

**DETERMINATION OF ACTIVE SWEET COMPONENTS OF COMMON NATURAL
SWEETNERS THAT ARE USED AS A REPLACEMENT FOR REFINED SUGAR;
CASE STUDY OF DATES AND COCONUT**

BY

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DEGREE OF BACHELOR OF SCIENCES (B.Sc HONS) IN BIOCHEMISTRY**

SUPERVISED

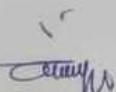
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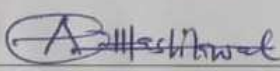
CERTIFICATION

This is to certify that the research project have been conducted by Jubril, Zainab Gbamache (2010304006) and has been approved as meeting part of the requirements for the award of Bachelor of Science (B.Sc) Degree in Biochemistry of Usmanu Danfodiyo University, Sokoto.



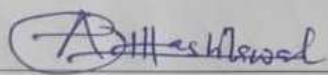
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DEDICATION

This project work is dedicated to Almighty Allah for His unwavering protection and to my parents, Mr. and Mrs. Jubril for their support.

ACKNOWLEDGEMENTS

All praises and adorations belong to Almighty Allah, the Creator of all, for His support, guidance, and protection throughout the course of this research. I extend my heartfelt appreciation to my supervisor, Dr. A. Lawal, for his invaluable guidance and unwavering commitment to the successful completion of this work. Words alone cannot adequately convey the depth of my gratitude. May Allah bless and reward you abundantly for your dedication and support.

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ABSTRACT

This study investigated the active sweet components and nutritional composition of dates (*Phoenix dactylifera*) and coconut (*Telfairiaoccidentalis*) to assess their suitability as natural alternatives to refined sugar. Proximate analysis was conducted to determine moisture, ash, crude fat, crude protein, and carbohydrate content, while spectrophotometric methods were used to quantify individual sugars; glucose, fructose, and sucrose. Results showed that dates contained significantly higher levels of reducing sugars, with glucose (6.90 ± 0.17 mg/mL) and fructose (7.27 ± 0.31 mg/mL) dominating their sugar profile. In contrast, coconut exhibited a higher sucrose concentration (7.20 ± 0.30 mg/mL), along with greater lipid ($45.32 \pm 0.08\%$), crude protein ($2.63 \pm 0.44\%$), and ash content ($1.58 \pm 0.06\%$). Dates were predominantly carbohydrate-rich ($80.99 \pm 0.42\%$), supporting their role as rapid energy sources, while coconut provided a more nutrient-dense profile. The findings reveal that dates and coconut offer distinct sweetness characteristics and functional properties, making them suitable for different food applications. Dates are ideal for products requiring quick sweetness release and high carbohydrate content, whereas coconut is better suited for formulations that benefit from sucrose-based sweetness, creaminess, and mineral enrichment. Overall, both natural sweeteners present valuable potential as healthier sugar-replacement options in food processing and nutritional product development.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

Natural sweeteners have gained significant global attention due to rising consumer awareness of the health risks associated with excessive consumption of refined sugar, including obesity, diabetes mellitus, cardiovascular diseases and dental problems. As a result, there has been growing interest in identifying healthy, nutrient-rich alternatives that not only provide sweetness but also deliver added functional benefits (Saraiva *et al.*, 2023). Dates (*Phoenix dactylifera*) and coconut-derived sweeteners have emerged as promising candidates because they contain naturally occurring sugars, plant-based bioactive compounds, and essential nutrients that may offer a more balanced metabolic response than refined sucrose. In many regions, especially the Middle East, Africa, and parts of Asia, dates and coconut products have been used traditionally as natural sources of energy, making them important subjects for scientific evaluation in modern dietary applications (Elghazali *et al.*, 2023).

