Sensory and Nutrient Evaluation of Cupcakes Made with Different Ratios of Date Fruit Paste and Refined Sugar

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Abstract

This study evaluated the sensory attributes and nutrient composition of cupcakes made with different ratios of date fruit paste as a sugar substitute. Five samples were formulated with varying ratios of refined sugar to date fruit paste: Sample A (0:100), B (70:30), C (50:50), D (30:70), and control sample E (100:0). Sensory evaluation by 30 trained panelists used a nine-point hedonic scale to assess colour, texture, flavour, and overall acceptability. Data were analysed using a one-way Analysis of Variance ANOVA using an IBM SPSS (version 24.0) and Duncan's test for sensory evaluation, while T-test was used for nutrient analysis comparing the nutrient content of the most accepted cupcake sample and the control sample. Results indicated that Sample D (30% sugar: 70% date paste) achieved the highest consumer preference, balancing taste and texture without compromising quality. Nutrient analysis showed that Sample D had higher protein (8.60%) dietary fibre (0.20%), ash (6.75%), calcium (168.00 mg), iron (1.10 mg), vitamin A (181.00), vitamin C (29.24 mg) and vitamin E (30.64 mg) compared to control Sample E (7.47% protein, 0.10% dietary fiber, 5.00% ash, 104.50 mg calcium, 0.27 mg iron, 101. vitamin A, 14.62 mg vitamin C, and 22.05 mg vitamin E). These findings suggest that date fruit paste is a viable alternative to refined sugar in baking, contributing to healthier food options and potential dietary interventions for managing sugar intake

Keywords: Sensory Evaluation, Date fruit paste, Nutrient Composition, Sugar, Cupcakes.

Introduction

The growing demand for healthier baked products aligns with concerns about excessive sugar consumption (WHO, 2015). Dates, rich in natural sugars, fibre, and essential minerals, offer a nutritious alternative to refined sugar in cupcakes (Ghnimi et al., 2017). Replacing sugar with dates can enhance nutritional value, providing fibre, potassium, and antioxidants while potentially lowering the glycemic index (Al-Farsi & Lee, 2008; Alkaabi et al., 2011). Nutrient composition analysis helps evaluate these benefits, considering macro and micronutrient changes (Greenfield & Southgate, 2003). However, sensory evaluation is essential to ensure consumer acceptance while assessing sweetness, texture, and appearance (Lawless & Heymann, 2010). Changes in ingredient composition can significantly affect the flavour and texture of baked foods (Gao et al., 2018). Understanding the nutritional and sensory impact of dates in cupcakes helps optimize recipes, balancing health benefits with taste and texture to create a viable, healthier alternative to traditional cupcakes

Dates *(Phoenix dactylifera L.)* have been a key dietary staple for millennia, especially in the Middle East and North Africa, due to their rich nutrition and adaptability in various foods. Rich in antioxidants and phytochemicals, dates offer health benefits such as enhanced heart health and reduced disease risk (Alfarsi et al., 2005). Their natural sweetness and moisture retention make them ideal for baked foods. Traditional cupcakes are usually made with refined flour, sugar, fats, eggs, dairy, and leavening agents, making them high in calories but low in nutrients. To make them healthier, researchers have tried using date-based ingredients like date paste and whole dates, which add more fibre, minerals, antioxidants, and natural sweetness while cutting down on refined sugar (Mrabet et al., 2016). Checking the nutritional value helps ensure these changes meet food standards and consumer needs. Tasting and testing dates for sweetness, texture, and aroma also help improve the final product. By combining these steps, date-based cupcakes can be a healthier choice without losing their great taste and texture.

