2), 25% (F3), 30% (F4) and 35% (F5) inulin. The participants of the sensory analysis were 50 untrained tasters, from both genders, between 7 and 10 years. In the physico-chemical analysis, it was determined the moisture content, ash, protein, fat, carbohydrates, crude fiber and calories. Sensorially, the sample F5 had lower grades than others in the appearance tribute and lower grades than the standard sample for the flavor attribute ($p < 0.05$). Therefore, the sample with 30% inulin

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was regarded as the product with a higher content of the ingredient and with sensory acceptance like the standard. In the physico-chemical composition, the sample with 30% inulin showed lower content of moisture, proteins and calories and higher contents of carbohydrates and crude fiber than the standard. Thus, the development of the products proved that an addition level up to 30% inulin in sliced loaves was better accepted, obtaining a sensory acceptance similar to the standard product, showing good marketing expectations.

Key words: cereal; prebiotics; fibers.

Resumo

Objetivou-se verificar a aceitabilidade sensorial de pão caseiro saborizado com chá da casca de abacaxi com adição de inulina, bem como determinar a composição físico-química da formulação tradicional e daquela contendo maior nível de inulina e com aceitação sensorial semelhante a padrão. Utilizaram-se cinco formulações de pães sendo: padrão (F1) e as demais adicionadas de 20% (F2), 25% (F3), 30% (F4) e 35% (F5) de inulina. Participaram da análise sensorial 50 provadores não treinados, de ambos os gêneros, com idade entre 7 e 10 anos. Nas análises físico-químicas foram determinados o teor de umidade, cinzas, proteínas, lipídios, carboidratos, fibra bruta e valor calórico. Sensorialmente, a amostra F5 apresentou menores notas que as demais no atributo aparência e menor nota que a amostra padrão para o atributo sabor ($p < 0,05$). Portanto, a amostra com 30% de inulina foi considerada como o produto com maior teor do ingrediente e aceitação sensorial semelhante a padrão. Na composição físico-química, a amostra com 30% de inulina apresentou menores teores de umidade, proteínas e calorias e maiores de carboidratos e fibra bruta ($p < 0,05$) que a padrão. Sendo assim, a elaboração dos produtos permitiu comprovar que um nível de adição de até 30% de inulina em pão de forma foi melhor aceito, obtendo-se aceitação sensorial semelhante ao produto padrão e com boas expectativas de comercialização.

Palavras-chave: cereais; prebióticos; fibras.

Introduction

The production of new beneficial foods to health presents growing scientific and commercial support. Among these there are products with low calorie and fiber enriched using ingredients such as fructooligosaccharides (FOS) and inulin. These products present many advantages, because they can replace, mainly, sugar and

fat in food products (FRANCK, 2002; ISIK et al., 2011; MANTZOURIDOU et al., 2012).

Inulin is a storage of polysaccharide presented in several plants such as onion, garlic, wheat, leeks, banana and chicory. Its industrial extraction occurs mainly from the latter (FRANCK, 2002; MEYER et al., 2011). It can be considered a soluble fiber and prebiotic because it is not digested by

the gastrointestinal tract and it is used as a substrate for beneficial colonic bacteria, contributing to the improvement of the intestinal microflora (MANTZOURIDOU et al., 2012).

The wide use of inulin in food industry is based on their nutritional and technological properties (MUZZARELLI et al., 2011). It is used in various products such as confectionery, beverages, dairy products, cereal bars, ice cream and others (MEYER et al., 2007; ISIK et al., 2011; GRANATO et al., 2012). Bread is a great tool for adding functional ingredients such as inulin, because in addition to supply a meaningful portion of daily energy and nutrients, it is highly consumed by the population (VASCONCELOS et al., 2006).

Thus, the food technology is being applied to products through enrichment techniques, by adding functional properties, lower costs, among others, searching for some kind of contribution for the food industry as well as aiming at bringing health benefits to people (MORRIS; MORRIS, 2012). However, to make a new product it is fundamental its assessment through sensory analysis in order to study its development, optimization and consumer acceptance (VON ATZINGEN; PINTO E SILVA, 2010). It is noteworthy that the sensory characteristics of added ingredients in products should look like the standard product and also reduce the substitution effects to obtain food with good appearance, aroma, taste, color and texture (MINIM, 2010; DUTCOSKI, 2011).

