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Influence of Substituting Sucrose with Date Palm Fruit Flour (DPFF) on the Nutritional and Organoleptic Properties of Bread

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ABSTRACT

The influence of substituting sucrose with date palm fruit flour (DPFF) on the nutritional and sensory attributes in bread production was studied. Bread was baked in varying proportions of sucrose and date palm fruit flour as follows: (100% sucrose: 0% DPFF), (50% sucrose: 50% DPFF) and (0% sucrose: 100% DPFF). The results of proximate analysis showed that (100% sucrose: 0% DPFF) had 61.90% carbohydrate and fat (3.73%) contents significantly ($p < 0.05$) higher than (50% sucrose: 50% DPFF) and (0% sucrose: 100% DPFF). The protein, ash and fiber contents of (0% sucrose: 100% DPFF) were 6.27, 3.67 and 2.03% higher ($p < 0.05$) than (100% sucrose: 0% DPFF) and (50% sucrose: 50% DPFF), respectively. Result of mineral composition showed that (0% sucrose: 100% DPFF) scored highest in calcium, phosphorus, iron, zinc, copper and selenium while (100% sucrose: 0% DPFF) had least value with the exception of zinc and selenium where (100% sucrose: 0% DPFF) and (50% sucrose: 50% DPFF) have the same values (0.10 and 0.01 mg/100 g), respectively and not significantly different from one another. General acceptability was highest for (100% sucrose: 0% DPFF) followed in descending order by (0% sucrose: 100% DPFF) and (50% sucrose: 50% DPFF). However, the study recommend (0% sucrose: 100% DPFF) as sweetener for bread production above (100%: 0% sucrose) and (50%: 50% DPFF) because it provides wide range of essential nutrients with many potential health benefits. However, there should be public enlightenment on the nutritional importance of date palm fruit and inclusion of date palm fruit flour in Nigerian diet better than sugar as this will reduce malnutrition, increase employment and boost Nigerian economy.

Introduction

Date palm (*Phoenix dactylifera* L.) is one of mankind's oldest cultivated plants and has been used as food for about 6000 years (Sahari et al., 2007). It is an important food crop in the Middle East and is considered to be one of the most important fruit tree particularly in North African and Asian countries. The fruit contributes to the economy and social life within these regions (Bastway et al., 2008) and is considered as a vital component of their diet (Vayalil, 2002). Dates is referred to as 'tree of life' because of its high nutritional value, great yields and its long life (Augstburger et al., 2002). They are rich in

carbohydrate which includes simple sugars like glucose, fructose and sucrose (Guizani et al., 2010). The sugars are easily digested and can immediately move to the blood after consumption and can quickly metabolize to release energy for various cell activities (Obiegbuna et al. 2013). They are good sources of dietary fiber, sodium, fat and cholesterol free. Each of these factors is important for reducing the risk of developing heart disease and cancer.

The fiber found in the fruit is in two forms: soluble and insoluble. Soluble fiber has been shown in controlling diabetes by decreasing high blood sugar as well as lowering high cholesterol, specifically low density

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lipoprotein (LDL) while insoluble fiber increases the body's ability and rate at which food is processed through the digestive system (Augstburger et al., 2002). It is also rich in some important minerals like iron, zinc, phosphorus, selenium and calcium and 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). Essential nutrients present in date palm fruit apparently necessitate its inclusion in bread production. Bread is a food product that is universally accepted as a very convenient form of food with desirability to the populace rich or poor, rural and urban (Nwanekezi et al., 2015). Its origin dates back to the neolithic era and is still one of the most consumed and acceptable stable in all parts of the world. In Nigeria, bread has become the second most widely consumed and non-indigenous food product after rice and has become an important source of food to Nigerians. It is consumed extensively in most homes, restaurants and hotels (Shittu et al., 2007). One of the ingredients for bread-making is sugar which is the primary food for the yeast (Bali, 2009). However, previous study explained the roles of sugar in bread making (Bali, 2009). It helps to improve the crust color through browning reaction; acts as a preservative as it is anti-staling agent; helps to retain moisture by keeping the bread moist; acts as bread improver and imparts flavor to it. Sugar also tenderizes the bread by preventing gluten formation (Gusba, 2009) despite all its functions; it has no benefits to human health.

