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Comparative Analysis of Bread Samples Produced With Different Sweeteners (Xylitol, Sugar, Honey and Date Powder)

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Abstract
This study investigated the effect of different sweeteners on bread quality characteristics. The sweeteners, xylitol, sugar, honey and date powder, were used to produce bread and designated as A101, B201, C301 and D401 respectively. The functional, proximate, mineral, vitamin, physical and sensory properties of the samples were determined using standard analytical methods. There were significant differences ($p<0.05$) in the functional properties of the flour samples. The proximate composition of the bread samples ranged from 28.24 to 29.46 % moisture, 5.32 to 7.34 % fat, 12.16 to 16.19 % protein, 2.03 to 3.33 % ash, 1.35 to 4.25 % crude fibre and 40.84 to 50.83 % carbohydrate, and 284.49 to 299.80 Kcal/J energy value. The volume, height, density and specific volume of the loaves varied from 570.07 to 760.77 ml, 48.50 to 52.50 mm, 4.76 to 6.90 g/cm^3 and 0.15 to 0.20 g/cm^3 respectively. The mineral content of the bread samples ranged from 88.55 to 124.26 mg/100g calcium; 121.24 to 141.64 mg/100g phosphorus; 206.43 to 271.12 mg/100g potassium; 9.66 to 16.43 mg/100g iron; 3.14 to 10.28 mg/100g zinc. Significant differences ($p<0.05$) were observed in the vitamin content of the bread samples. Results of the sensory evaluation indicated that all the bread samples were generally accepted but the sample containing honey was most appealing to the panellists. Sample containing date powder was observed to be the most nutritious and provided the highest amount of protein, fibre, energy, minerals, and vitamins compared to the other samples, and therefore recommended for functional bread production.
Keywords: Sweeteners, functional bread, wheat, xylitol, sugar, honey, and date powder

Introduction

Bread is a loaf that results from the baking of starch dough obtained from the mixture of grain flour, sugar, yeast, salt and water. Other baking ingredients like shortening, milk solids, eggs and antioxidant preservatives may be added (Ocheme *et al*., 2010). Sweeteners are one of the most important ingredients used in bakery foods. While there are many different sweeteners available, sucrose (or sugar) is perhaps the most versatile (Jenny, 2008). Sugar is one of the ingredients for bread-making, and it is the primary food for yeast (Nwanekezi *et al*., 2015). In the course of bread-making; the wheat flour dough is fermented with yeast. Fermentation is a process by which yeast acts on sugar and changes it into carbon dioxide gas and alcohol. The release of carbon dioxide gas produces the leavening action in breads. According to Nwanekezi *et al.* (2015), sugar helps to improve the bread crust colour through a browning reaction, acts as a preservative since it is an anti-staling agent, helps the bread to retain moisture by keeping the bread moist, acts as an improver and imparts flavour and also tenderizes the bread. Sugar not only makes foods taste sweet, but it also has many other functions such as sensory properties, physical properties, microbial (food preservation and fermentation), and antioxidant activity (Jenny, 2008). However, due to the high consumption of sucrose, seeking alternative sources is necessary. By now, sugar from carob, glucose syrup from local starch sources such as palm and cassava, fructose from cashew apple juice and cereal stems, date fruit and its products, inulin and polydextrose, arabinoxylan oligosaccharides, and other sources have been used to reduce sucrose consumption (Mariotti and Alamprese, 2012; Aidoo *et al*., 2014). It has been reported that sugar substitutes taste like sugar but have no calories or carbohydrates, do not contribute to weight gain cause cavities or raise blood sugar levels (University of California San Francisco Parnassus, 2010). Since sugar substitutes are many times sweeter than sugar, only small amounts are needed to sweeten foods and beverages, and all except saccharin are approved as safe for use during pregnancy. The substitution of a type of sugar for another has typically been studied in food products to find a level of replacement that will improve the product characteristics (Adeboye and Bamgbose, 2015). Bakery products are now modified to include diet sugar-free pastries purposely for a growing number of people with diabetes and to help avoid the risk inherent in excessive intake of sugar calories.