Obesity and diet-related diseases are rising globally, with excessive sugar intake identified as a major contributor (Stanhope, 2016; WHO, 2023). In Nigeria, urbanization has increased processed food consumption, worsening health risks (Akarolo-Anthony et al., 2014). Traditional baked foods, like cupcakes, are high in refined sugar and low in nutrients (Bennion & Scheule, 2010). However, reducing sugar often compromises taste and texture (Struck et al., 2014). This study, therefore, aims to determine the sensory and nutrient attributes of cupcakes made with dates, as a promising alternative to sugar, enhancing nutritional value while maintaining sensory appeal (Ghnimi et al., 2017). Their incorporation could support healthier dietary choices. This study, therefore, aims to determine the sensory and nutrient evaluation of cupcakes made with different ratios of date fruit paste and refined sugar.

Objectives of the study: The study aimed to;

1. assess the sensory attributes (colour, texture, flavour, and overall acceptability) of cupcakes made with different ratios of date fruit paste as sugar substitute;
2. determine the proximate composition (moisture, ash, crude protein, crude fat, crude fibre and carbohydrate) of the most accepted cupcake sample.
3. determine the mineral composition (zinc, iron, calcium) of the most accepted cupcake sample.
4. determine the vitamin composition (Vitamin A, Vitamin C and Vitamin E) of the most accepted cupcake sample.

Materials and Methods

Sample procurement*:* Fresh date seeds (10 kg), all-purpose flour, granulated sugar, eggs, oil, baking powder, and vanilla were sourced from Ogige Market, Nsukka.

Date paste preparation*:* Dates were washed, sorted, and manually pitted. They were softened by soaking in room temperature water (22°C) for 10–15 minutes, then drained. The softened dates were blended into a smooth paste with one cup of water added. The paste was packed in airtight jars and stored on a shelf.

Sample preparation*:* This involved the development of cupcake formulations using varying proportions of date fruit paste as a sugar substitute in the following percentages (30%, 50%, 70%, and 100% replacement of sugar). A control formulation using 100% sugar was also prepared for comparison**.**

Table 1: Proportions of Sugar-Date fruit paste Ratio Used in Cupcake Samples

Sample	Refined sugar (%)	Date fruit paste (%)
A	0	100
B	70	30
C	50	50
D	30	70
E (control)	100	0

A- date fruit paste (100%)
B-refined sugar (70%) and date fruit paste (30%)
C- refined sugar (50%) and date fruit paste (50%)
D- refined sugar (30%) and date fruit paste (70%)
E- refined sugar (100%)

Recipe and Procedure for Cupcakes with Sugar-Date Additions

Ingredients for All Samples

- 150g sugar-date fruit paste samples
- 350g all-purpose flour
- 10g baking powder
- 5g salt
- 225g butter (softened)
- 200g sugar
- 200g eggs (about 4 large eggs)
- 5g vanilla extract
- 150g milk

Procedure

The oven was preheated to 180°C (350°F). A 12-cup muffin tin was lined with cupcake liners. All ingredients and necessary equipment were gathered. In a medium bowl, the all-purpose flour, baking powder, and salt were whisked together.

In a large mixing bowl, the softened butter and depending on the sample, an appropriate sugar-date mixture was incorporated as per the specifications were creamed together. Three eggs were beaten until the mixture was light and fluffy. The eggs were added a little at a time to the butter-sweetener mixture, beating well after each addition. The vanilla extract was added, and the batter was mixed until properly combined after each addition.

The butter was evenly divided among the prepared cupcake liners, filling each about 2/3 full. After which, the samples were baked in the preheated oven for 18-22 minutes. The samples were tested for doneness by inserting a toothpick into the centre of a cupcake until it came out clean, which meant it was ready. The cupcakes were allowed to cool for 5 minutes. And then removed them from the tin to cool completely.

Sensory Evaluation: A panel of 30 semi-trained students familiar with sensory evaluation were selected from the University of Nigeria Nsukka. They evaluated the samples using a nine-point hedonic scale. Water was provided for each panelist for rinsing their mouth after each product to avoid carryover of taste in the mouth. Sensory attributes assessed included colour, flavour, texture, taste, and overall acceptability. Scores were recorded anonymously on individual score sheets.