Nigeria spends most of its foreign exchange on importation of sugar. This foreign currency spent on sugar importation depletes the country's foreign exchange reserve. Complete replacement of sucrose with date palm fruit in bread making will not only save substantial fraction of foreign exchange expended on importation of sugar but will also uplift the nutritional profile of bread in view of numerous nutrients in date palm fruit. The non-use of this fruits for human food constitutes a real economic loss since it is rich in bioactive compounds and dietary fiber, which can be extracted and used as value-added ingredients. An attempt should be made to establish these unutilized fruits into value-added products. However, the aim of this study is to evaluate the influence of substituting date palm flour with sucrose on the nutritional and organoleptic attributes of bread.

Materials and methods

Date fruit was purchased at Bodija market, Ibadan. Other ingredients like yeast, wheat flour etc., was purchased at Aleshiloye market, Ibadan Oyo State, Nigeria. The date fruits were washed, de-pitted, re-washed and oven dried at 40 °C. It was then crushed

in a Qlink grinder (Model No. QBL – 1861A; Turinar Corp. No 1682, Fu-Yong Ave, Nan-Tun County, Shang-Hai, China) to obtain fine particles. The flour was stored in air tight polythene prior to use.

Date palm fruit processing into flour

Date palm fruit was produced first by removing the seeds of the fruit manually with the aid of knife and weighing the dried palm fruit. The date palm fruit was washed with water to remove adhering dirt. The de-seeded fruit was then oven dried at 60 °C for 8 h and subsequently milled using Qlink grinder (Model No. QBL – 1861A; Turinar Corp. No 1682, Fu-Yong Ave, Nan-Tun County, Shang-Hai, China) (Figure 1).

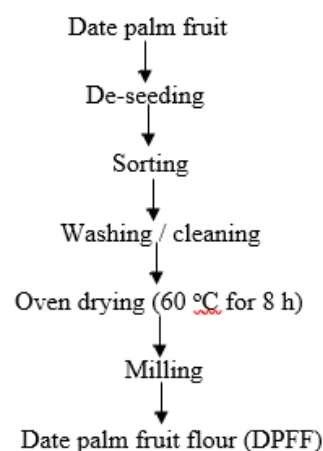


Fig. 1. Processing of date palm fruit into flour

Production of bread

Bread was produced using straight dough method. Date palm fruit flour (DPFF) was used as a replacement for granulated sugar in varying proportion of sugar and DPFF as follows: (100% sugar: 0% DPFF), (50% sugar: 50% DPFF) and (0 % sugar: 100 % DPFF). The dry ingredients were measured in the required quantities and mixed; water was added to form dough and mixed thoroughly. The dough was kneaded until smooth and air spaces became small. The dough was allowed to proof at room temperature 30-45 minutes. The dough was baked in a hot oven (220 °C for 15 min) until golden brown (Table 1 and Figure 2).

Table 1. Recipe for bread production

Ingredients	Quantity
Wheat flour	1200 g
Yeast	60 g
Salt	30 g
Sugar / DPFF	50 g
Water	430 mL



Fig. 2. Bread samples during baking

Chemical Analysis

Proximate composition such as moisture, protein, fat, ash, fiber; and carbohydrate was determined by difference. Vitamins (ascorbic acid, thiamin, riboflavin and niacin) and minerals (calcium, phosphorus, iron, zinc, copper and selenium) were carried out on DPFF and enriched bread (AOAC, 2010).

Sensory Evaluation of bread

Sensory evaluation of the bread as influenced by sucrose with sugar was done by quantitative descriptive method. The acceptability was assessed by trained panelists of twenty people who are bread lover aged between 20-50 years comprising of Industrial Training students and researchers of Forestry Research Institute of Nigeria, Ibadan. They were randomly selected and requested to assess the bread using a nine point hedonic scale (1 and 9) representing 'extremely disliked' and 'extremely liked' respectively.