Dates are particularly rich in carbohydrates, with simple sugars primarily glucose, fructose, and sucrose making up between 60% and 80% of their dry weight, depending on the variety and stage of ripening. These sugars are accompanied by dietary fiber, potassium, magnesium, phenolic acids and antioxidants, which collectively contribute to the fruit's nutritional and sensory properties (Sayas-Barberá *et al.*, 2023). The presence of both reducing and non-reducing sugars influences not only sweetness intensity but also browning reactions, viscosity, and overall flavor development in food applications. Recent analyses have shown that the ratios of glucose and fructose vary widely among different date cultivars, demonstrating the need for standardized, analytical comparison when evaluating their suitability as sugar replacements (Elghazali *et al.*,

2023). Because fructose has a higher sweetness index than glucose and sucrose, dates may deliver satisfying sweetness with potentially lower glycemic impact, a factor that strengthens their position as natural sweeteners.

Similarly, coconut sweeteners such as coconut sap sugar, coconut nectar, and coconut syrup have become increasingly popular in the global natural food market. These sweeteners are typically derived from the sap of coconut inflorescences and processed through evaporation or thermal concentration to produce syrup or granular sugar. Coconut milk sugar is predominantly composed of sucrose, often exceeding 70% of its dry mass, alongside minor sugars such as glucose and fructose, amino acids, vitamins, minerals (such as potassium and zinc) and phenolic antioxidants (Saraiva *et al.*, 2023; Sarpong, 2024). The presence of these additional components influences sweetness perception and may offer nutritional advantages over refined sugar. In addition, coconut sugar has been reported to have a lower estimated glycemic index compared to sucrose, although the accuracy of these claims varies depending on processing conditions and sample purity. Understanding the active sweet components in coconut-derived products can therefore clarify their role in promoting healthier dietary patterns.

Despite the increasing commercial use of these natural sweeteners, there remain knowledge gaps concerning the chemical identity of the sweet components and how they compare to traditional refined sugar in sweetness intensity, stability, and functional behavior during food processing. Furthermore, environmental factors such as cultivar type, soil conditions, harvesting period and processing temperature can significantly alter sugar composition, making it essential to conduct detailed scientific studies that isolate, quantify, and evaluate these active sweet components (Elghazali *et al.*, 2023).

Therefore, a systematic determination of the active sweet components of dates and coconut is needed to better understand their chemical characteristics, sweetness intensity, and suitability as replacements for refined sugar. With growing consumer demand for healthier sweetening options, such research contributes valuable scientific evidence to support food processing industries, nutrition experts, and policymakers in developing functional, nutrient-rich alternatives that promote better health outcomes (Saraiva *et al.*, 2023; Sarpong, 2024). The findings of this study are expected to provide foundational insights that will advance the formulation of natural sweetener-based products and strengthen the evidence supporting the use of date and coconut sweeteners in various dietary and industrial applications.

1.2 Justification of the Study

This study is justified by the growing need for healthier alternatives to refined sugar, which is linked to health problems such as diabetes, obesity, and cardiovascular diseases. Dates and coconut are naturally sweet, nutrient-rich, and widely available, yet their sweetening components are not fully documented, especially in Nigeria (Alu'datt *et al.*, 2025). Evaluating their sugar profiles and nutritional properties will provide scientific evidence on their suitability as natural sweeteners.

The study also supports the promotion of locally sourced sweeteners to reduce dependence on industrial sugar and encourage healthier food choices (Arshad *et al.*, 2022). By identifying the glucose, fructose, and sucrose content of dates and coconut, the research provides valuable information for food processors, nutritionists, and consumers seeking natural and functional sweeteners. Additionally, the findings contribute to existing literature and offer a foundation for future research and product development involving natural sweeteners.

1.3 Statement of the Problem

Despite the increasing popularity of dates and coconut sugar as natural sugar substitutes, there is still limited scientific clarity regarding the specific components responsible for their sweetness and how these compare with refined sucrose. The identity, concentration, and relative contribution of active sweet compounds vary significantly depending on factors such as fruit maturity, processing method, and storage conditions (Elghazaliet *al.*, 2023; Sarpong, 2024). These gaps create uncertainty and limit the ability to recommend dates and coconut sugar as reliable alternatives to refined sugar in terms of sweetness intensity, stability, safety, and nutritional benefits (Saraivaet *al.*, 2023).