Chemical Analysis of the Cup Cake samples

Proximate Analysis

The proximate analysis typically includes the determination of six primary components: Moisture Content, Ash Content, Crude Protein Content, Crude Fat Content, Crude Fiber Content, Carbohydrate Content (by difference).

Crude Protein Content

The crude protein content was determined using the Association of Official Analytical Chemists (AOAC, 2010) method. This method is based on the Kjeldahl method, in which the total nitrogen content of a sample is measured and then converted to crude protein using a conversion factor. The sample was dried, ground, and homogenized to ensure uniform composition. A known amount of the sample was digested in concentrated sulphuric acid (H_2SO_4) with a catalyst (usually copper or selenium) at high temperatures (370-410°C). Through this process, organic nitrogen was converted to ammonium sulfate.

The digested sample was made alkaline with sodium hydroxide (NaOH), which will convert ammonium ions to ammonia gas. The ammonia was distilled into a receiving flask containing boric acid solution. The ammonia in the boric acid solution was titrated with a standardized acid (usually hydrochloric acid or sulphuric acid) to quantify the amount of nitrogen present. The nitrogen content was calculated based on the amount of acid used in titration. This value was then multiplied by a conversion factor (usually 6.25 for most foods) to estimate the crude protein content.

The general formula for crude protein calculation is:

Crude Protein (%) = (Volume of acid × Normality of acid × 14.007 × 100 × 6.25) / (Sample weight × 1000)

Where: the atomic weight of nitrogen

6.25 is the standard conversion factor (assumes 16% nitrogen in proteins)

Fat Content

The analysis of fat content of the sample was done using the Soxhlet extraction, which is described in AOAC Official Method 920.39 (AOAC International, 2010). A known weight of date fruit paste (typically 2-5 grams) was placed in a cellulose thimble, which was placed in the Soxhlet extractor. Petroleum ether was used as the solvent, the extraction process will run for 6-8 hours to ensure complete fat extraction. After extraction, the solvent was evaporated, and then it was dry the extracted fat in an oven at about 100°C for 30 minutes to remove any remaining solvent. The extracted fat weighed, and the fat content was calculated as a percentage of the original sample weight. The calculation is done as follows:

Fat content (%) = (Weight of extracted fat / Weight of sample) × 100

Crude Fibre

The proximate analysis of crude fibre content of the sample, as described by the AOAC method from 2010, involves a series of steps to isolate and quantify the indigestible plant matter. The date fruit paste sample was dried first and finely ground to ensure uniformity and maximize surface area for extraction. If the fat content of the sample is higher than 1%, it is typically defatted first using petroleum ether or hexane extraction. The AOAC Official Method 962.09 (AOAC International, 2010) is commonly used for crude fibre determination in flour samples, including the sample

The process involves Acid Digestion. A known weight of the sample (usually 2-3 g) was placed in a beaker. 200 mL of boiling 1.25% sulphuric acid solution was added. The mixture was boiled for 30 minutes, with the volume being maintained with distilled water, the mixture was then filtered through a linen cloth or Whatman No. 541 filter paper. The residue will be washed with boiling water until the washings are no longer acidic. The residue was transferred back to the beaker with 200 mL of boiling 1.25% sodium hydroxide solution. This was boiled for another 30 minutes, the mixture was filtered again, and the residue was washed with boiling water, followed by 1% HCl and then boiling water again. A final wash with ethanol was performed. The residue was dried at 130°C for 2 hours, then cooled in a desiccator and weighed. The dried residue was ashed in a muffle furnace at 550°C for 30 minutes, then cooled in a desiccator and weighed again.

