**Development and Characterization of a Probiotic-Rich Fermented Beverage: Exploring the Influence of Chickpea Flour and Inulin Concentrations**

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**Abstract**

Plant-based fermented foods are an excellent alternative to supply the need for functional and nutritious foods. Therefore, this study aimed to develop a new fermented drink. Thus, we evaluated the physical and chemical properties of fermented beverages with a culture of probiotic microorganisms prepared with different concentrations of chickpea flour and inulin. A completely randomized design with a 3 x 3 factorial arrangement was used, with three concentrations of chickpea flour (10, 20, and 30%) and three concentrations of inulin (5, 10, and 15%). The inulin concentration influenced mainly the carbohydrate contents and energy value. In fermented beverages, five chemical components were identified by CG-MS as 1-propanol, hexanal, 1-propanol, 2-methyl, 1-butanol, 3-methyl, 1-hexanol. We concluded that the beverage formulation with 20% of chickpea flour with the addition of 15% of inulin was suitable regarding nutritional and physicochemical characteristics. Further studies on the sensorial evaluation are needed.

**Keywords:** pulses; plant-based beverage; Lactobacillus acidophilus; fiber; gas chromatography.

**Introduction**

In recent years, plant-based food products have been standing out in the market due to the awareness of consumers on the benefits of animal-free products. As a consequence, industries started to research, develop and produce novel food products that attend to this new claim (Buhl; Christensen; Hammershøj, 2019). Furthermore, the projection of the vegetable beverage market is expanding. Between 2018 and 2024, the annual forecast growth will be 14% (Angelino et al., 2020). This trend is associated with the increase of veganism and vegetarianism supporters, and people with dietary restrictions, for example, those with lactose intolerance (Vanga; Raghavan, 2018).

The chickpea crop is significant due to its rusticity. It has low demand for water, inputs, and energy, which contributes to the production of more sustainable foods. As a consequence, its consumption can help to reduce food insecurity at a global level (Loke *et al*., 2016). Chickpea is a pulse, a plant from the family *Fabaceae*, along with beans, lentils, and peas. These dry grains are versatile products that can be consumed in several ways, such as cooked, roasted, or as flour in different formulations (Varshney; Thudi; Muehlbauer, 2017). Therefore, chickpeas have a high potential for industrial use.

With good nutritional quality, high protein content, and a significant amount of lipids, fibers, and minerals in its composition, chickpea flour can be used in the formulation or enrichment of products (Margier *et al*., 2018). Its nutritional constituents are essential for humans’ health promotion due to their characteristics, such as low glycemic index (Aisa *et al*., 2019), and the presence of bioactive compounds, carotenoids, and phytosterols, such as isoflavones (Niño-Medina *et al*., 2019).

Few vegetables are used to formulate plant-based beverages as an alternative to cow's milk (Sethi; Tyagi; Anurag, 2016). Recently, chickpeas have been studied in the production of alternative foods due to their flour functional and technological properties, such as emulsifying activity, and oil absorption and retention capacity (Meurer; De Souza; Marczak, 2020); as well as producing vegetable beverages with low allergenic potential (Ricon; Botelho, De Alencar, 2020), such as fermented beverages.

Probiotics are microorganisms that, when appropriately used, benefit the individual's health, as they secrete metabolites such as short-chain fatty acids, organic acids, and enzymes, and also compete with pathogenic organisms (FAO/WHO, 2002; Plaza-Dias *et al*., 2019). They have been used in several fermentation processes of non-alcoholic beverages (Mantzourani *et al*., 2019). Fermentation is an antique food preservation process in which non-pathogenic microorganisms are used to acidify the environment and to cause biochemical changes, such as glycolysis, proteolysis, and lipolysis. These modifications not only add functional value to the product and increase food safety but also provide differences in the sensory characteristics (aroma, flavor, and/or texture) of the product. (Ashaolu, 2020). Using oligosaccharides, such as inulin, in fermented beverages stimulates the growth of probiotic microorganisms, and contributes to the health improvement of individuals that consumes products enriched with prebiotic fibers (Wasilewskisk *et al*., 2015).

Thus, we hypothesize that it is possible to verify the technological and nutritional viability of a based chickpea flour and inulin-fermented beverages. This is justified by the market necessity of plant-based alternatives focused on those consumers that are vegetarian, vegan, or with dietary restrictions. Therefore, the objective of this work was to evaluate the physical and chemical properties of fermented beverages with a culture of probiotic microorganisms prepared with different concentrations of chickpea flour and inulin.