Honey as a sugar substitute has been known to have some health benefits and anti-microbial properties (Shultz, 2009). Beyond many health claims and the ability to mask any taste deficiency that may have resulted from ingredient interactions, the inclusion of honey into bread formulation is reported to offer functional benefits, improve the water-binding capacity of dough, provide increased volumes and improve the shelf life of baked products (Babajide *et al*., 2014). Date palm fruit *(Phoenix dactylifera)* is a delicious fruit with a sweet taste and a fleshy mouth feel. The major component of date fruits are carbohydrates (mainly the sugars sucrose, glucose and fructose), which may constitute about 70 % (Nwanekezi *et al*., 2015). The sugars of date fruit are easily digested and can immediately be moved to the blood after consumption and metabolized to release energy for various cell activities. Date fruits are a good source of fibre and contain very important vitamins and minerals, including significant amounts of calcium, iron, fluorine and selenium (Nwanekezi *et al*., 2015). Date fruit can be used as a practical supplement for iron deficiency without any side effects. At least six vitamins (thiamine, riboflavin, niacin, ascorbic acid, pyridoxine and vitamin A) have been reported to be present in dates in visible consideration (Nwanekezi *et al*., 2015). Xylitol has been recently attracting growing attention. It is as sweet as sucrose and can replace it in a 1:1 ratio. The energy xylitol provides is only 10 kJ/g, which is 40 % less than the energy from sucrose and this makes xylitol a good sugar substitute for producing reduced-energy foods. At equivalent concentrations, it has a lower water activity than sucrose, contributing to the microbial stability and shelf life of the final product (Eleonora *et al*., 2007). Slow absorption and entry into metabolic pathways independently of insulin and without rapid fluctuation of blood glucose levels support the use of xylitol as a diabetic sweetener (Eleonora *et al*., 2007). The pleasant taste profile and cooling effect with no unpleasant aftertaste make it a desirable ingredient for chewing gums. Since xylitol is not utilized by the acid-producing bacteria of the human oral cavity, it is regarded as a non-cariogenic sweetener (Eleonora *et al*., 2007).

Over the years there has been increasing use of excessive sugar in pastry products all over the world despite certain health conditions in some consumers cannot tolerate high sugar content in foods. Excessive refined sugars and calorie intake are known to promote tooth decay, diabetes, overweight, osteoporosis and heart diseases in people who are insulin resistant (Hu and Malik, 2010). To effectively check this problem, additional research must be carried out to evaluate the impact of other sweeteners on the nutritional quality of bread. Due to its high calorie and related problems, sucrose can be substituted with alternative sweeteners such as xylitol, honey and date powder. Some advantages of using alternative sweeteners include slow absorption, low calorie, non-carcinogenicity, non-participation in non-enzymatic browning, and being rarely metabolized. It is expected that findings from this research will not only contribute to existing academic literature but can be useful to health agencies, food researchers, policymakers, and other relevant stakeholders in the development and implementation of better alternatives for sugar in the food industry. The objective of this research was to undertake a comparative quality evaluation of bread samples produced with different sweeteners.

Materials and Methods

Materials collection

Wheat grains, date palm fruit, honey, salt, granulated sugar, margarine and yeast were purchased from *Orie Ugba* local market in Umuahia, Abia State, Nigeria, and xylitol sweetener was procured from Jumia online shopping in January 2022.

Sample preparation

The wheat grain (1 kg) was sorted and winnowed to remove dirt and foreign materials. The wheat seed was then dulled by abrasion with the grinding plates, milled into flour, sieved into fine particles and packed in a polyethene bag (Nwanekezi *et al*., 2015). The date palm fruit (200 g) was processed by removing the seeds manually with the aid of a knife, washed with water to remove adhering dirt, oven-dried at 65°C for 8 hrs and then milled into powder using a hand milling machine (Nwanekezi *et al*., 2015).