It is known that childhood is the development stage of eating habits, which turns the school into an environment conducive to encourage the consumption of nutritionally adequate food. Thus, it becomes

important to introduce healthy food in age from 7 to 10 years, considered school age, and analyze the physico-chemical composition of the standard product because once the child acquires the right eating habits, they will hardly be modified in adulthood (VON ATZINGEN; PINTO E SILVA, 2010).

Thus, the goal of this study was to prepare flavored homemade bread added with inulin to evaluate the sensory acceptability among school-age children and to analyze the physico-chemical composition of the standard product and also to determine the ones with higher inulin content and similar acceptance.

Material and Methods

Raw material acquisition

The products were purchased in supermarkets in Guarapuava, PR and inulin was donated by national partner companies.

Pineapple peel tea acquisition

First, pineapple was cleaned with running water and left in a sodium hypochlorite solution (chlorine concentration of 2 to 2.5%) for 15 minutes and then peeled. For the tea preparation, 300 g of pineapple rinds were boiled in 500 ml of water (100°C) for 5 minutes and the liquid drained and the rinds discarded.

Formulations

Five formulations of homemade bread were added to the pineapple rind tea and inulin. For the purposes of classification it was considered only the inulin addition, as follows: F1 standard (0%), F2 (20%),

F3 (25%), F4 (30%) and F5 (35%). These percentages were defined after sensory preliminary with the product. In Chart 1 it can be verified bread formulations added with inulin.

The formulations were prepared individually in Technical Dietetics Laboratory of the Nutrition Department at the Midwest State University – UNICENTRO. The weight of all the ingredients was performed on a digital scale (Filizola®, Brasil) with a precision of 0.1 g and a maximum capacity of 15 kg. First, all ingredients were manually mixed, kneaded and left to rest for fermentation for 30 minutes. Inulin was added in the amount presented in Chart 1. The resulting dough was delivered in aluminum molds 30 x 12 cm and baked in a preheated oven (Brastemp®, Brasil) at 200°C for 50 minutes

Sensory analysis

The participants of this research were 50 untrained children, enrolled in a Municipal School in Guarapuava, Paraná, of both genders, aged between 7 and 10 years.

The products were subjected to a sensory evaluation, in a specific school

room, with each student being evaluated at a time. Each test was performed in individual booths, type urn, and the children were assisted by the researchers to fill the answers the questionnaires.

The sensorial trial evaluated the sensory attributes of appearance, aroma, taste, texture and color through a structured hedonic facial scale of 7 points ranging from 1 (“Super Bad”) to 7 (“Super Good”), adapted from Kimmel et al. (1994). It was also applied global questions of acceptance and purchase intention through a structured hedonic scale of 5 points (1 “disliked very much”/“would not buy” to 5 “really liked”/“would buy definitely”), as suggested by Minim (2010).

Each judge received a portion of each sample (approximately 10 g) in disposable white plastic dishes, coded with three digit numbers, in a randomized, balanced, followed by a glass of water for conducting the samples. The formulations were offered to judges in a sequential monadic way.

Acceptability index (AI)

The index calculation of acceptability of five formulations was performed according to Monteiro (1984), based on the formula:

Chart 1 - Formulations ingredients of flavored homemade bread added of tea from pineapple peel and inulin

| Ingredients | F1 | F2 | F3 | F4 | F5 |
|-------------------------|-------|-------|-------|-------|-------|
| Refined wheat flour (%) | 52,63 | 44,21 | 39,21 | 34,21 | 29,21 |
| Pineapple peel tea (%) | 21,05 | 21,05 | 21,05 | 21,05 | 21,05 |
| Crystal sugar (%) | 11,58 | 0,00 | 0,00 | 0,00 | 0,00 |
| Egg yolk (%) | 6,32 | 6,32 | 6,32 | 6,32 | 6,32 |
| Margarine (%) | 5,26 | 5,26 | 5,26 | 5,26 | 5,26 |
| Fresh yeast (%) | 3,16 | 3,16 | 3,16 | 3,16 | 3,16 |
| Inulin powder (%) | 0,00 | 20,00 | 25,00 | 30,00 | 35,00 |

Source: Authors (2013).

Note: F1: standard; F2: 20% of inulin; F3: 25% of inulin; F4: 30% of inulin; F5: 35% of inulin.

AI (%) = 100 x A/B (A: average score obtained for the product, B: maximum score given to the product).

Physico-chemical analyzes

The physico-chemical analyzes were performed at the Food Analysis Laboratory in the Food Engineering Department at UNICENTRO and in the Food Science and Food Composition Laboratory at São Judas Tadeu University, in São Paulo, SP.