**Material and Methods**

**Raw material and reagents**

The chickpea flour was donated by Milhão Indústria e Comércio de Ingredientes, located in Goianira, GO. Inulin (Longevitá, Goiânia, Brazil) and probiotic strains (Longevitá, Goiânia, Brazil) were purchased locally. The reagents used in the analyses had analytical purity (P.A.).

**Processing of extracts and fermented beverages**

The research was carried out at the Graduate Laboratory of the School of Agronomy at UFG (Universidade Federal de Goiás). A completely randomized design with a 3 x 3 factorial arrangement was used, with three concentrations of chickpea flour (10, 20, and 30%) and three concentrations of inulin (5, 10, and 15%), in 3 original replications. Samples in proportions of chickpea flour and water (g/mL), were mixed in an industrial blender until obtaining a homogeneous mixture. The sample mixture was termed an aqueous chickpea extract. Each extract containing 500 mL of water was heated in a Cap-Lab water bath to a temperature of approximately 60 °C for 30 minutes for pasteurization. Then 5 g of sucrose and inulin were added at different concentrations (5, 10, and 15 g/100g of extract).

Then, each mixture was cooled to approximately 45°C, and the probiotic colony containing *Saccharomyces Boullardii* 2 blh ufc (microbial counting unit), *Lactobacillus acidophilus* 2 blh ufc, *Bifidobacterium bifidum* 2 blh ufc in the amount of 0.2 U was added, corresponding to 2% v/v of the sample volume for the fermentation process. Fermentation took place at a temperature of 45º C for 6 hours. Then, the fermented beverages were packaged in identified plastic pots with screw caps and stored under refrigeration (5°C ± 1°C) for 14 days, according to the protocol established by Ricon, Botelho and De Alencar (2020).

**Chickpea and beverage analytical determinations**

The solubility in water as a function of pH (3.0-9.0) was determined according to the method described by Ghribi *et al*. (2015), where 100 mg of sample was dispersed in 20 mL of distilled water and the pH was adjusted to the desired value (7.0) using 0.1 mol NaOH/L. The suspensions were magnetically stirred for 1 h at room temperature and centrifuged at 8000×g for 15 min.

The water and oil absorption capacity of the samples were determined according to Aydemir and Yemenicioĝlu (2013). Approximately 0.05 g of sample was dispersed in 1.5 mL of distilled water and sunflower oil in centrifuge tubes and vortexed, to be kept at room temperature for 30 min and centrifuged (15,000×g, 20 min, 4 °C) and the pellet was weighed. Results were expressed as g of water or oil absorbed per g of sample, respectively.

To determine the foaming capacity and stability of the samples, the methodology was described by Ghribi *et al*. (2015). The solutions of each sample (30 g/L) were adjusted to pH 7.0 using 0.1 mol NaOH/L. The samples were shaken at 11,000 rpm for 2 min with a homogenizer to form the foamed solution. The foam volume was measured between 10, 30, and 60 min after stirring.

The viscoamylograph characteristics of the samples were determined using a Rapid Visco Analyzer (RVA) equipment (Perten, RVA 4500, Huddinge, Sweden), using a moisture level of 14% as a standard. Minimum viscosity, viscosity breakdown, final viscosity, the tendency to retrograde, peak temperature, and gelatinization temperature were obtained.

The proximal composition of the samples was performed according to the Association of Official Analytical Chemists (AOAC, 2019), using methods 930.04 for moisture, 930.05 for ash, 960.52 for nitrogen determination and 922.16 for total fiber determination. The lipid content was determined by the Bligh and Dyer method (1959) using methanol. The carbohydrate content was estimated by the difference method, subtracting from 100 the values of moisture, ashes, proteins, lipids, and fibers. The total energy value was calculated using the coefficients of Atwater and Woods (1896).

Total soluble solids were determined using a digital refractometer (PHOX, RM-T90, Paraná, Brazil); pH with a portable digital pH meter (Linelab, classic, Arizona, USA); and the total acidity by titration with 0.1 N NaOH, as recommended by the AOAC (2016).