Bread production

The bread samples were prepared using the straight dough method described by Bredariol *et al.* (2019) with slight modifications. The ingredients (flour, water, sugar/xylitol/honey/date powder, margarine, yeast, and salt) as shown in Table 1 were mixed at low speed for 18 min. After this, the dough was left to rest for 10 min at room temperature and then divided into portions of 150 g and allowed to rest for another 15 min. The bread was then fermented at 35 °C and 85% relative humidity until it reached 3.5 times its initial volume (1 hour) and bake at 200 °C for 14 min. The bread prepared with sugar (B201) served as a control.

Functional properties analysis

The functional properties, swelling capacity, water absorption capacity (WAC), oil absorption capacity (OAC), foam capacity (FC) and bulk density (BD) were determined with the methods described by Onwuka (2018).

Bread physical properties evaluation

The bread height, volume, specific volume and density were determined with the methods described by See *et al.* (2007).

Proximate and energy value analysis

Protein, crude fibre, moisture, ash, fat and carbohydrate contents were determined by the official methods of AOAC (2010). The energy value was estimated using Atwater factors as described by AOAC (2010).

Mineral analysis

The method described by AOAC (2010) was employed to determine the calcium, phosphorus, potassium, iron and zinc content of the bread.

Vitamins determination

The method described by Onwuka (2018) was employed to analyze vitamin A. For vitamins B1 (thiamin), B2 (riboflavin), B3 (niacin) and vitamin C (ascorbic acid), the methods described by Okwu and Josiah (2006) were used for their determination.

Sensorial analysis

The bread samples were subjected to sensorial analysis 1 h after baking using a trained twenty-member panel from Michael Okpara University of Agriculture, Umudike, who tasted and scored the bread using a 9-point Hedonic scale. The scale ranged from nine for "extremely like" to one for "dislike extremely" (Mannay and Shadaksharawary, 2005). They were instructed to take one or two bites and slowly masticate the product before rating the sample. The bread samples were evaluated based on crust appearance, crumb browning, texture, taste, aroma and general acceptability.

Statistical design and analysis

A completely randomized experimental design (CRD) was employed with all four different sweeteners as variables. Data were analyzed using one-way analysis of variance (ANOVA) with a statistical package for the social science (SPSS) software (Version 21.0 SPSS, Inc.). Differences between means were determined by Duncan's test (95 % confidence level).