The following physico-chemical determinations were performed in triplicate in the standard bread (F1) and in the formulation with higher inulin content, which obtained a similar sensory acceptance to the standard one:

Moisture: it was determined at 105°C in a greenhouse up the constant weight, according to AOAC (2011); *Ash*: it was analyzed in oven (550°C), according to AOAC (2011); *Total Lipids*: it was used the cold extraction method (BLIGH; DYER, 1959); *Protein*: it was evaluated by total nitrogen content from the sample by the Kjeldahl method, established semimicro level (AOAC, 2011). We used the nitrogen conversion factor of 6.25 for protein; *Crude Fiber*: it was used the hot extraction method H₂SO₄ (1.25% w/v) and NaOH (1.25% w/v) AOAC (2011) *Carbohydrate*: The carbohydrates determination (including crude fiber) of the products were performed by theoretical calculation (by difference) in the triplicate results, according to the formula: % Carbohydrates = 100 - (% moisture + % protein + % fat + % ash); *Calories*: Total calories (kcal) were calculated for 50 g of sample, using the next numbers: lipids (8.37 kcal/g), proteins (3.87 kcal/g),

and carbohydrates (4.11 kcal/g) (MERRILL; WATT, 1973), and to inulin:1,5 kcal/g (carbohydrates) (BENEO® HP, 2012).

Determination of the Reference Daily Value (DV)

For the calculation of DV, it was performed an average of the recommended values by Dietary Reference Intakes (2005), for children (7-10 years). The nutrients were assessed by the average calculations: 1802.55 kcal/day, 258.89 g carbohydrates, 62.92 g protein and 65.91 g lipid.

Ethical issues

This study was approved by the Ethics Committee of Research at UNICENTRO, opinion number n°. 49549/2012. However, as exclusion criteria for the participants it was considered the following factors: having allergy to any ingredient used in the bread preparations, not belonging to the same school proposed by the research and not delivering the Informed Consent Form Document (ICFD), signed by the legal guardian.

Statistical analysis

Data were analyzed using the Statgraphics Plus® software version 5.1, through variance analysis (ANOVA), by knowing that average comparison was performed by the Tukey average test and t of student, both with 5% significance level.

Results and Discussion

Sensorial analysis

Chart 2 presents sensory acceptance in flavored bread standard and added with inulin.

Chart 2 - Averages from sensory test and purchase intent performed for flavored pineapple bread formulations standard and enriched with 20, 25, 30 and 35% inulin

| Formulations/ Attributes | F1 Mean±SD | F2 Mean±SD | F3 Mean±SD | F4 Mean±SD | F5 Mean±SD |
|-----------------------------|------------------------|-------------------------|-------------------------|-------------------------|------------------------|
| Appearance | 6,33±1,03 ^a | 6,23±0,91 ^a | 6,27±0,89 ^a | 6,20±0,87 ^a | 5,64±1,28 ^b |
| Aroma | 6,32±1,07 ^a | 6,18±1,02 ^a | 6,01±1,11 ^a | 6,11±1,23 ^a | 6,20±1,09 ^a |
| Taste | 6,58±0,77 ^a | 6,29±0,83 ^{ab} | 6,29±0,99 ^{ab} | 6,17±1,04 ^{ab} | 6,00±1,36 ^b |
| Texture | 6,29±0,94 ^a | 6,14±1,05 ^a | 6,20±1,09 ^a | 6,00±1,11 ^a | 5,85±1,18 ^a |
| Color | 6,28±1,06 ^a | 6,25±0,88 ^a | 6,20±1,05 ^a | 6,02±0,97 ^a | 5,97±1,10 ^a |
| Overall acceptance | 4,79±0,45 ^a | 4,72±0,57 ^a | 4,69±0,50 ^a | 4,69±0,66 ^a | 4,69±0,63 ^a |
| Purchase intent | 4,68±0,58 ^a | 4,62±0,60 ^a | 4,47±0,89 ^a | 4,52±0,85 ^a | 4,31±0,92 ^a |

Source: Authors (2013).

Note: Different letters in the line indicate significant difference by Tukey's test ($p < 0.05$); SD: Standard deviation; F1: standard; F2: 20% of inulin; F3: 25% of inulin; F4: 30% of inulin; F5: 35% of inulin.

There was not meaningful difference ($p > 0.05$) between the samples related to the attributes aroma, texture and color, corroborating with studies from Moscatto et al. (2004) who evaluated the chocolate cake acceptability added with inulin (6%) among adults.