1.4 Aim and objectives of the Study

- i. To conduct proximate analysis (moisture, ash, crude fat, crude protein, and carbohydrate content) of dates and coconut to determine their overall nutritional composition.
- ii. To determine the total sugar content of dates and coconut.
- iii. To identify and quantify the individual sugar components (such as glucose, fructose, and sucrose) present in dates and coconut to understand their contribution to sweetness

1.5 Scope and Limitations

This study focuses on laboratory extraction and analysis of selected date and coconut-derived sweeteners, using analytical methods such as spectrophotometry to determine active sweet components. However, limitations exist due to natural variability among cultivars, seasonal influences, and processing methods, which may affect sugar composition and sweetness perception (Elghazaliet *al.*, 2023; Sarpong, 2024).

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Overview of Natural Sweeteners

Interest in natural sweeteners has accelerated over the past decade as consumers and health professionals seek alternatives to refined sucrose because of links between high sugar intake and obesity, type 2 diabetes, dental caries and other metabolic disorders (Arshad, 2022). “Natural sweeteners” is an umbrella term that includes whole-food sources of sweetness (e.g., dates, fruit syrups), plant-derived syrups (e.g., maple, coconut milk sugar), and minimally processed crystalline products (e.g., coconut sugar). Unlike non-nutritive sweeteners, natural nutritive sweeteners provide calories and nutritional co-factors (minerals, phenolics, fiber) that may modulate metabolic responses and sensory perception (Saraiva *et al.*, 2023). Comparative reviews emphasize that each natural sweetener must be evaluated individually because compositional differences (sugar profile, fiber, minor bioactives) and processing routes greatly influence sweetness intensity, caloric density and functional behaviour in food systems (Arshad, 2022; Saraiva *et al.*, 2023).

2.2 Nutritional Composition of Dates

Dates (*Phoenix dactylifera L.*) are characterized by a high carbohydrate fraction dominated by soluble sugars mainly glucose, fructose, and depending on variety and ripening stage, variable amounts of sucrose often accounting for 50–80% of the fruit’s dry weight (Ibrahim, 2024; Khatibet *et al.*, 2022). In addition to sugars, dates contain appreciable dietary fiber, potassium, magnesium, small amounts of protein and lipids, and a range of phenolic compounds (phenolic acids, flavonoids) with antioxidant activity (Khatibet *et al.*, 2022; Ibrahim, 2024). Recent compositional surveys and metabolomics studies demonstrate strong cultivar- and maturity-dependent variability in both total sugar and individual sugar ratios (glucose:fructose:sucrose),

which has direct consequences for sweetness perception and glycemic response (Ibrahim, 2024; Zhong *et al.*, 2023). These features make dates attractive as a “whole-food” sweetening option, but they also imply that standardized characterization (proximate + detailed sugar profiling) is required before recommending substitutions for sucrose in food formulations.

2.3 Nutritional Composition of Coconut

Coconut fruit and the concentrated products derived from it (coconut syrup, coconut milk sugar) are increasingly marketed as minimally processed sweeteners with a broader micronutrient profile than refined sugar (Saraiva *et al.*, 2023). Analytical reviews indicate coconut sugar’s dry mass is largely sucrose (often >60–70%), with appreciable but smaller fractions of glucose and fructose; additionally, coconut sugar contains amino acids, minerals (e.g., potassium, magnesium, zinc), and phenolic antioxidants, the concentrations of which depend on milk collection and heating/evaporation practices (Saraiva *et al.*, 2023; Sarpong, 2024). Some studies report a relatively low estimated glycemic index for coconut sugar compared with sucrose, although GI estimates can vary with processing and measurement methods; thus, rigorous compositional and clinical assessments are necessary to substantiate health claims (Saraiva *et al.*, 2023).