**Chromatographic analysis**

Some samples were analyzed in a gas chromatograph coupled to a mass spectrometer (GCMS) (Shimadzu, Nexis GC2030), equipped with an SH-Stabilwax-ms column (30 m x 250 μm, 0.25 μm). The samples were previously heated via headspace at 100 °C for 60 min and a volume of 1.0 mL was injected into the chromatograph in split mode, with a ratio of 10:1 and an equilibrium time of 3 min. The oven temperature was initially programmed at 40 °C and maintained for 1 min, with heating ramps from 5 °C/min to 160 °C and 10 °C/min to 250 °C, totaling 49 minutes of analysis. Helium 5.0 was used as the carrier gas, under the pressure of 4.7 psi, flow rate of 0.94 mL/min, and linear velocity of 35.0 cm/s. The temperature of the injector, interface, and ion source was maintained at 250 °C. The mass spectrometer was operated in scan mode recording ions in the range from 20 to 400 m/z, with a scan time of 150 ms.

**Statistical analysis**

The results of the extracts and the fermented beverage were submitted to analysis of variance (factorial Anova and One-way Anova) and the Tukey test was applied to identify significant differences between the means, considering a probability of 5% (p < 0.05). The best formulation was determined by Principal Component Analysis. The computer program Statistica 10.0 (StaSoft Inc., Tulsa, USA) was used. Analysis results were expressed as mean ± standard deviation.

**Results and Discussion**

**Proximal composition of chickpea flour**

The maximum moisture that allows for maintaining microbiological stability and the conservation of flour adequately during storage is 15% (BRASIL, 2005). The moisture determined in the chickpea flour was 7.69% (Table 1), therefore, it was within the quality standard established by the legislation. Other authors reported higher moisture values for chickpea flour of 8.7% (Fernandes, 2019) and 10% (Molina, 2010), probably due to differences in the drying time of the grains before obtaining the products.

Chickpea flour had an ash content of 2.77% (Table 1), a fair value for food and beverages according to RDC No. 263 (BRASIL, 2019). Values above 3% of ash in leguminous flours, such as soy, can mean product contamination or processing failures (BRASIL, 1996).

Due to the high content of lipids present in chickpea flours, compared to other pulses, chickpeas are presented as an option to improve the technological properties of vegan products (Bashir; Aggarwal, 2016). The sample had about 6.32% of lipids (Table 1), a result similar to that reported by Schubert (2017), who determined a value of around 6.92%. However, the lipid content may vary depending on the chickpea cultivar, in another study, values between 6.7 and 7.6% were found (Sanjeewa, 2010).

The protein content of chickpea flour was 23.84% (Table 1), higher than the values reported by Polesi (2012) and Meurer (2019), of 21, 46%, and 17.75%, respectively. Among legume flours, chickpea flour is the one with the highest protein bioavailability (Jukanti *et al*., 2012). When combined, plant-based proteins provide all the essential amino acids necessary for human metabolic homeostasis (Harvard, 2010).

The total dietary fiber content of chickpea flour was determined to be 9.8% (Table 1), much lower than the levels between 20.86% and 33.02% reported by Kanai (2021). According to Schutyser (2015) there may be differences in dietary fiber values because of the size of the granules of starch particles and protein bodies.

The estimated digestible carbohydrate content of chickpea flour was 49.58% (Table 1), close to the minimum content of the 50 to 64% range reported by Meurer (2019), and above the values in the range between 25.39% and 46.22% obtained in same studies. These differences in digestible carbohydrate values may be related to the plant species and its cultivation method (Kanai, 2019).

The high levels of carbohydrates (49.58 ± 0.77%) are due to the nature of the plant material. In addition, we can also observe significant values of dietary fiber, lipids, and proteins in the analyses. These values justify the caloric value of approximately 388.16 kcal.100g-1 of chickpea flour (Kishor *et al*., 2017).

**Physicochemical and technological characteristics of chickpea flour**

The water solubility of chickpea flour was 21.23% (Table 2), higher than the value of 16% reported by Moreno (2019) and lower than the value of 23.68% determined by Fernandes (2019). Water solubility varies according to the greater presence of water-soluble components such as saccharides and the concentration of soluble proteins (Dadon; Abbo; Reifen, 2017), which varies depending on the cultivar, climatic conditions, and cultural and post-harvest management.

The water absorption capacity determined for chickpea flour was 2.58%, which corroborates the values of 3% and 2.62% reported by Fernandes *et al*. (2019) and Moreno (2019), respectively. The water solubility properties, water, and oil absorption capacity vary according to the number of soluble molecules present in the sample and depend on the intensity and type of reaction that will occur in the treatment of the raw material (Santana; Filho; Egea, 2017). The higher the water absorption capacity, the greater the amount of protein and dietary fiber in the flour (Pires *et al*., 2017), which can be classified as flour rich in fiber because it has a content higher than 6%, and is rich in protein because it has a protein fraction with good bioavailability (Kishor *et al*., 2017).