It is noteworthy that during the preparation of the bread formulations, the higher levels of inulin added to the mass resulted in softer mass, making it difficult for the mass modeling. However, as previously mentioned, this technological texture change was not detected by children after cooking.

Evaluating the attribute appearance, it is possible to verify that sample F5 was less accepted by the judges, showed a significant difference from the standard sample (F1) ($p < 0.05$), but without a statistical difference among the other samples, containing inulin. Yet, research with adult judges (MOSCATTO et al, 2010), evaluating biscuits type cookies added 10, 20 and 30% with inulin, resulted in lower appearance

scores in products containing 30% of ingredient.

Some researches confirm that the presence of inulin in products can modify their appearance. Peressini and Sensidoni (2009) verified that additions of 5 and 7.5% inulin increased the growth of bread dough, what was also verified in this survey. Yet, Wang, Wilson and Griffith (2002) found that the mass height was lower when added 3% inulin to the dough. According to Morris and Morris (2012), inulin can interfere to the elasticity and deformation resistance of masses, interfering in gluten network, resulting in a product with lower final development volume, effect observed in the present work. These technological changes may explain the lower scores for appearance to the sample with higher inulin content.

For the taste attribute, the standard formulation (F1) showed greater acceptance ($p < 0.05$) than F5, without statistical difference from the others, whose results were also verified by Aplevicz and Dias (2010). This fact can be explained because inulin

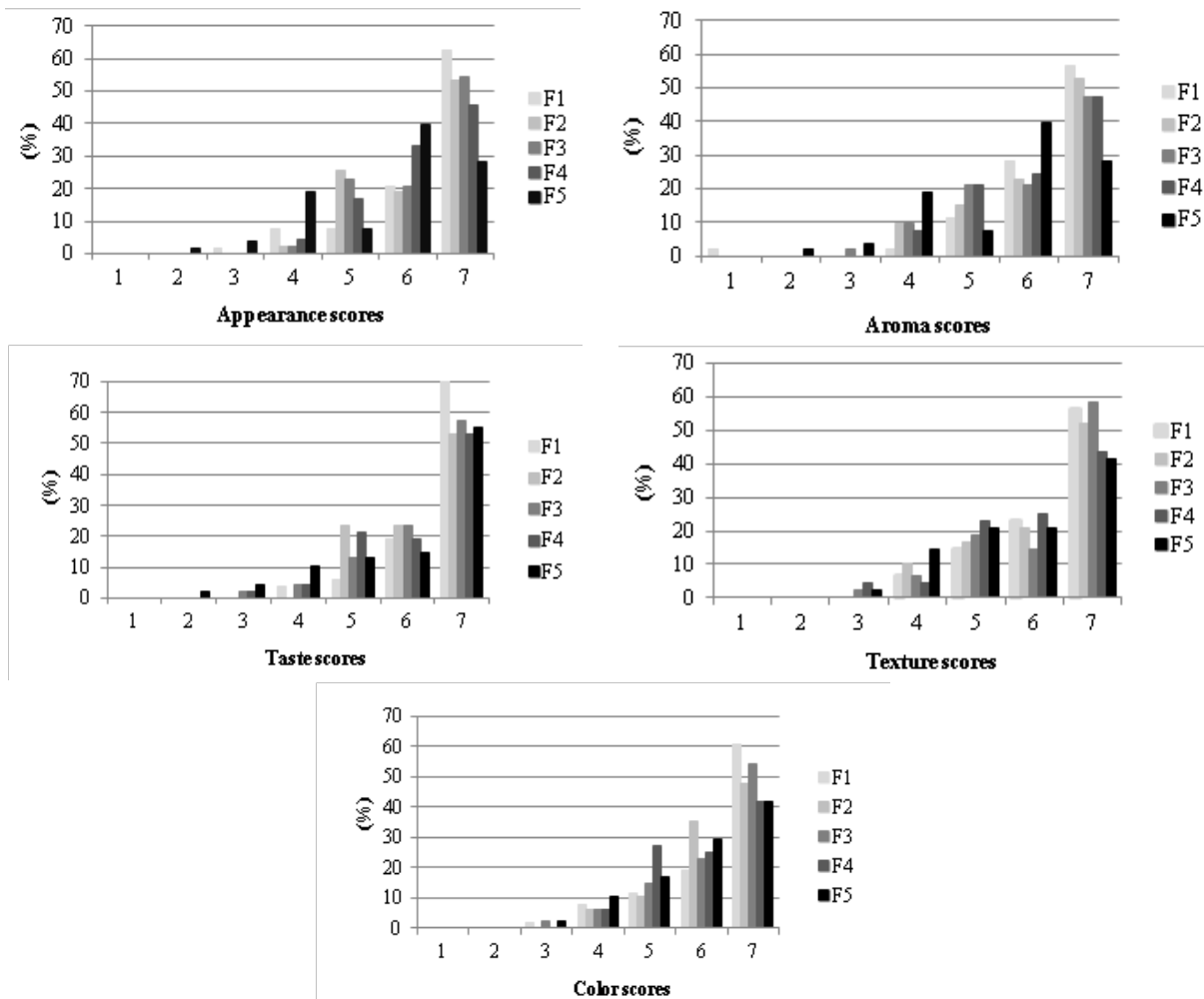
is slightly sweet, representing only 10% of the sweetness of sucrose (ISIK et al., 2011), which was reduced in the formulations of the present research.