Results and Discussion

Functional properties of wheat flour with different sweeteners

Table 2 shows the effect of the different sweeteners on the functional properties of wheat flour. The bulk density of the wheat flour samples with different sweeteners ranged from 0.76 to 0.83 g/ml with sample A101 (wheat flour with xylitol) recording the highest which was not significantly ($p>0.05$) different from sample B201, wheat flour with sugar (control), while sample C301 (wheat flour with honey) recorded the lowest value which was similar to sample D401 (wheat flour with date powder). Bulk density, also called volumetric density or apparent density, is defined as the mass of many particles of flour material divided by the total volume they occupy. It is a functional property of flours, powders, fine particles, granules, and other divided solids of foods (or food ingredients) (Awuchi *et al*., 2019). The water absorption capacity of the flours ranged from 0.10 to 2.20 g/ml with sample B201 recording the highest while sample C301 had the lowest value. Samples A101 and D401 differed significantly ($p<0.05$) from samples B201 and C301. Adeleke and Odedeji (2010) reported a water absorption capacity value of 2.45 g/ml for wheat flour, which was higher than the values reported for wheat flour in this study. Water absorption capacity is the amount of water (moisture) taken up by food/flour to achieve the desirable consistency and create quality food products. It is the optimum amount of water required to be added to the dough before it becomes excessively sticky to process. Very low or excessive water absorption can negatively affect the quality of food products. The water absorption capacity of flour is an indication of the amount of water available for gelatinization (Edema *et al*., 2005). The result of this study suggests that sample B201 (wheat flour with sugar) would be useful in foods such as bakery products which require hydration to improve handling features (Akubor and Yusuf, 2013). The oil absorption capacity of the samples ranged from 8.60 to 9.00 g/ml with samples B201 and D401 recording the highest followed by C301 while sample A101 had the lowest value. The samples differed significantly ($p<0.05$) from each other. Oil absorption capacity is an essential functional property that contributes to enhancing mouth feel while retaining the food products' flavour (Iwe *et al*., 2016). It is an indication of the rate at which the protein binds to fat in food formulations (Onimawo and Akubor, 2012). The high oil absorption capacity of sample D401 (wheat flour with date powder) agrees with the studies conducted by Elleuch *et al*. (2008) on the physicochemical properties of dietary fibre extracted from date flesh. The relatively high oil absorption capacity of samples D401 and C301 (wheat flour with honey) suggests that they could be useful in food formulations where oil holding capacity is needed such as sausage and bakery products. The highest foam capacity was observed for sample B201 (control) and this was significantly different ($p<0.05$) from the other samples that were observed to have lower values for foam capacity. The foaming capacity of food or flour is measured as the amount of interfacial area created by whipping the food or flour. Foaming capacity and stability generally depend on the interfacial film formed by the proteins, which maintains the suspension of air bubbles and slows down the coalescence rate (Awuchi *et al*., 2019). This result is not in agreement with the observation that foods containing high protein have high foam capacity (Arukwe *et al*., 2021). The swelling index of the wheat flours with different sweeteners ranged between 14.48% and 33.45 % with sample C301 (honey flour) recording the highest while sample B201 (control flour) had the lowest and all the samples were significantly different ($p<0.05$) from each other. The swelling index also known as swelling capacity is the measure of the starch's ability to absorb water and swell, and also reflects the extent of associative forces in the starch granules. Swelling capacity (index) is considered a quality measure in some food products such as bakery products. It is an indication of the non-covalent bonding between the molecules of starch granules and also one of the factors of the α-amylose and amylopectin ratios (Iwe *et al*., 2016).

Physical characteristics of bread samples with different sweeteners

The effect of different sweeteners on the bread samples' physical properties is shown in Table 3. Results depicted that there was a decrease in the height of the bread samples from 52.50 to 48.50 mm. The minimum height was observed in sample D401 when compared to the control (B201) and other samples. The volume and specific volume of the loaves significantly ($p<0.05$) decreased from 760 to 570 ml and 0.20 to 0.15 cm^3/g

respectively as granulated sugar was replaced with xylitol, honey and date powder. The density of the bread samples ranged between 4.76 g/cm^3 and 6.90g/cm^3. When compared to sample B201 (control), it was noted that samples A101, C301 and D401 had higher density values. All the samples were significantly ($p<0.05$) different from each other. The decrease observed in the height of the different bread samples could be due to the effect of the sweeteners, especially the crude fibre content of sample D401 which may have caused a decrease in the amount of readily available fermentable sugar. The reduction in specific volume could be because sugar for yeast activity and consequently for the evolution of gas is lower in sample D401 which contains protein and crude fibre. Specific volume is the volume per unit weight of the loaf. It is the integral of the weight and volume of the loaf related to the rising power of the loaf during baking (Ayo *et al*., 2008) and has been generally adopted in the literature as a more reliable measure of loaf size (Shittu *et al*., 2007). The higher density values recorded for the other sweeteners (xylitol, honey and date) could be because most sugar substitutes especially polyols can substitute for both the physical bulk and sweetness of sugar (Sharma *et al*., 2015).