2.4 Chemical Constituents Responsible for Sweetness

Sweetness in food matrices arises principally from monosaccharides and disaccharides fructose, glucose and sucrose each with different intrinsic sweetness potency (fructose typically perceived as sweeter than sucrose and glucose on a weight basis). Many date cultivars show elevated glucose and fructose levels, while coconut sugar is often richer in sucrose (Ibrahim, 2024; Saraiva *et al.*, 2023). Beyond these primary sugars, other compounds can modulate perceived sweetness: sugar alcohols (e.g., sorbitol, erythritol) provide sweetness with altered caloric

contribution and temporal profiles when present; inulin-type fructans and soluble fibers influence mouthfeel and sweetness perception; and Maillard reaction products or certain volatile phenolics formed during thermal processing can either enhance or suppress sweetness perception depending on concentration and matrix interactions (Khatibet *al.*, 2022; Sayahet *al.*, 2024).

2.5 Analytical Techniques for Component Identification

Analytical techniques provide quantitative and qualitative information about the sugar profile and nutritional composition of natural sweeteners.

2.5.1 Spectrophotometry

This is often used after sugar derivatization, provides detailed profiling of minor sugars and bioactive compounds (Jeonget *al.*, 2023).

2.5.2 Proximate Analysis Techniques

Standard AOAC methods are used to measure moisture, ash, crude fat, crude fiber, crude protein, and carbohydrate content. These analyses determine the nutritional value and functional properties of dates and coconut sweeteners.

1. Moisture Content

Moisture content refers to the amount of water present in a food sample. It is one of the most critical parameters in proximate analysis because it directly affects the shelf life, microbial stability, and storage quality of food materials, including natural sweeteners such as dates and coconut sugar. High moisture foods like fresh dates are more susceptible to spoilage, fermentation, and enzymatic reactions, which accelerate deterioration. Low-moisture sweeteners, such as coconut sugar, tend to have longer shelf stability because reduced water activity slows

microbial growth. Moisture also influences texture, weight, and processing characteristics, making its accurate determination essential in food quality evaluation.

2. Crude Fat

Crude fat represents the total lipid content in a sample, including triglycerides, fatty acids, and other fat-soluble compounds. Although natural sweeteners generally contain low levels of fat, its measurement is important because even small quantities can influence flavor, browning reactions, and caloric value. In dates, crude fat is typically minimal (<1%) and high in coconut milk sugar, but it contributes to the overall energy profile of the sweetener. Lipids also play a role in oxidative stability; however, because their levels in these sweeteners are low, their impact on rancidity or storage issues is limited.

3. Ash Content

Ash content reflects the total amount of inorganic mineral residue remaining after the sample is completely burned at high temperatures. It serves as an indicator of mineral composition in food materials. Natural sweeteners such as dates and coconut sugar tend to have higher ash content compared to refined sugar because they retain essential minerals such as potassium, magnesium, zinc, iron, and calcium. These minerals contribute to their nutritional advantage and functional benefits. Ash analysis is therefore important for assessing mineral richness and distinguishing minimally processed sweeteners from highly refined ones.

4. Crude Protein

Crude protein is determined by measuring the nitrogen content of the sample and converting it to protein using a standard factor. Although sweeteners are not typically protein-rich, dates contain

modest amounts of protein (1–3%), which contribute to their nutritional quality. Coconut sugar also contains small amounts of protein due to the natural composition of coconut sap. Protein contributes to enzymatic and metabolic processes in the body and may also play a minor role in browning and flavor development through Maillard reactions during heating.

5. Carbohydrate Content

Carbohydrates are calculated by subtracting the sum of moisture, protein, fat, ash, and fiber from the total weight of the sample. This parameter is particularly important because carbohydrates are the main component responsible for sweetness and energy supply. Dates contain 70–80% carbohydrates on a dry weight basis, primarily as simple sugars such as glucose and fructose. Coconut sugar contains over 80% carbohydrates, largely as sucrose along with small amounts of glucose and fructose. The carbohydrate profile determines caloric value, sweetness intensity, and suitability as a sugar substitute in food formulations.