Despite the lower evaluation for appearance and taste attributes of F5, issues of global acceptance and purchase intention received positive results, since the judges did

not detect differences between the standard samples and those with inulin ($p > 0.05$).

It is noteworthy that global products acceptability obtained a score within the recommended by the National Fund for Education Development (ENDF) (4-5 points in facial hedonic scale of 5 points). Therefore, this product could be inserted in

Figure 1 - Distribution of judges by hedonic values (1-7) obtained in the evaluation of the attributes appearance, aroma, taste, texture and color of flavored pineapple bread formulations standard and enriched with 20, 25, 30 and 35% inulin



Source: Authors (2013).

school snacks due to the high acceptance by children (above 4 points) (BRASIL, 2009).

In Figure 1 we can observe the judges distribution by hedonic values obtained in the evaluation of attributes of flavored bread standard and inulin added.

In general, scores 6 (very good) and 7 (super good) were the most frequently mentioned by the judges, showing that the inulin addition on bread was well accepted by children, generating results that were confirmed by assessing the acceptability index of formulations which is shown in Figure 2.

All samples showed IA above 70% (Figure 2), which considers the products with good sensory acceptability, according to Teixeira et al. (1987).

According to Alamanou et al. (1996) attributes like aroma and taste are the most important characteristics which influence the sensory properties of food products

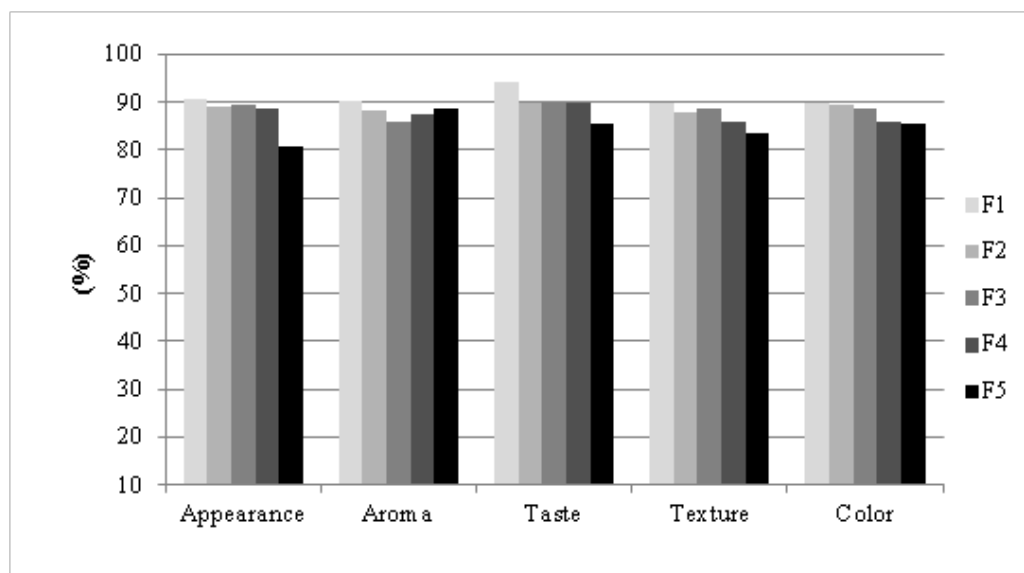
added with different ingredients. As a result, the sample F4 (30% inulin) was selected for comparison purposes, with the pattern (F1), for being the one with the highest content of inulin and similar acceptance to the standard (taste attribute).

