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PHYTOCHEMICAL AND METAL ANALYSIS OF DATE (*Phoenix dactylifera* L.) FRUITS AND ITS PRODUCTS

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Abstract

Date palm fruits (Phoenix dactylifera L.) and their processed products are widely consumed due to their nutritional and functional importance. This study evaluated the phytochemical composition, proximate content, and mineral profiles of date fruits and selected products including syrup, puree, powder, and syrup fortified with ginger and garlic. Standard analytical procedures were used for phytochemical screening, proximate analysis, and mineral determination. Qualitative phytochemical analysis revealed the presence of flavonoids, alkaloids, saponins, tannins, phenols, phytates, oxalates, and cyanogenic glycosides. Proximate analysis showed that carbohydrate had the highest value (51.67 ± 0.66%), followed by moisture (14.38 ± 0.62%) and crude fibre (7.04 ± 0.08%), while crude fat had the lowest value (0.51 ± 0.02%). Mineral analysis indicated high concentrations of potassium, calcium, magnesium, phosphorus, sodium, and manganese across all samples, with fortified syrup samples showing comparatively higher mineral levels. The findings demonstrate that date fruits and their processed products are rich sources of nutrients and essential minerals, supporting their potential application in food formulation and functional nutrition.

Keywords: date fruits; phytochemicals; minerals; nutritional analysis; diet preparation

1. Introduction

Date palm (*Phoenix dactylifera* L.) (Figure 1) is one of the most widely cultivated fruit crops globally, valued for its nutritional, economic, and medicinal properties. Hundreds of varieties with diverse textures, colors, and flavors are utilized in food processing, largely due to their high dietary fibre and phenolic antioxidant content (Al-Karmadi & Okoh, 2024). Historically, date palm has been an important food security crop in the Middle East and Africa for over 5000 years, earning names such as the “sacred tree” and “bread of the desert” (Al-Habsi, 2025). The fruit comprises pericarp, mesocarp, endocarp, and seed, with edible pulp rich in carbohydrates, fibers, proteins, and bioactive compounds. Date seeds, representing 10–15% of the fruit, are potential sources of dietary fibre for functional food applications (Barakat & Alfheeaid, 2023).

Date products, including syrups, purees, and powders, are widely consumed and utilized in confectioneries, beverages, and bakery items due to their high nutritional and functional value (Muñoz-Tebar *et al*., 2023). Dates are rich in essential nutrients and may also contain trace metals, some of which have been reported to contribute to nutritional functions and heavy metal detoxification processes (Belew *et al*., 2024; Salem & Mohamed, 2025). Despite their widespread use, there is limited information on the comparative phytochemical composition and metal content of date fruits and their processed products.

Therefore, this study aimed to evaluate the phytochemical composition and mineral contents of date fruits and selected date products in order to determine their nutritional significance and potential health benefits for human consumption. Figure 1 shows the fresh date fruits used for the study.

Figure 1. Fresh date fruits use ... t al. (2019).

2. Materials and Methods

2.1 Materials and Preparation of Date Products

2.1.1 Collection of Date Fruits

Date fruits were purchased from a local market in Zaria, Kaduna State, Nigeria, in February 2025. All chemicals and reagents used in the study were of analytical grade.

2.1.2 Preparation of Date Syrup, Puree, and Powder

The seeds were manually removed from the date fruits. One hundred grams (100 g) of the edible flesh were weighed, washed thoroughly to remove dirt and debris, and soaked in distilled water for 2 hours at room temperature.

Date powder was prepared by air-drying the rehydrated date pulp and grinding it manually into a uniform powder. The resulting powder was stored in airtight containers until analysis.

Date syrup was produced by boiling the rehydrated date pulp for 5 minutes, followed by filtration using muslin cloth. The filtrate was further concentrated by continuous boiling until a thick consistency was obtained and then allowed to cool before storage.

Date puree was prepared by blending the rehydrated date pulp until a smooth paste was obtained.

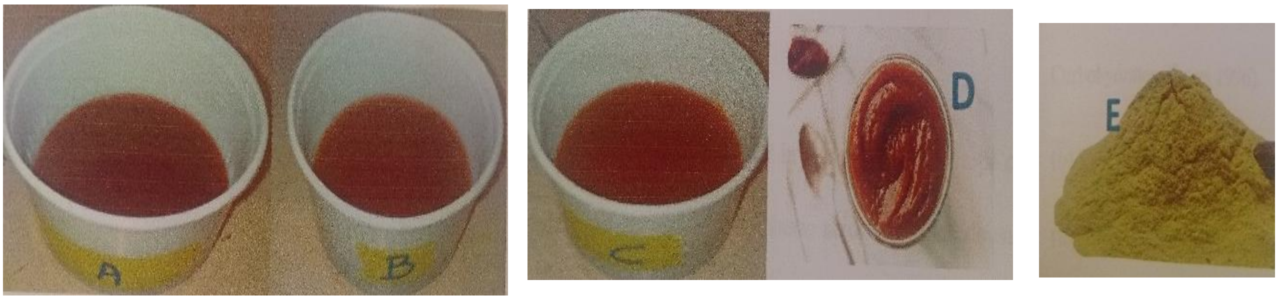

Figure 2: Pictures of date products (A is date syrup, B contains date syrup supplemented with 10 g of ginger, C contains date syrup supplemented with 10 g of garlic, D is date paste/puree and E is date powder) (Source: Author’s laboratory work, 2025)

2.2 Qualitative Phytochemical Analysis

Qualitative phytochemical screening was conducted to detect the presence of bioactive compounds using standard procedures as described by Evans (1996), Sofowora (1993), and Trease and Evans (2002).