Statistical Analysis

The data was analyzed with the use of a one-way analysis of variance (ANOVA) of SPSS. Also the mean separation was done by the Duncan's multiple range tests using Statistical Package for the Social Sciences (SPSS) 16.0 (SPSS Inc., Chicago, IL, USA).

Results and discussion

Proximate composition of DPFF

The results of the proximate composition of DPFF are shown in Table 2. The moisture content obtained was 12.6%, higher than values (2.25 – 7.65%) reported by

(Abdulrahman et al., 2020) on nutritional composition of date fruits varieties but analogous to reports on coconut meals (Ojobor et al., 2018). However, moisture content of date fruit depends on their harvesting time, maturation period and environmental factor such as humidity and temperature in growing period and storage conditions (Ojobor et al., 2018). The value of moisture obtained showed that DPFF can be stored for a long period of time without spoilage and it will not be susceptible to microbial growth and enzyme activities (Abdulrahman et al., 2020). Protein content obtained is similar to values (17.15%) reported by (Sadiq et al., 2013) and 17.09% (Agboola and Adejumo, 2013) for nutritional composition of Nigerian date palm fruit. The quantification of the result obtained agrees with values found between 15.19 and 19.3% (Nwanekezi et al., 2015). On the contrary, Borchani et al. (2010), analyzed eleven Tunisia cultivars of date fruit for protein and found the highest protein of 2.85% dry matter. This shows that Nigerian wild date is rich in protein which has good potential for nutritional benefits.

The low level of fat content recorded showed that DPFF is safe for the heart and high blood pressure patients because it contains a low level of fatty acids and cholesterol. The value obtained is low compared to 2.69 – 5.46% reported by (Abdulrahman et al., 2020). The ash content which is an index of mineral in most edible fruits was 4.73%, which is higher than earlier study in the literature ranged from 1.56 - 2.7% (Abdulrahman et al., 2020) but opposite the values (9.13%) reported by (Agboola and Adejumo, 2013). The variations might be due to the differences in nutritional attributes. Date fruit can be considered as a good source of dietary fiber. The fiber content obtained falls between 2.1 and 12.2%, which is within the recommended average fiber intake. Available carbohydrate obtained is analogous to 75.85% reported on nutritional evaluation and medicinal value of date fruit (Sadiq et al., 2013).

Table 2. Proximate composition of DPFF

Parameter (%)	DPFF
Moisture	12.6
Protein	18.8
Fat	0.6
Ash	4.73
Fiber	5.67
Carbohydrate	71.93

Water soluble vitamin and mineral composition of DPFF

The DPFF contain many kinds of vitamins like ascorbic acid, thiamin, riboflavin and niacin (Table 3). Vitamins are essential micro-nutrients required to fight against degenerative disease. Ascorbic acid was

the predominant vitamin (15.2 mg/100g) followed in descending order by niacin (0.22 mg/100 g), riboflavin (0.07 mg/100 g), and thiamin (0.04 mg/100 g). These values obtained are lower when compared with previous study in the literature on nutritional composition of Nigerian date palm fruit (Agboola and Adejumo, 2013). The DPFF contained significant amount of minerals (Table 4). Phosphorus was the abundant mineral (101.67 mg/100 g) followed in descending order by calcium (75.00 mg/100 g) and iron (5.57 mg/100 g). The values reported in the literature were lower to values obtained ranged between 31.96 and 21.36 for phosphorus and calcium (Agboola and Adejumo, 2013). However, Shaba et al. (2015), reported higher values for phosphorus, calcium and iron as 793.50, 371.50 and 61.50 mg/100 g, respectively, on nutritional and anti-nutritional composition of date palm fruits. The differences could be attributed to varieties, origin and environmental factors.