The crude fibre content is calculated as follows: Crude Fiber (%) = [(Weight after drying - Weight after ashing) / Original sample weight] × 100

Ash content

The crucible was thoroughly cleaned and dried in an oven at 105°C for 1 hour. It was then cooled in a desiccator and weighed accurately. A well-homogenized cake sample weighing 2–5g was accurately measured and placed into the pre-weighed crucible. The crucible containing the cake sample was placed on a hot plate or gently heated over a Bunsen burner until it was fully charred. This step helped to minimize excessive smoke formation in the furnace. The crucible was transferred to a muffle furnace preheated to 500°C–600°C. It was left inside for 4–6 hours until a constant weight was achieved, ensuring the complete combustion of organic matter. The residue turned light grey or white. If black particles remained, the ashing process was extended. The crucible was carefully removed using tongs and placed in a desiccator to cool to room temperature. After cooling, the crucible with the remaining ash was weighed accurately.

The percentage of ash was calculated using the formula:

Ash content (%) =
(Weight of ash (g)
Weight of sample (g)) ×10
Ash content (%)} =Weight of ash (g)
Weight of sample (g) times 100

Where:

Weight of ash = (Final weight of crucible + ash) - (Initial weight of crucible)

Weight of sample = Initial weight of the cake sample before incineration

For percentage calculation:

Mineral content (%) = Mineral content (mg/kg) × 100 / 1,000,0003.6.1.5 Moisture Content

Moisture Content

The proximate analysis of moisture content in the sample, as described by the AOAC method from 2010, involves the removal of water from the sample through controlled heating. This is a critical measurement as moisture content affects the stability, quality, and shelf life of the flour. The sample was mixed to ensure uniformity. No additional preparation is typically required. Clean, dry aluminum dishes or glass dishes with tight-fitting lids were used. These dishes were dried in an oven at 98-100°C for 1 hour, cooled in a desiccator, and weighed accurately. Approximately 2-3 grams of the sample were then accurately weighed into the prepared dish. The sample was spread evenly across the bottom of the dish.

The dish with the sample was placed in a forced-air oven and dried at 98-100°C for 3 hours. The dish was covered with its lid while still in the oven. The covered dish was transferred to a desiccator and allowed to cool to room temperature (usually about 30 minutes). The dish with the dried sample was weighed accurately. The dish was returned to the oven for an additional hour. It was then cooled and weighed again. This process was repeated until consecutive weighings differed by no more than 0.5 mg.

The moisture content was calculated as follows: Moisture content (%) = [(Initial weight - Final weight) / Initial weight] × 100 Where: Initial weight = Weight of sample before drying Final weight = Weight of sample after drying

Carbohydrate Content

The proximate analysis of carbohydrate content in the sample, as described by AOAC methods, is typically determined by difference rather than by direct measurement. This approach is known as the "carbohydrate by difference" method.

The formula used is:

Total Carbohydrates (%) = 100 - (Weight in grams [Protein + Fat + Water + Ash] in 100 g of food)

Determination of Micronutrients (Beta Carotene, Vitamins, and Minerals)

Beta Carotene

Beta carotene, a fat-soluble pigment and precursor to vitamin A, was determined in date fruit paste through extraction using organic solvents, followed by quantification using spectrophotometry or high-performance liquid chromatography (HPLC). HPLC was preferred for its higher accuracy and specificity, 2-5g of date fruit paste was weighed into a centrifuge tube, with the exact weight recorded to 0.1 mg precision. 20 mL of the extraction solvent containing 0.1% BHT was added and the mixture was vortexed for 2 minutes. The sample was sonicated in an ultrasonic bath for 15 minutes and then centrifuged at 4000 rpm for 10 minutes. The supernatant was collected in an amber glass flask, and the extraction was repeated twice more, with all supernatants being combined. The combined extract was evaporated to dryness using a rotary evaporator at 35°C or under a gentle stream of nitrogen. Finally, the residue was reconstituted in 2 mL of HPLC-grade acetonitrile.