Proximate composition and energy value of bread samples with different sweeteners

In the result presented in Table 4, the carbohydrate content of the bread samples where sugar (sucrose) was substituted at the same ratio as date palm powder, xylitol, and honey ranged from 40.84 to 50.83 %. The carbohydrate content of the loaves was found to decrease significantly ($p<0.05$) with sample A101 as the highest and sample D401 as the least value. This might be due to the replacement of sucrose, a carbohydrate, with date palm powder which contains other nutrients. Also, compared to sample B201 (control), the protein, moisture, ash, crude fibre and fat increased significantly ($p<0.05$) among samples C301 and D401 except for sample A101 which is produced with a lower-calorie sweetener. This agreed with the work of Sadiq *et al*. (2013) that the increase in protein and other nutrients in the bread greatly improved the nutritional quality of bread and this is highly beneficial. This also agrees with the work of Nwanekezi *et al*. (2015) who reported a proportional increase in protein, moisture, ash, crude fibre, and fat content as well as a proportional decrease in the carbohydrate content of the bread samples as sugar was replaced with increasing percentage of date palm fruit pulp. In addition, the energy value of the samples significantly ($p<0.05$) increased, ranging from 284.49 to 299.80 Kcal/J with sample A101 (xylitol) recording the highest value and sample D401 (date) the lowest value. This result on xylitol however disagrees with the earlier works of Van Loveren (2004) and Shankar *et al.* (2013) who reported that xylitol contains 40% fewer calories than sugar.

Vitamin composition of bread samples with different sweeteners

The vitamin composition of the bread samples is shown in Table 5. Vitamin A varied from 4.35 to 6.41 mg/100 g. Sample D401 had the highest value while sample A101 had the least value and the samples were significantly ($p<0.05$) different from each other. This result shows that pro-vitamin A was found more in bread samples produced from date flours. This might be a result of the high level of β-carotene in date. The results also showed that thiamine (vitamin B1) content ranged between 0.85 mg/100g and 1.15 mg/100 g and indicated significant ($p<0.05$) differences. Sample D401 recorded the highest vitamin B1 followed by sample C301 (1.05 mg/100 g) while sample A101 had the lowest value. This implies that the substitution of sugar with date and honey increased the vitamin B1 content of the bread samples. The riboflavin (vitamin B2) content varied from 0.68 to 1.09 mg/100g. Sample C301 composed of honey as sweetener had the highest value followed by sample D401 sweetened with date (1.02 mg/100 g) and the lowest value was recorded for sample A101. There were significant ($p<0.05$) differences among all the bread samples. This result implies that the substitution of sugar with honey and date can significantly increase the vitamin B2 content of the bread samples compared to the other samples sweetened with sugar and xylitol. The niacin (vitamin B3) content of the bread samples ranged from 1.07 to 1.54 mg/100g. Sample D401 had the highest vitamin B3 content and was significantly different ($p<0.05$) from the other samples. The increase in the quantity of vitamin B3 in sample D401 suggests that the date used as the sweetener is a rich source of vitamin B3. The ascorbic acid (vitamin C) content varied significantly ($p<0.05$) from 14.30 to 31.90mg/100g. Sample A101 which was substituted with xylitol as a sweetener had the lowest value and sample D401 had the highest value. The result revealed that the sample produced with date powder had the highest ascorbic acid and suggests that date fruit is richer in vitamin C followed by honey than the other sweeteners. The results obtained from this study have shown that using date and honey as sweeteners in bread production can be of immense benefit in ameliorating the vitamin deficiencies prevalent in Nigeria and other developing countries.