Table 3. Water soluble vitamin composition of DPFF

Parameter (mg/100 g)	DPFF
Ascorbic acid	15.2
Niacin	0.22
Riboflavin	0.07
Thiamin	0.04

Table 4. Mineral composition of DPFF

Parameter (mg/100 g)	DPFF
Phosphorus	101.67
Calcium	75.00
Iron	5.57

Proximate composition of bread

Result of proximate composition of bread influenced by date substitution for sugar (Table 5) showed that normal bread had highest carbohydrate and fat content while bread + sugar + DPFF scored low content. Comparing the carbohydrate content in normal bread with bread + DPFF, it was observed that replacement of sucrose with DPFF significantly decreased the carbohydrate content. This statement was justified in the literature as increase in date pulp meal substituted with sucrose decreased the carbohydrate content of bread (Nwanekezi et al., 2015). The highest moisture was observed in bread + sugar + DPFF whereas bread + DPFF had lowest content. However, bread supplemented with DPFF only significantly (p<0.05) increased in protein, ash and fiber which indicate that date palm contained the most essential nutrients necessary for human activities and health benefits. Increment in protein in this study was

in agreement with earlier study in the literature, which indicates the presence of significant quantity of nutrients in bread, greatly improved the nutritional quality of bread and highly beneficial to consumers (Sadiq et al., 2013). The highest fiber content in bread + DPFF revealed an added advantage as fiber has been reported to aid digestion and to prevent some kinds of cancer (Murphy et al., 2012).

Similarly, the low level of fat content in bread + DPFF compare with normal bread and bread + sugar + DPFF means that, it is safe for diabetic and obese patients owing to low fatty acid and cholesterol free (El-Sohaimy and Hafez, 2010). Also, the significant (p<0.05) level of ash content in bread substituted with DPFF increased the mineral content of the bread better than normal bread and bread + sugar + DPFF, because micronutrient deficiency is receiving attention globally. The previous studies in the literature reviewed lower contents in protein and ash for 3.00 and 2.13% on nutritional characterization of date palm fruit (El-Sohaimy and Hafez, 2010); high content in carbohydrate (74.5%) and fiber (9.4%) on production of biscuit (Gamal et al., 2011). The differences in values could be attributed to varieties, origin and environmental factor. However, values in ash content were concurred by a previous study in the literature on bread substituted with date palm pulp meal with sugar ranging from 2.26 – 3.84% (Obiegbuna et al., 2013). According to earlier scientist, table sugar is made up of carbohydrates and very little quantity of ash (1.0%). The value is lower to values obtained indicating that DPFF is more nutritious than table sugar and the effect of substitution is clearly shown in bread + DPFF samples.

Table 5. Proximate composition of bread as influenced by date substitution for sugar

Parameter (mg/100 g)	Normal bread	Bread + sugar + DPFF	Bread + DPFF only
Carbohydrate	61.90 ^a ± 0.45	59.57 ^c ± 0.29	60.93 ^b ± 0.21
Moisture	24.67 ^b ± 0.15	25.97 ^a ± 0.15	23.63 ^c ± 0.38
Protein	5.30 ^c ± 0.20	5.80 ^b ± 0.10	6.27 ^a ± 0.15
Fat	3.73 ^a ± 0.15	3.67 ^a ± 0.15	3.13 ^b ± 0.15
Ash	3.30 ^b ± 0.10	3.47 ^{ab} ± 0.15	3.67 ^a ± 0.15
Fiber	1.10 ^c ± 0.10	1.53 ^b ± 0.15	2.03 ^a ± 0.06

Mineral composition of bread

The mineral contents of bread as influenced by DPFF substitution for sugar is shown below (Table 6). It was observed that Bread + DPFF significantly (p<0.05) increased in all the parameters (mineral) analyzed with the exception of zinc and selenium, found in normal bread and bread + sugar + DPFF having the same values.