Beta carotene content (µg/100g) = (C × V) / (W × 10)

Where: C = Concentration of beta carotene in the sample solution (µg/mL)

V = Final volume of the extract (mL)

W = Weight of the sample (g)

Vitamin C

A 10g of the sample was weighed accurately and transferred to a 100mL volumetric flask. 3% metaphosphoric acid solution was added up to the mark. The mixture was shaken well and allowed to stand for 10 minutes. The solution was filtered through filter paper.

A standard ascorbic acid solution (1mg/mL) in 3% metaphosphoric acid was prepared. 10mL of the filtered sample solution was pipetted into an Erlenmeyer flask. This solution was titrated with the standardized 2,6-dichlorophenolindophenol dye solution until a light pink colour persists for 15 seconds. The volume of dye used was recorded, 5mL of the standard ascorbic acid solution was titrated with the dye. The dye factor (mg ascorbic acid equivalent to 1mL of dye) was then calculated.

Calculation:

Vitamin C content (mg/100g) = (T × D × V) / (W × A) × 100

Where: T = Titration volume of dye for sample (mL)

D = Dye factor (mg ascorbic acid / mL dye)

V = Volume of extract (mL) W = Weight of sample (g)

A = Aliquot of extract used for titration (mL)

Minerals (Calcium, Iron, and Zinc)

Method: Acid Digestion followed by AAS or ICP-OES Analysis

A 0.5g of the sample was weighed accurately into a digestion vessel. 10mL of concentrated HNO3 and 2mL of H2O2 was added. The mixture was allowed to stand for 15 minutes for pre-digestion. Using a hot plate, the mixture was heated gently on the hot plate until the initial reaction subsided, then heating continued until the solution is clear and near dryness. The digested samples were allowed to cool and then the solution was filtered through filter paper into a 50mL volumetric flask.

The solution was diluted to the mark with deionized water. A series of standard solutions for calcium, iron, and zinc was prepared using certified standard solutions. A calibration curve was created for each mineral.

Calculate the mineral content in mg/100g of date fruit paste using the formula: Mineral content (mg/100g) = (C × V × D) / (W × 10)

Where: C = Concentration of mineral in sample solution (mg/L)

V = Volume of sample solution (mL)

D = Dilution factor (if any)

W = Weight of sample (g).

Statistical analysis: Data were analysed using a one-way Analysis of Variance ANOVA using an IBM SPSS (version 24.0) and Duncan's test for sensory evaluation, while T-test was used for nutrient analysis comparing the nutrient content of the most accepted cupcake sample and the control sample. Significance for all analyses was accepted at a 5% confidence level ($p<0.05$) (Steel & Torre, 1980).

Results

Sensory Properties of the Products

Table 2 shows the sensory properties of the samples. Sample D (30% sugar:70% date) had the highest mean score on taste attribute (8.33). The flavour score ranges from the lowest value - 5.73 in Sample A (100% date) to the highest value - 8.57 in Sample D (30% sugar:70% date). The score of colour perception ranged from 5.80-8.50 in samples A to D, with sample D (30% sugar:70% date) having the highest mean colour score. Sample A (100% dates) had the lowest ($\bar{x}$ = 6.00), and sample D (30% sugar: 70% date) had the highest ($\bar{x}$ = 8.57) in texture evaluation. The general acceptability scores of Sample A (100% date; $\bar{x}$ = 6.13), Sample C (50% sugar:50% date; 6.67), and sample B (70% sugar:30% date; $\bar{x}$ =7.13), were significantly lower than the control sample E (100% sugar; $\bar{x}$ = 7.20) while sample D (30% sugar:70% date; $\bar{x}$ =8.57) had the general acceptability score significantly higher than the control sample E. Sample D (30% sugar:70% date) was, therefore, the most accepted.