Physico-chemical analyzes

In Chart 3 it is possible to verify the physico-chemical composition and Reference Daily Value (DV) of flavored pineapple standard bread and added with 30% inulin, compared to a reference product.

Higher moisture and protein contents were verified for the F1 ($p < 0.05$). Both formulations are in accordance with recommendation of the RDC N^o. 90, the National Health Surveillance Agency (ANVISA), which defines a maximum of 38% moisture to bread (BRASIL, 2000). The

Figure 2 - Acceptability index of formulations flavored pineapple bread standard and enriched with 20, 25, 30 and 35% inulin, relative to the evaluated attributes



Source: Authors (2013).

Chart 3 - Physico-chemical composition and Reference Daily Value - DV * (50 grams middle portion) of standard bread (F1) and added to 30% inulin (F4), compared with the reference product **

| Evaluation | F1 | | F4 | | Reference** |
|---|--------------------------|---------|--------------------------|---------|-------------|
| | Mean±SD | DV (%)* | Mean±SD | DV (%)* | |
| Moisture (%) | 33,24±0,00 ^a | ND | 24,51±0,04 ^b | ND | 25,80 |
| Ash (g.100g ⁻¹)*** | 0,56±0,02 ^a | ND | 0,50±0,01 ^a | ND | 1,50 |
| Proteins (g.100g ⁻¹)*** | 8,02±0,02 ^a | 6,38 | 6,79±0,05 ^b | 5,40 | 8,40 |
| Lipids (g.100g ⁻¹)*** | 2,51±0,05 ^a | 1,90 | 2,58±0,09 ^a | 1,96 | 2,80 |
| Carbohydrate (g.100g ⁻¹)*** | 55,66±0,07 ^b | 10,75 | 65,62±0,02 ^a | 12,67 | 61,50 |
| Calorie value (kcal.100g ⁻¹)*** | 280,85±0,28 ^a | 7,64 | 239,27±0,46 ^b | 6,64 | 311,00 |
| Crude fiber (g.100g ⁻¹)*** | 7,12±0,03 ^b | ND | 9,03±0,10 ^a | ND | ND |

Source: Authors (2013).

Note: Different letters in the line indicate significant difference by student's test ($p < 0.05$); *DV: nutrients evaluated by the average of the DRI (2005), with base in a diet of 1.802,55 kcal/day; **Values compared with "Traditional homemade bread" (TACO, 2011); *** Results expressed in humid base; SD: Standard deviation; ND: not available.

higher moisture content recorded on F1 can be explained according to Morris and Morris (2012), water absorption is reduced by inulin addition. Yet, the highest protein content in the sample pattern can be explained by the greater amount of flour present in this formulation, which has a higher protein content in their composition (9.8%) (TACO, 2011) than inulin (0%) (BENEO® HP, 2012). However, both F1 and F4 showed lower results than the reference product (TACO, 2011)

Despite the reduction in the protein content of the inulin product added (F4), which somewhat reduces its nutritional value, it was possible to lower the calorie content of 14.81%, a beneficial fact for children, since a smaller calorie intake reduces the risk of chronic diseases in the future (SILVEIRA; ABREU, 2006).

There was no meaningful difference between the formulations in ash and lipids evaluations. Through Chart 3 we can see that higher levels of carbohydrates and crude fiber were observed in the formulation with inulin, increasing also the DV product. This fact is

justified because inulin has high carbohydrate levels (96.87%) and fiber (96.87%) in their chemical composition (BENEO® HP, 2012), when compared to wheat flour (75.1% and 2.3%) (TACO, 2011).

It stands out as the main result of this work the fiber content found in the formulation F4 (9.03 g.100g⁻¹), expressing a meaningful increase of 26.82% compared to F1. This is due mainly to the high content of dietary fiber showed in inulin. These results make the product into an excellent choice for school, considering the low fiber intake by this group (RINALDI et al., 2008). According to Brazilian legislation (BRASIL, 2012), it is considered as a good source of dietary fiber when the food presents at least 6% fiber.

Conclusion

The products development proved that an addition level up to 30% inulin in flavored bread was well accepted by the judges, obtaining sensory acceptance similar to standard product. The adding of 30%

inulin provided the increase in nutrients such as carbohydrates and reduced proteins, humidity and calories. It is noteworthy that inulin addition to bread made a high fiber intake possible, improving the nutritional

product profile. Thus, inulin can be considered a potential ingredient with functional properties that can be offered to school-age children, showing good marketing expectations acceptance.

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