In chickpea flour, the oil absorption capacity was around 1.65%, an adequate value for the product proposal since the fermented beverage does not undergo the addition of fat in its formulation, and it is not lipid rich in its composition (Table 3). The gelatinization temperature of chickpea flour was 73.17 °C, representing a high temperature since it is reported a starch's gelatinization temperature of approximately 60 °C (Hu *et al*., 2019). This property interferes with the amount of raw material used in the formulation of the products and the preparation method when very high temperatures are used, for example (Santana; Filho; Egea, 2017). The gelatinization temperature of chickpea flour may be related to its macronutrient composition, such as protein and lipids, and its fiber content (Kiumarsi *et al*., 2019).

An interesting characteristic of chickpea flour is its low setback of 57.37 RVU (Table 2), compared to other flours with a greater tendency to retrograde, for example, rice flour (Nabeshima, 2007). The setback is characterized by the reorganization of the starch molecules, causing the dispersion of excess water. The lower the retrogradation values, the lower the chances of deformation of the paste during cooling (XIA *et al*., 2018), so chickpea flour is suitable for producing chilled fermented beverages.

The viscosity peak represents the maximum viscosity between the heating and cooling of a starchy product. It was 149.04 RVU (Table 2) in chickpea flour, a value lower than the values reported by Moreno (2019), whose average was 182.33 RVU. It happened probably due to differences between the genetic materials and the prevailing soil, the climate conditions in the places of origin, and the management used.

Viscosity breakdown is important to assess the degree of stability of the paste under high temperatures and agitation, and it is inversely proportional to the stability of the sample (Bashir; Aggarwal, 2016). Chickpea flour had a breakdown of 14.87 (Table 2).

**Physicochemical analysis of fermented beverages**

The pH values of the beverages produced (Table 3) are still within the range conducive to bacterial growth, both of probiotics, bacteria, and other spoilage and pathogenic microorganisms (Moretti, 2009). Anyhow, this product has a short shelf life, so conservation methods must be allied. In addition, pH has a significant variation in the formulations. A more acidic pH was observed in the drinks without adding inulin, according to the higher concentration of chickpea flour in the extract. The variations between beverages presented values of 4.61 ± 0.01, 4.51 ± 0.05, and 4.32 ± 0.006 in the formulations containing the extracts of 10% chickpea flour, 20% flour, and 30% chickpea flour, respectively (p < 0.05). In the analyzed samples, the pH values were inversely proportional to the amount of inulin present in the formulations. Carbohydrates and oligosaccharides in fermented products provide more significant metabolic activity of probiotic bacteria (Hussein *et al*., 2020), which agrees with the pH values found. Regarding the acidity of the analyzed products, the values varied between 0.37 ± 0.10 and 0.57 ± 0.34% (Table 3). Despite this variation in formulations, the products are within the range of values determined by Brazil's current legislation (BRASIL, 2007). Higher levels of sugar or oligosaccharides, such as inulin, result in higher titratable acidity, a characteristic observed in all groups. This proportionality relationship can be explained by the metabolic activity of probiotics since sugar and inulin are good sources of carbon, as consequence during the metabolism of this carbon, microorganisms release organic acids that contribute to acidity increase (Davoodi *et al*., 2016).

Soluble solids values are similar to vegetable drinks found in supermarkets (Nunes *et al*., 2014). The soluble solids values in this analysis ranged from 6.75 ± 0.01 to 9.13 ± 0.08. The lowest value was obtained in the BF1 sample, while the highest was the BF9 sample. The concentration of total soluble solids (°BRIX) in the products is related to the addition of inulin and sugar in the formulation.

The moisture of the products is directly interconnected with their conservation. Beverages have a high moisture content, as it is a product with a liquid consistency. The moisture values found did show a significant difference (*p* < 0.05) according to the increase in inulin content and the use of extracts with a higher concentration of chickpea flour.

A significant difference was observed between the lipid levels concerning the amount of inulin (*p* < 0.05). The samples with different concentrations of chickpea flour varied between 1.40 ± 0.03 and 1.94 ± 0.01 %. The results obtained were significantly higher than those of the study by Wang, Chelikani and Serventi (2018), who got an average lipid value of 0.34 g/100g.