The mineral content of bread samples with different sweeteners

The mineral content of the bread samples is given in Table 6. The potassium content ranged from 206.43 to 271.12mg/100g. It was noted that sample A101 contained the lowest amounts of this element among the other bread samples. When compared to sample B201 (control), the values of potassium increased significantly ($p<0.05$) with the substitution of date and honey as sweeteners except for xylitol. All the samples were significantly ($p<0.05$) different from each other. Arukwe (2021) recorded a rise in potassium with the increased addition of combined processed pigeon pea flour to wheat flour for chin chin production. The calcium content of the bread samples varied between 88.55 mg/100 and 124.26 mg/100g. All samples were significantly ($p<0.05$) different from each other. Sample D401 had the highest value while sample A101 had the least value. This result implies that date fruit is rich in calcium and this aligns with the findings of Majzoobi *et al*. (2016). The zinc content of the bread samples ranged from 3.14 to 10.28 mg/100g. The highest amount of this element was recorded in sample D401, bread produced with date palm powder as a sweetener. This indicates that date fruit powder is rich in zinc. Sample C301 also had a significantly high value of zinc which also can be attributed to the honey content. The lowest amount of zinc was noted in sample A101. All the bread samples were significantly ($p<0.05$) different from each other. The phosphorus content of bread samples ranged between 121.24mg/100g and 141.64 mg/100g and showed significant ($p<0.05$) differences. The highest phosphorus was recorded in sample D401 followed by sample C301 while the lowest sample A101 had the least value. This result suggests that date fruit is a better source of phosphorus compared to other sweeteners. The iron content of bread samples ranged from 9.66 to 16.43mg/100. The highest and second highest values were observed in samples D401 and C301 respectively, whereas sample A101 had the lowest value. All the bread samples were significantly ($p<0.05$) different from each other.

Sensorial attributes of bread samples with different sweeteners

Table 7 summarises the mean scores of hedonic sensory evaluation for crust appearance, crumb texture, taste, aroma and general acceptability of the bread samples. It was observed that the substitution of sugar with honey, xylitol and date palm powder had a significant ($p<0.05$) effect on all sensory parameters of the bread samples. Samples C301 and D401 were not significantly ($p>0.05$) different in crust appearance but were significantly different from samples A101 and B201 (control). The addition of date powder and honey caused a darker colour and denser texture which was acceptable to the consumers. Feili *et al*. (2013) noted that the colour of the bread is one of the important factors in sensory evaluation. Average scores of bread aroma which were determined by the sense of smell, were significantly ($p<0.05$) lower in sample A101 and sample B201 compared to C301 and D401. As shown in Table 7, the same trend was not observed in taste, because sample C301 had a higher score than the other samples with sample D401 recording the least score. This could be attributed to the fibre content of sample D401 which some of the panellists could not appreciate. On general acceptability, Sample C301 recorded the highest score (8.35) followed by the control sample (8.30) and sample D401 (8.25) while sample A101 recorded the lowest value (8.10). The highest value recorded for the bread sample sweetened with honey could be attributed to the taste of honey which the panellist found to be most appealing.

Conclusion

This study revealed that date powder could be considered a better alternative to refined sugar in bread baking compared to the other sweeteners since it has the same level of sweetness, is safe and contains better nutrients. Bread made with date powder had the highest protein, fibre, energy, minerals and vitamins. The sensory evaluation result showed that bread sweetened with honey was most preferred followed by the sample with sugar and date powder. This study has also revealed that the use of sugar substitutes could be beneficial to consumers as it will enable food manufacturers to formulate a variety of foods and beverages with good taste and lower caloric content than sugar-sweetened alternatives. Public enlightenment on the nutritional importance of date palm fruit and honey is highly recommended. Furthermore, increased agricultural production of date palm fruit is needed to ensure its replacement of sugar in our food industries and guarantee all-round availability of the sweetener for bread production.

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Table 1: Bread samples formulations with different sweeteners

Ingredients	Sugar (B201)	Xylitol (A101)	Honey (C301)	Date powder (D401)
Flour	100 g	100 g	100 g	100 g
Yeast	10 g	10 g	10 g	10 g
Salt	16 g	16 g	16 g	16 g
Margarine	32 g	32 g	32 g	32 g
Water	480 g	480 g	480 g	480 g