Table 2: Results of the sensory evaluation

Sample	Taste	Colour	Flavour	Texture	General acceptability
A	5.90 ± 1.73[d]	5.80 ± 1.45[d]	5.73 ± 1.82[c]	6.00 ± 1.55[c]	6.13 ± 1.53[d]
B	7.80 ±1.09[bc]	6.93 ± 1.72[c]	7.70± 1.12[b]	7.60 ± 1.65[b]	7.13 ± 2.19[b]
C	7.27± 1.31[c]	7.63c ±1.45[b]	7.43± 1.25[b]	7.33 ± 1.63[b]	6.67 ± 1.79[c]
D	8.33 ± 0.66[a]	8.57 ± 0.50[a]	8.57 ± 0.50[a]	8.57 ± 0.73[a]	8.57 ± 0.63[a]
E (control)	7.80 ±1.09[bc]	6.93 ± 1.72[c]	7.70± 1.12[b]	7.60 ± 1.65[b]	7.20 ± 1.35[b]

Values -means ± S.D of duplicate determinations. Means with different superscripts along the columns are significantly ($p<0.05$) different.
A- date fruit paste (100%)
B- refined sugar (70%) and date fruit paste (30%)
C- refined sugar (50%) and date fruit paste (50%)
D- refined sugar (30%) and date fruit paste (70%)
E- refined sugar (100%)

Nutrient Content of the Products

The most accepted sample (Sample D) was analyzed together with the control sample E (100% sugar), to compare the results.

Proximate analysis of the most accepted sample (Sample D) and the control sample (Sample E) (carbohydrates, protein, fat, fibre, moisture, ash)

Table 3 shows the proximate composition of the most accepted sample D (30% sugar:70% date fruit paste) and the control sample E (100% sugar). Sample D contained higher protein ($\bar{x}$ = 8.60±0.22mg) than the control sample E ($\bar{x}$ = 7.47±0.04mg). Ash content was higher in D ($\bar{x}$ = 6.75±1.06) and lower in the control, sample E ($\bar{x}$ = 5.00±4.24). Fibre content was slightly higher in Sample D ($\bar{x}$ = 0.20±0.00) and lower in the control sample E ($\bar{x}$ = 0.10±0.00), though the difference was not significant. Fat content was higher in the control, sample E (12.75±1.06mg), than in sample D (10.50±0.71mg). Moisture content was higher in the control, sample E ($\bar{x}$ = 51.75±1.06), and lower in D ($\bar{x}$ =49.50±0.71). Carbohydrate was higher in the control, sample E ($\bar{x}$ =25.67±1.02), and lower in D ($\bar{x}$ = 24.20±1.20). Sample D (30% sugar:70% date fruit paste) was statistically higher in protein, ash, and fibre compared to the control, sample E (100% sugar).

Table 3: Proximate composition of cupcakes sample per 100g

Sample	Protein (mg)	Fat(mg)	Ash(mg)	Fibre(mg)	Moisture (mg)	Carboydrate (mg)
E	7.47±0.04[b]	12.75±1.06[a]	5.00±4.24[b]	0.10±0.00[a]	51.75±1.06[a]	25.67±1.02[a]
D	8.60±0.22[a]	10.50±0.71[b]	6.75±1.06[a]	0.20±0.00[a]	49.50±0.71[b]	24.20±1.20[b]

Values -means ± S.D of duplicate determinations. Means with different superscripts along the columns are significantly ($p<0.05$) different.
E- refined sugar (100%)
D- refined sugar (30%) and date fruit paste (70%)

Mineral Composition of the Cupcake Samples (Zinc, Calcium, Iron)

Table 4 shows the zinc, calcium and iron contents of the cupcake samples. Zinc level was higher in the control, sample E (0.89±0.05 mg) compared to D (0.60±0.45mg). The calcium content of the cupcake was higher in Sample D (168.00 mg ±5.66) compared to the control, Sample E (104.50 mg ±0.71). Iron content was higher in Sample D (1.10 mg ±0.25) compared to the control, Sample E (0.27 mg ±0.01). Sample D (30% sugar:70% date fruit paste) was higher in iron and calcium compared to the control, sample E (100% sugar), which was higher in zinc.