According to the World Health Organization (2013), the recommended daily protein intake is between 10 and 15%. The average values found in the formulations per 100 g of product varied between Studies with yogurt drinks made with vegetable extract (soy) (Ladislau *et al*., 2017). That is, the values found during the analysis of the samples of the formulations of the present study are lower. The average protein content varied between 1.16 ± 0.01 and 1.40 ± 0.04%. No significant difference was observed between the values of proteins (*p* > 0.05) about the values of inulin and the difference in concentration of the extracts.

Regarding the values of fiber and total carbohydrates, the differences found were also not significant (*p* < 0.05). The relationship between the amount of fiber and carbohydrate content, with the concentration of chickpea flour in the extract and inulin, is directly proportional. The formulation that presented the highest amount of fiber and carbohydrate was the beverage containing 30% of chickpea flour and the addition of 15 g of inulin. This proportionality relationship also occurred in the context of energy value. The higher the extract's concentration and the greater the amount of inulin in the drink, the greater its energy value.

**Chromatographic analysis**

The best formulation developed showed greater adequacy of macronutrients concerning energy value (Figure 1), that is, the BF6 formulation (beverage containing 20 % of chickpea flour and with the addition of 15 % of inulin), through determination through Principal Component Analysis (Figure 2).

In the qualitative analysis, the presence of five Volatile Organic Compounds - VOCs in the fermented beverage was identified: 1-propanol, hexanal, 1-propanol, 2-methyl, 1-butanol, 3-methyl, 1-hexanol (Figure 3 and Table 4). Eleven VOCs were found in chickpea flour, of which only two (hexanal and 1-hexanol) are the same found in fermented beverages. The VOCs mentioned above, found in the formulations of vegetable beverages, are responsible for the aroma and flavor of some fermented beverages (Ott, Fay, Chaintreau, 1997).

The fatty acids profile in beverages is directly related to the raw material used in their formulation. However, another way to modify these characteristics in the final product is associated with the microorganisms used in the fermentation process. The product's chemical composition is influenced by bacterial metabolism, which interacts with the medium during growth and converts specific chemical components into products of its metabolism (Heller, 2001). Condurso *et al*. (2008) report that the volatile compounds formed result from the biochemical changes due to the fermentation process.

According to Zourari, Accolas and Desmazeaud (1992), the chemical compounds 1-propanol,2-methyl and 1-butanol, and 3-methyl present in the chromatographic analyzes originate exclusively from pyruvate, as some cultures of microorganisms are unable to metabolize citrate. Also, 1-Propanol, 2-methyl-propanol, and 3-methyl-butanol are congeneric alcohols produced in the fermentation process through the contamination of other bacteria or the degradation of amino acids (Cardoso, 2013). From the chromatograms, VOCs show slight variation. Further studies need to be conducted to quantify the components present in the formulations, as errors in the formulations and the sample matrix can interfere with the results (Jackson, 2020).

**Conclusion**

The chickpea flour concentrations and the inulin contents influenced the results obtained in the proximate composition of the beverages and the physicochemical analyses. Regarding the chromatographic analysis, we observed that keeping a symbiotic relationship in the analyzed samples was possible. Because of the data obtained in the present study, it is possible to suggest that chickpea flour is an excellent raw material to use in the formulation of vegetable products. And that fermented chickpea drink, with the correct formulation (beverage containing 20 % of chickpea flour and with the addition of 15 % of inulin), can be a substitute for fermented milk, especially for vegetarians, vegans, and people with food intolerances and allergies to animal milk components, such as the milk protein lactose. In conclusion, future studies should evaluate the acceptability of chickpea-fermented beverages and the health benefits of individuals due to their consumption.

**Acknowledgments**

The *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior* (CAPES) for the master's scholarship. The Milhão Food Industry and Longevitá Manipulation Pharmacy for the partnership and donation of the raw material, probiotics, and inulin, respectively. And to the Federal University of Goiás for technical and structural support.