Table 2: Functional properties of wheat flours with different sweeteners

Samples	Bulk Density (g/ml)	Water Absorption Capacity (g/ml)	Oil Absorption Capacity (g/ml)	Foam Capacity (%)	Swelling Index
B201	$0.81^{a} \pm 0.00$	$2.20^{a} \pm 0.00$	$9.00^{a} \pm 0.00$	$0.106^{a} \pm 0.00$	$14.48^{d} \pm 0.00$
A101	$0.83^{a} \pm 0.00$	$1.40^{b} \pm 0.00$	$8.60^{b} \pm 0.00$	$0.008^{b} \pm 0.00$	$15.92^{c} \pm 0.00$
C301	$0.76^{b} \pm 0.00$	$0.10^{c} \pm 0.00$	$8.90^{b} \pm 0.00$	$0.004^{b} \pm 0.00$	$33.45^{a} \pm 0.00$
D401	$0.77^{b} \pm 0.00$	$1.40^{b} \pm 0.00$	$9.00^{a} \pm 0.00$	$0.002^{b} \pm 0.00$	$22.90^{b} \pm 0.00$

Mean values with different superscripts within the same column are significantly different ($p < 0.05$). B2101 = Wheat flour with sugar; A101 = Wheat flour with xylitol; C301 = Wheat flour with a blend of honey; D401 = Wheat flour with date powder.

Table 3: Physical characteristics of bread samples with different sweeteners

Samp les	Height (mm)	Volume (ml)	Specific Volume (cm3/g)	Density (g/cm3)
B201	$52.50^{a} \pm 0.71$	$760.77^{a} \pm 0.00$	$0.20^{a} \pm 0.00$	$4.76^{d} \pm 0.00$
A101	$51.00^{b} \pm 0.00$	$680.92^{b} \pm 0.00$	$0.17^{b} \pm 0.001$	$5.80^{c} \pm 0.00$
C301	$49.50^{bc} \pm 0.71$	$610.63^{c} \pm 0.00$	$0.16^{b} \pm 0.00$	$6.33^{b} \pm 0.00$
D401	$48.50^{c} \pm 0.71$	$570.07^{d} \pm 0.00$	$0.15^{b} \pm 0,00$	$6.90^{a} \pm 0.00$

Mean values with different superscripts within the same column are significantly different ($p < 0.05$). B2101 = Bread sample produced with sugar; A101 = Bread sample produced with xylitol; C301 = Bread sample produced with a blend of honey; D401 = Bread sample produced with date powder

Table 4: Proximate composition and energy value of bread samples with different sweeteners

Samples	Moisture (%)	Dry Matter (%)	Total Ash (%)	Crude Fibre (%)	Total Fat (%)	Crude Protein (%)	CHO (%)	Energy Value Kcal/J
B201	$28.24^{b} \pm 0.03$	$71.68^{a} \pm 0.03$	$2.03^{c} \pm 0.04$	$1.44^{c} \pm 0.05$	$5.39^{c} \pm 0.02$	$12.86^{d} \pm 0.12$	$49.86^{b} \pm 0.11$	$299.34^{b} \pm 0.26$
A101	$28.32^{b} \pm 0.03$	$71.68^{a} \pm 0.03$	$2.03^{c} \pm 0.04$	$1.35^{c} \pm 0.03$	$5.32^{c} \pm 0.02$	$12.16^{c} \pm 0.12$	$50.83^{a} \pm 0.13$	$299.80^{a} \pm 0.18$
C301	$29.46^{a} \pm 0.03$	$70.54^{b} \pm 0.03$	$2.58^{b} \pm 0.04$	$1.89^{b} \pm 0.02$	$6.15^{b} \pm 0.03$	$14.09^{b} \pm 0.12$	$45.85^{c} \pm 0.13$	$295.06^{c} \pm 0.18$
D401	$29.07^{a} \pm 0.01$	$70.93^{b} \pm 0.01$	$3.33^{a} \pm 0.04$	$4.25^{a} \pm 0.03$	$7.34^{a} \pm 1.36$	$16.19^{a} \pm 0.12$	$40.84^{d} \pm 0.16$	$284.49^{d} \pm 0.58$

Mean values with different superscripts within the same column are significantly different ($p < 0.05$). B2101 = Bread sample produced with sugar; A101 = Bread sample produced with xylitol; C301 = Bread sample produced with a blend of honey; D401 = Bread sample produced with date powder. CHO = Carbohydrate