Table 4: Mineral composition of cupcakes sample per 100%

Sample	Zinc(mg)	Calcium(mg)	Iron(mg)
E	0.89±0.05b	104.50±0.71a	0.27±0.01a
D	0.60±0.45a	168.00±5.66b	1.10±0.25b

Values -means ± S.D of duplicate determinations. Means with different superscripts along the columns are significantly ($p<0.05$) different.
E- refined sugar (100%)
D- refined sugar (30%) and date fruit paste (70%)

Vitamin Composition of Cupcake Samples: Vitamin A, Vitamin C, Vitamin E

Table 5 shows the Vitamins A, C, and E contents of the cupcake sample D (30% sugar:70% date fruit paste) and the control sample E (100% sugar). Vitamin C level was significantly higher in Sample D (29.24±2.43mg) compared to the control, Sample E (14.62±1.22 mg). The vitamin E content of the cupcake was higher in Sample D (30.64±0.54mg) than in Sample E (22.05±0.78mg), and the Vitamin A content was also higher in Sample D (181.00±2.83mg) compared to the control, Sample E (101.50±2.12mg). Sample D (30% sugar:70% date fruit paste) was statistically higher in all the assessed vitamins compared to the control, sample E (100% sugar).

Table 5: Vitamin Composition of the Cupcake Samples per 100%

Sample	Vitamin C(mg)	Vitamin E(mg)	Vitamin A(mg)
E	14.62±1.22[b]	22.05±0.78[b]	101.50±2.12[b]
D	29.24±2.43[a]	30.64±0.54[a]	181.00±2.83[a]

Values -means ± S.D of duplicate determinations. Means with different superscripts along the columns are significantly ($p<0.05$) different.
E- refined sugar (100%)
D- refined sugar (30%) and date fruit paste (70%)

Discussion

The sensory evaluation showed that the 30% sugar:70% date sample had the most preferred taste, colour, texture and flavour, indicating that replacing a greater proportion of sugar with date fruit paste enhances sweetness, colour, texture, and overall flavour. This aligns with the report of Al-Farsi and Lee (2008), who found that dates contain natural sugars and compounds that improve food taste. Similarly, Hussain et al. (2021) reported that baked foods with fruit-based sweeteners were rated better in taste and aroma than those using only refined sugar. Al-Hooti et al. (2002) also found that dates contribute richer, more complex flavors due to their natural sugars and aroma. The better color rating of 30% sugar:70% date sample may result from date sugar caramelization, as observed by Al-Shahib and Marshall (2003), who noted that dates enhance the colour of baked foods. For texture, the 30% sugar:70% date sample was most preferred, supporting Mamat and Hill (2014), who found that sugar influences moisture retention and softness. Since dates contain fiber and natural sugars that help absorb moisture, contributing to the chewiness and tenderness of the cake, which improves texture, making cupcakes softer when used appropriately. Overall, the 30% sugar:70% date sample was rated higher than the control (100% sugar) and other (100% date, 50:50, 70:30) substitution ratios, indicating a preference for mixed sweeteners. Al-Harrasi et al. (2019) also found that replacing refined sugar with dates enhances taste and provides more fiber and nutrients.