Table 6. Mineral composition of bread as influenced by DPFF substitution for sugar

Parameter (mg/100 g)	Normal bread	Bread + sugar+ DPFF	Bread + DPFF
Calcium	181.67 ^c ± 2.89	188.33 ^b ± 2.89	196.67 ^a ± 2.89
Phosphorus	155.00 ^a ± 5.00	161.67 ^{ab} ± 2.89	170.00 ^b ± 5.00
Iron	7.77 ^c ± 0.15	8.13 ^b ± 0.15	8.43 ^a ± 0.21
Zinc	0.10 ^b ± 0.00	0.10 ^b ± 0.01	0.20 ^a ± 0.00
Copper	0.37 ^c ± 0.06	0.50 ^{ab} ± 0.10	0.63 ^a ± 0.06
Selenium	0.01 ^b ± 0.00	0.01 ^b ± 0.01	0.02 ^a ± 0.00

Table 7. Sensory evaluation of bread

Samples	Taste	Aroma	Colour	appearance	Texture	General acceptability
Normal bread	7.05 ^b ± 0.89	7.10 ^b ± 1.37	7.50 ^c ± 1.15	7.65 ^b ± 1.04	6.55 ^a ± 2.03	7.60 ^b ± 1.10
Bread + DPFF + sugar	5.90 ^a ± 1.74	5.70 ^a ± 1.22	6.60 ^b ± 1.60	5.70 ^a ± 1.34	6.00 ^a ± 0.92	5.80 ^a ± 1.19
Bread + DPFF	5.90 ^a ± 1.48	5.80 ^a ± 1.11	5.40 ^a ± 1.23	5.20 ^a ± 1.40	5.45 ^a ± 2.14	6.00 ^a ± 1.41

Means of three replicate analyses; means within the same column not followed by the same superscripts are significantly (p<0.05) different

The results obtained revealed that date palm is a good source of calcium, iron, phosphorus and copper, and the statement was in agreement with (Nwanekezi et al., 2015). The use of DPFF as sugary agent to replace granulated sugar in bread production significantly improved the mineral content compared to normal bread. Previous study revealed lower calcium content ranged from 68.83 – 119.39 mg/100g on nutritional properties of some selected date palm fruits (Abdulrahman et al., 2020). Calcium has been reported to be the most abundant mineral in the body because it regulates cellular processes and has important structural role in living organism (Gayathri, 2019). Calcium has been found to help keep muscle working correctly (Bouhlali and Chakib, 2015). The amount of calcium observed in the bread + DPFF indicates that the sample is a good source of bone strength and growth when consumed. The value of zinc and copper obtained were lower than earlier study in the literature on nutritional composition of date fruit for 74.82 and 1.69 mg/100 g (Agboola and Adejumo, 2013), respectively. Copper is needed for the production of red blood cells; selenium is useful in the body as anti-cancer agents and stimulates immune system; iron prevent anemia; calcium helps in bone formation and prevent osteoporosis; (Jasim et al., 2014). Date fruits may be considered as an almost ideal food providing a wide range of essential nutrients and potential health benefits (El-Sohaimy and Hafez, 2010). The differences in mineral values could be attributed to varieties, origin and environmental factors.

Sensory attributes of bread as influenced by sucrose substituted with DPFF

The results of comparative sensory evaluation of the substitution as influenced by sucrose with sugar are indicated in Table 7. Bread + DPFF rated low in terms

of color, appearance and texture compared to other loaf samples. Normal bread scored highest in general acceptability followed by bread + DPFF and bread + DPFF + sugar. There seems to be an improvement in the sensory properties of bread + DPFF + sugar. Addition of sugar with DPFF in bread enhanced the color, appearance and texture better than bread substituted with DPFF only. The gap in the aforementioned parameters is attributed to inclusion of sugar. Sugar is known as tenderizing agents; improve production of golden brown color of bread crust, improvement of texture of the crumb and retention of moisture in the crumb. With all these functions, sugar is not considered essential to human and has no health benefits comparing with date palm fruit. Nevertheless, bread + DPFF were rated second after normal bread.

Conclusion

This study has shown that bread can be produced adequately using date palm fruit flour substituted with sugar. The study confirmed that date palm fruit could be considered as an ideal food that provides a wide range of essential nutrients (increased protein, fiber, ash, vitamin and minerals, and low fat) with many potential health benefits which reflected in bread substituted with date palm fruit flour only. Therefore, authors thereby suggest public enlightenment on the nutritional importance of date palm fruit and also recommend date palm fruit flour in Nigerian diet better than sugar. Also, protein quality of the loaves sample must be determined.

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