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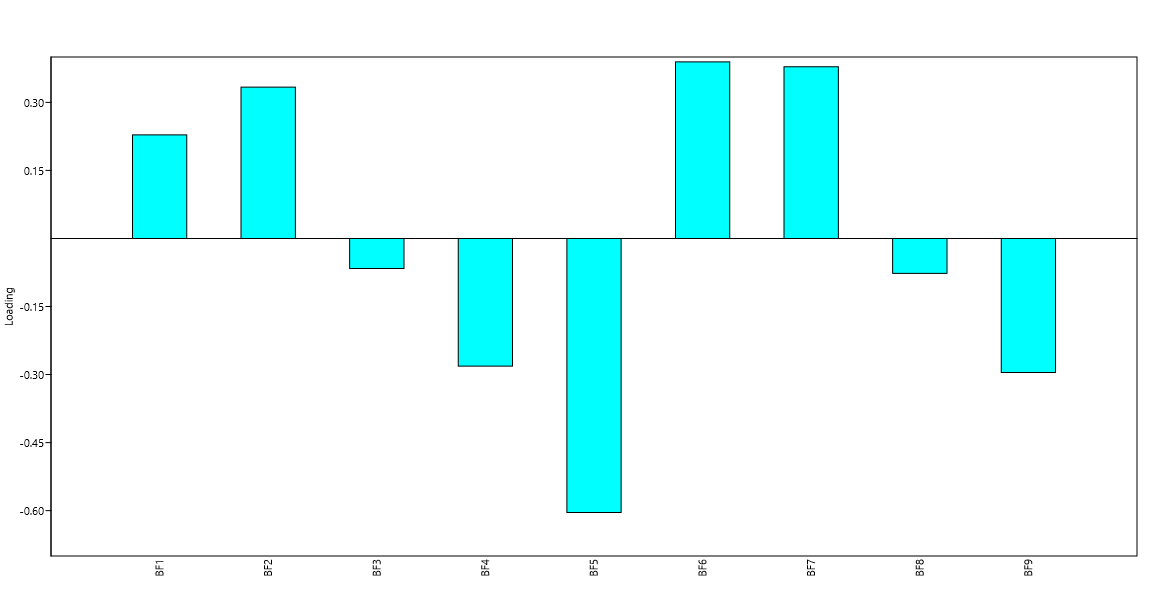
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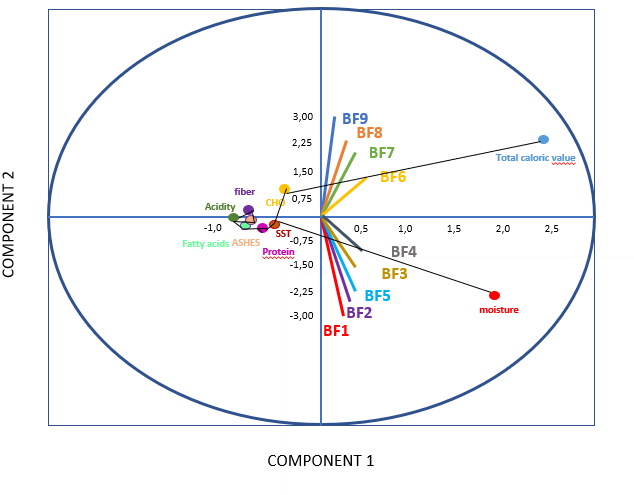
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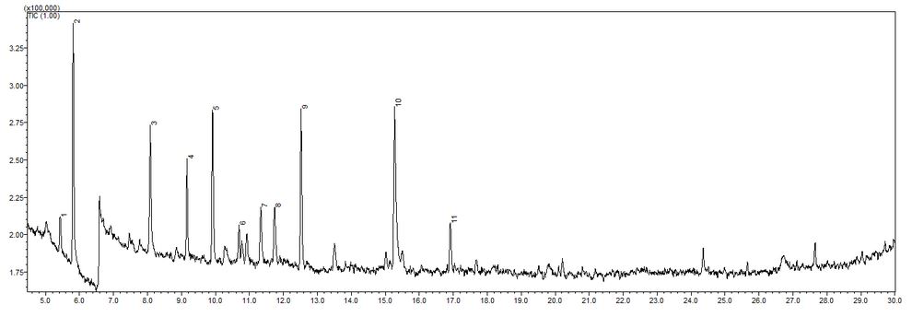