- **Carbohydrates (Molisch Test):** A reddish-brown ring at the interface indicated the presence of carbohydrates.

- **Anthracene Derivatives (Borntrager's Test):** Formation of a colored ammoniacal layer indicated anthraquinones.
- **Cardiac Glycosides (Keller–Killiani Test):** A brown or purple-brown ring at the interface with a pale green upper layer indicated cardiac glycosides.
- **Saponins (Frothing Test):** Persistent frothing upon warming indicated saponins.
- **Steroids (Salkowski Test):** Cherry-red coloration indicated steroids, while golden yellow indicated triterpenoids.
- **Tannins (Lead Sub-Acetate Test):** Formation of a purple precipitate indicated tannins.
- **Flavonoids (Shinoda Test):** An orange-red coloration indicated flavonoids.
- **Alkaloids (Meyer's Test):** Formation of a milky yellow precipitate indicated alkaloids.

2.3 Proximate Analysis

Proximate composition was determined using standard analytical procedures according to the methods of the AOAC (2019).

2.3.1 Dry Matter

Moisture content was determined by oven-drying 1–5 g of each sample in a pre-weighed crucible at 105°C until a constant weight was obtained according to the method of AOAC (2019). The loss in weight after drying was taken as moisture content and calculated using the formula:

$$\text{Moisture content (\%)} = \frac{W1-W2}{W1} \times 100 \quad (1)$$

Where W1 is the initial sample weight before drying and W2is the final weight after drying.

Dry matter content was calculated as:

Dry Matter (%) =100−Moisture Content (%) (2)

2.3.2 Crude Protein

Crude protein content was determined using the Kjeldahl method as described by AOAC (2019), involving digestion of the sample, distillation of ammonia, and titration with 0.01 M HCl. The nitrogen value obtained was multiplied by a factor of 6.25 to estimate crude protein content.

2.3.3 Ether Extract (Crude Fat)

Crude fat was determined using Soxhlet extraction with petroleum ether (boiling point 60–80°C). The extracted fat was quantified gravimetrically after solvent evaporation.

2.3.4 Crude Fibre

Crude fibre content was determined by sequential digestion of defatted samples with 1.25% sulfuric acid and 1.25% sodium hydroxide, followed by drying, ashing at 600°C, and gravimetric determination.

2.3.5 Ash Content

Ash content was determined by incinerating dried samples in a muffle furnace at 600°C for 4 hours. The remaining inorganic residue was weighed and expressed as a percentage of the original sample weight.

2.3.6 Nitrogen-Free Extract

Nitrogen-free extract (NFE) was calculated by difference according to AOAC (2019) as follows:

NFE (%)=100-(% moisture + % crude protein + % crude fat + % crude fibre + % ash). Where moisture content was determined using the oven-drying method described in Section 2.3.1.

2.4 Determination of Mineral Composition

Mineral analysis was carried out using modified methods described by Layton-Matthews and McClenaghan (2021). Sodium and potassium were determined using a Gallenkamp flame analyzer. Calcium, magnesium, iron, zinc, and copper were determined using an Atomic Absorption Spectrophotometer (Buck Model 205). Phosphorus was determined using the phosphovanadomolybdate colorimetric method with a Jenway 6100 spectrophotometer. Samples were ashed at 600°C, digested with 3 N HCl, filtered, and analyzed accordingly.

2.5 Statistical Analysis

All analyses were performed in triplicate, and results were expressed as mean ± standard deviation. Data were analyzed using SPSS version 25.0. Descriptive statistics and one-way analysis of variance (ANOVA) at a 5% significance level ($p < 0.05$).

Ethical approval was not required for this study because no human or animal subjects were involved.

3. Results and Discussion

This section may be divided by subheadings. It should provide a concise and precise description of the experimental results, their interpretation, as well as the experimental conclusions that can be drawn. In addition, the section should interpret the results in relation to the study objectives and existing literature. Authors are expected to explain how the findings support, contrast with, or extend previous research and to address the implications of the results within a broader environmental and scientific context. Limitations of the study should be acknowledged where relevant. Future research directions may also be suggested to guide subsequent studies.

4. Conclusions

This study demonstrated that date fruits and their processed products contain a range of phytochemicals, including flavonoids, alkaloids, saponins, tannins, phenols, and phytates, indicating their potential nutritional relevance. Proximate analysis revealed that the samples are predominantly carbohydrate-rich with appreciable fibre content and low-fat levels, confirming their suitability as energy-dense food materials. Mineral analysis showed high concentrations of essential elements, particularly potassium, calcium, magnesium, phosphorus, and sodium, across all samples, with enhanced mineral levels observed in date syrup fortified with ginger and garlic. Although trace levels of non-nutritional metals were detected, their concentrations were generally low. Overall, the findings highlight the nutritional composition of date fruits and their processed products and suggest their potential use in food formulations and functional food development. Further studies may focus on processing effects on nutrient stability and bioavailability.

5. **Patents**

Author Contributions: *Conceptualization, UBI. and GO.; Methodology, UBI.; Formal Analysis, UBI; Investigation, GO,; Data Curation, UBI.; Writing—Original Draft, UBI and GO.; Writing—Review & Editing.* All authors reviewed and edited the manuscript, contributed to the interpretation of results, and approved the final version for submission.

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Nomenclature: Not applicable.

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