The proximate analysis showed higher protein content in the 30% sugar:70% date sample than in the 100% sugar sample, likely due to dates' richer nutrient profile. Hussain et al. (2021) also found that fruit-based sweeteners increase protein levels in baked goods. Fat content was lower in the sample with 30% sugar:70% date than in the 100% sugar sample, indicating higher fat retention in refined sugar samples (Mamat & Hill, 2014). Ash content, indicating mineral presence, was greater in the 30% sugar:70% date sample (6.75mg) than in the 100% sugar (5.00mg), supporting Al-Hooti et al. (2002), who noted dates' richness in potassium, magnesium, and calcium. Dietary fiber was slightly higher in the date sample (0.20mg) than in 100% sugar (0.10mg), reinforcing findings by Habib and Ibrahim (2009) that dates enhance fiber content. Moisture content was higher in 100% sugar (51.75mg) than in the date sample (49.50mg), as sugar tends to retain more moisture (Serra et al., 2021). Carbohydrate content was slightly lower in the sample that contained date (24.20mg) than in 100% sugar (25.67mg), aligning with Al-Harrasi et al. (2019), who observed a drop in available carbohydrates when sugar was replaced with dates in sweet foods. The higher protein, ash, and fiber levels suggest dates improve the nutritional quality of snacks, supporting Al-Shahib and Marshall (2003) who recommend date fruit as a better alternative to refined sugar in baked goods.

The 30% sugar:70% date sample had higher calcium (168.00 mg) and iron (1.10 mg) than 100% sugar, enhancing mineral content and overall nutritional value of the snack (Al-Hooti et al., 2002; Habib & Ibrahim, 2009). Dates improve mineral content, making cupcakes healthier (Al-Shahib & Marshall, 2003). However, the zinc content in 100% sugar was higher than that of the sample with 30% sugar:70% date. This finding is unexpected because dates are a natural source of zinc (Abo-El-Saad & Shawir, 2024), and the refining process tends to reduce the mineral content of sugar, including zinc. This finding suggests that zinc may have been introduced to the refined sugar during the refining process.

Further findings show that the 30% sugar:70% date sample had higher vitamin C (29.24 mg), vitamin E (30.64 mg), and vitamin A (181.00 RE). The finding on the vitamin content of the cupcakes shows that using date paste instead of sugar might improve their vitamin content. This corroborates the findings of research by Al-Farsi and Lee (2008), which found that dates are rich in Vitamin C, helping boost immunity and acting as an antioxidant. Since sugar does not contain Vitamin C, replacing some of it with dates makes the cupcakes healthier. Vitamin E was also higher in the sample with 30% sugar: 70% date (30.64 mg) compared to 100% sugar (22.05 mg). This supports the findings of Al-Hooti et al. (2002), who said date-based products contain more vitamins. Vitamin E helps protect cells and keeps skin healthy, so adding dates to the recipe increases these benefits. Vitamin A was also higher in the sample with 30% sugar: 70% rate (181.00 RE) than in 100% sugar (101.50 RE). Research by Al-Shahib and Marshall (2003) shows that dates provide provitamin A, which is good for eyesight and the immune system. This implies that using date paste appears to make the cupcakes more nutritious than using only refined sugar. This agrees with other studies, like Habib and Ibrahim (2009), which suggest that fruit-based sweeteners improve the nutrition of baked goods. Overall, adding dates instead of sugar makes cupcakes a healthier snack.

Conclusion

This study demonstrates that substituting refined sugar with date paste in cupcakes enhances both their nutritional quality and consumer appeal. Cupcakes with a higher proportion of date paste (30% sugar, 70% date) showed better taste, flavor, color, and texture, making them the most preferred. These findings align with previous research, which shows that natural sweeteners improve the sensory characteristics of baked goods. Substituting sugar with dates further highlights the benefits of using date paste. Cupcakes with more date content had higher protein, fiber, and essential minerals like calcium and iron, making them a more nutritious alternative. Additionally, they contained increased levels of vitamins A, C, and E, which support immune functions, skin health, and overall well-being. These results reinforce existing studies that advocate for natural sweeteners such as honey as healthier substitutes for refined sugar.

Recommendations

1. Snacks producers should incorporate the use of date paste as sugar replacement to improve both the sensory appeal and nutritional value of snacks.
2. Further research could be done on other snacks using different ratios of sugar and date paste.
3. Food and Nutrition Extension Officers should educate consumers and promote awareness of the health benefits, dietary advantages, and practical uses of date paste in home and commercial baking.

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