**Figure 1.** Adequacy of macronutrients in relation to the value of fermented beverages.

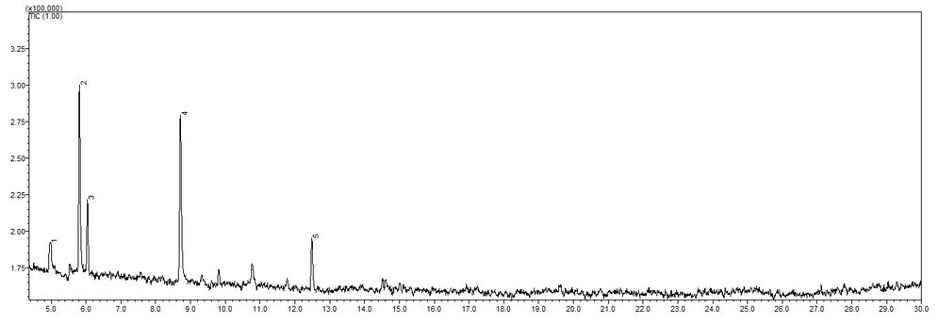


BF (Fermented drink); FGB (chickpea flour); I (inulin). BF1: 10% de FGB + 5% I; BF2: 10% de FGB + 10% I; BF3: 10% de FGB + 15% I; BF4: 15% de FGB + 5% I; BF5: 15% de FGB + 10% I; BF6: 15% de FGB + 15% I; BF7: 20% de FGB + 5% I; BF8: 20% de FGB + 10% I; BF9: 20% de FGB.

**Figure 2.** Principal Component Analysis

**(A)**

Peaks: (1) 2,3 – Pentanedione, (2) Hexanal, (3) 2 – Heptanone, (4) Furan, 2 – Pentyl, (5) 1 – Pentanol, (6) 2 – Octanone, (7) 2 – Propanone, 1 – Hydroxy, (8) Pyrazine, 2 -5 Dimethyl, (9) 1-Hexanol, (10) Acetc acid, (11) Benzaldegyde.



**(B)**

Peaks: (1) Propanol, (2) Hexanal, (3) 1 – Propanol, 2 - Methyl , (4) 1 – Butanol, 3 - Methyl, (5) 1 – Hexanol.

**Figure 3.** Panoramic chromatograms of (A) chickpea flour, and (B) fermented beverage with 20 g/100mL of chickpea flour in the extract and 15 g/100 mL of inulin.

**Table 1.** Centesimal composition and total energy value of chickpea flour (wet basis)

|  |  |
| --- | --- |
| **Component** | **Value3** |
| Moisture1 | 7.69 ± 0.05 |
| Ashes1 | 2.77 ± 0.08 |
| Lipids1 | 6.32 ± 0.04 |
| Proteins1 | 23.84 ± 0.07 |
| Total dietary fiber1 | 9.8 ± 0.83 |
| Digestible carbohydrates1 | 49.58 ± 0.77 |
| Total caloric value2 | 388.16 |

1%; 2 kcal. 100 g-1; 3mean ± standard deviation

**Table 2.** Physicochemical and viscoamylographic properties of chickpea flour

|  |  |
| --- | --- |
| **Attribute** | **Value7** |
| Solubility in water1 | 21.23 ± 0.10 |
| Water absorption capacity2 | 2.58 ± 0.40 |
| Oil absorption capacity2 | 1.65 ± 0.17 |
| Viscosity peak3 | 105.21 ± 0.75 |
| Peak time4 | 5.55 ± 0.06 |
| Gelatinization temperature5 | 73.17 ± 0.34 |
| Viscosity break6 | 14.87 ± 0.81 |
| Final viscosity3 | 149.04 ± 0.87 |
| Retrogradation tendency3 | 57.37 ± 0.42 |

1 %; 2 g gel/100 g sample; 3 RVU; 4 seconds; 5 °C; 6 dimensionless; 7 mean ± standard deviation

### **Table 3.** Physicochemical characteristics and total energy value of fermented beverages made with different chickpea and inulin proportions