Table 5: Vitamin content of bread samples with different sweeteners

Samples	Vitamin A mg/100g	Vitamin B1 mg/100g	Vitamin B2 mg/100g	Vitamin B3 mg/100g	Vitamin C mg/100g
B201	$6.13^{ab} \pm 0.01$	$0.95^{b} \pm 0.04$	$0.84^{c} \pm 0.01$	$1.15^{c} \pm 0.01$	$18.70^{c} \pm 1.56$
A101	$4.35^{c} \pm 0.01$	$0.85^{d} \pm 0.04$	$0.68^{d} \pm 0.01$	$1.07^{d} \pm 0.01$	$14.30^{d} \pm 1.56$
C301	$5.93^{b} \pm 0.01$	$1.05^{ab} \pm 0.04$	$1.09^{a} \pm 0.01$	$1.28^{b} \pm 0.01$	$23.10^{b} \pm 1.56$
D401	$6.41^{a} \pm 0.01$	$1.15^{a} \pm 0.04$	$1.02^{b} \pm 0.01$	$1.54^{a} \pm 0.01$	$31.90^{a} \pm 1.56$

Mean values with different superscripts within the same column are significantly different ($p < 0.05$). B2101 = Bread sample produced with sugar; A101 = Bread sample produced with xylitol; C301 = Bread sample produced with a blend of honey; D401 = Bread sample produced with date powder.

Table 6: Mineral content of bread samples with different sweeteners

Samples	Calcium (mg/100 g)	Phosphorus(mg/100 g)	Potassium(mg/100 g)	Iron(mg/100 g)	Zinc (mg/100 g)
B201	$94.67^{c} \pm 0.04$	$125.75^{c} \pm 0.03$	$212.32^{c} \pm 0.02$	$10.84^{c} \pm 0.02$	$5.56^{c} \pm 0.02$
A101	$88.55^{d} \pm 1.39$	$121.24^{d} \pm 0.03$	$206.43^{d} \pm 0.03$	$9.66^{d} \pm 0.02$	$3.14^{d} \pm 0.02$
C301	$103.82^{b} \pm 0.01$	$130.52^{b} \pm 0.03$	$236.86^{b} \pm 0.02$	$12.36^{b} \pm 0.04$	$7.72^{b} \pm 0.02$
D401	$124.26^{a} \pm 0.02$	$141.64^{a} \pm 0.02$	$271.12^{a} \pm 0.03$	$16.43^{a} \pm 0.04$	$10.28^{a} \pm 0.02$

Mean values with different superscripts within the same column are significantly different ($p < 0.05$). B2101 = Bread sample produced with sugar; A101 = Bread sample produced with xylitol; C301 = Bread sample produced with a blend of honey; D401 = Bread sample produced with date powder.

Table 7: Means of sensorial attributes of bread samples with different sweeteners

Samples	Crust Appearance	Crust Texture	Taste	Aroma	General Acceptability
B201	$7.90^{b} \pm 1.07$	$7.80^{bc} \pm 0.69$	$7.85^{b} \pm 1.31$	$7.85^{c} \pm 1.18$	$8.30^{b} \pm 0.57$
A101	$7.75^{c} \pm 1.48$	$7.70^{c} \pm 1.53$	$7.70^{c} \pm 1.34$	$7.75^{d} \pm 1.45$	$8.10^{d} \pm 1.29$
C301	$8.10^{a} \pm 0.72$	$8.00^{a} \pm 0.73$	$8.10^{a} \pm 0.72$	$8.05^{b} \pm 1.05$	$8.35^{a} \pm 0.67$
D401	$8.00^{ab} \pm 0.56$	$7.85^{b} \pm 0.81$	$7.65^{d} \pm 0.75$	$8.25^{a} \pm 0.72$	$8.25^{c} \pm 0.55$

Mean values with different superscripts within the same column are significantly different ($p < 0.05$). B2101 = Bread sample produced with sugar; A101 = Bread sample produced with xylitol; C301 = Bread sample produced with a blend of honey; D401 = Bread sample produced with date powder.