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Attribute** | **Fermented beverages made with different amounts of chickpea flour (FGB) and inulin (I)** | | | | | | | | | |
| **BF1** | **BF2** | **BF3** | **BF4** | **BF5** | **BF6** | **BF7** | **BF8** | **BF9** |
| pH1 | 4.68±0.00003a | 4.64±0.0001a | 4.61±0.0007b | 4.66±0.0019a | 4.64±0.0028a | 4.55±0.0007b | 4.65±0.0003a | 4.62±0.0001a | 4.32±0.0001c |
| ATT2 | 0.37±0.004c | 0.37±0.0039c | 0.38±0.0043c | 0.37±0.0031c | 0.39±0.0052c | 0.43±0.009b | 0.39±0.0009c | 0.41±0.0016bc | 0.57±0.0036a |
| SST3 | 6.75±0.00b | 6.84 ± 0.019b | 6.96 ± 0.18b | 6.89±0.0021b | 7.06±0.0025b | 7.22±0.003b | 7.54 ±0.15b | 8.32± 0.04a | 9.13 ±0.08a |
| Moisture2 | 86.58± 0.43ª | 85.18± 0.84ª | 82.31± 0.16a | 81.52 ± 0.43a | 82.99 ± 0.15a | 75.,87 ± 0.56b | 73.34 ± 0.2b | 72.63± 0.49b | 70.02± 0.10b |
| Ashes2 | 0,35±0,0002ª | 0,35±0,0002a | 0,34±0,0007a | 0,38±0,0001a | 0,38±0,0003a | 0.39±0,0003a | 0,42±0,0004a | 0,42±0,0001a | 0.43±0.0001a |
| Lipids2 | 1,94±0,0019ª | 1.91±0.0037a | 1.88±0,0013a | 1.57±0,0013a | 1.54±0,0019ab | 1.57±0.0021a | 1.43±0.0031b | 1.41±0.0013b | 1.40 ± 0.03b |
| Proteins2 | 1.34 ± 0.002ª | 1.33±0.0009a | 1.33±0.0003a | 1.27±0,0003a | 1.25±0.0001a | 1.22±0.0002a | 1.18±0.0021a | 1.16±0.0004a | 1.4 ± 0.04a |
| FAT2 | 0.98 ± 0.43c | 1.03 ± 0.05c | 1.09 ± 0.10c | 1.49 ± 0.05b | 1.66 ± 0.04b | 1.91 ± 0.03b | 2.13 ± 0.03ab | 2.31 ± 0.14a | 2.69 ± 0.04a |
| CHOd2 | 8.82 ± 0.04b | 10.19 ± 1.4b | 13.05 ± 0.43b | 13.79 ± 0.65b | 12.15 ± 0.01a | 19.03 ± 0.60b | 21.50 ± 0.19a | 22.2 ± 0.19a | 24.06 ± 0.18a |
| VET4 | 62.01 | 67.28 | 78.8 | 80.29 | 74.12 | 102.82 | 112.11 | 115.37 | 125.2 |

BF (Fermented drink); FGB (chickpea flour); I (inulin). BF1: 10% de FGB + 5% I; BF2: 10% de FGB + 10% I; BF3: 10% de FGB + 15% I; BF4: 15% de FGB + 5% I; BF5: 15% de FGB + 10% I; BF6: 15% de FGB + 15% I; BF7: 20% de FGB + 5% I; BF8: 20% de FGB + 10% I; BF9: 20% de FGB + 55% I. 1 dimensionless; 2 %; 3 °Brix; 4 kcal. 100 g-1; 5mean ± standard deviation. \*Means followed by the same letters on the same lines do not differ statistically from

Each other by Tukey's test at 5% probability.

**Table 4.** Result of the elaborated analyzes of GC-SM chickpea flour and fermented beverages with 20% FGB and 15% Inulin.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Chickpea Flour** | | | | **Fermented beverages with 20% FGB and 15% Inulin** | | | |
| **Number** | **TR** | **%** | **Compound** | **Number** | **TR** | **%** | **Compound** |
| 1 | 5.426 | 2.73 | 2,3 – Pentanedione | 1 | 4.966 | 9.27 | 1 – Propanol |
| 2 | 5.813 | 18.33 | Hexanal | 2 | 5.806 | 33.32 | Hexanal |
| 3 | 8.081 | 9.82 | 2-Heptanone | 3 | 6.037 | 11.37 | 1 - Propanol, 2 – Methyl |
| 4 | 9.163 | 7.2 | Furan, 2-Pentyl | 4 | 8.711 | 35.07 | 1 - Butanol, 3 – Methyl |
| 5 | 9.915 | 12.55 | 1-Pentanol | 5 | 12.486 | 10.98 | 1 – Hexanol |
| 6 | 10.695 | 2.22 | 2 – Octanone | - |  |  |  |
| 7 | 11.336 | 5.14 | 2-Propanone, 1 – hydroxy | - |  |  |  |
| 8 | 11.74 | 5.46 | Pyrazine, 2-5-dimethyl | - |  |  |  |
| 9 | 12.523 | 12.99 | 1-Hexanol | - |  |  |  |
| 10 | 15.272 | 18.72 | Acetic acid | - |  |  |  |
| 11 | 16.912 | 4.85 | Benzaldehyde | - |  |  |  |

TR - retention time, % percentage of compounds found in the sample.