2.6 Comparison between Natural and Artificial Sweeteners

Natural nutritive sweeteners supply energy and micronutrients, unlike non-nutritive artificial sweeteners (e.g., sucralose, aspartame) that provide intense sweetness with negligible calories. Each category has tradeoffs: artificial sweeteners reduce caloric intake but face consumer skepticism regarding long-term metabolic and microbiome effects, while natural sweeteners deliver calories and bioactive compounds that may be beneficial but still contribute to total sugar intake (Arshad, 2022; Saraiva *et al.*, 2023). From a functional standpoint, the thermal stability, hygroscopicity and Maillard-reaction potential differ markedly between sucrose and natural matrices; for instance, coconut sugar's residual amino acids can enhance Maillard browning compared with pure sucrose, affecting color and flavor development in baked goods (Saraiva *et*

al., 2023). Thus, the choice between natural and artificial sweeteners depends on nutritional goals, sensory targets and processing constraints.

2.7 Health Implications of Using Natural Sweeteners

While some natural sweeteners are marketed for lower glycemic response or additional antioxidants, evidence is nuanced. Coconut sugar has been reported to contain minerals and inulin that might modestly affect glycemic response, but clinical substantiation across diverse populations remains limited and GI claims vary by processing and testing protocol (Saraiva *et al.*, 2023). Dates offer fiber and antioxidants that may blunt post-prandial glycemic peaks relative to pure sucrose, but they still supply rapidly absorbable sugars and calories that must be considered in dietary planning (Ibrahim, 2024; Arshad, 2022). Importantly, thermal processing of natural sweeteners can form undesirable compounds (e.g., hydroxymethylfurfural HMF) depending on temperature and time; such contaminants require monitoring when recommending processed products as “healthier” alternatives (Saraiva *et al.*, 2023). Overall, natural sweeteners can be part of reduced-risk diets if portioning and processing are managed appropriately, but they are not a free pass to unlimited consumption.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Materials and Reagents

3.1.1 Materials

Materials used for these experiments are Dates and Coconut and standard materials (equipments/glass wares and reagents) with their models and manufacturers are listed in table 3.1 and table 3.2.

Sample Collection and Identification of Date Samples

Date fruit samples were collected from a local market, Tsohuwarkasuwa in Sokoto, Nigeria. The market was selected due to its accessibility and its role as a major distribution point for commonly consumed date within the region.

Fresh, mature dates identified as Dabino Kurmashi, a well-known local variety were selected based on uniformity in color, size, absence of physical defects and a long shelf life. Only fruits that showed no signs of microbial spoilage, bruising, or fermentation were included. The collected samples were placed in clean, food-grade polyethylene bags, labeled appropriately, and transported to the laboratory under hygienic conditions to prevent contamination or moisture gain during handling.

Sample Collection and Identification of Coconut Samples

Coconut samples locally known as Kwa-kwa were collected from the same local market, Tsohuwarkasuwa in Sokoto, Nigeria. Fresh, mature coconuts were selected based on standardized maturity indicators such as shell hardness, weight, intact husk, and the audible presence of coconut water when shaken. Only coconuts free from cracks, mold growth,

discoloration, or signs of deterioration were selected. The samples were placed in clean, durable polyethylene bags to prevent contamination during transport.

Table 1. List of Equipment and Glassware used.

NAME	GRADE	MANUFACTURER
Beakers		Pyrex, England.
Orbital shaker		
Blender		Binatone
Conical flask		Pyrex, England.
Funnel		Pyrex, England.
Measuring cylinder		Pyrex, England.
Glass rod		Pyrex, England.
Filter paper	Whatman	Finland.
Weighing balance	AES 100-4C	KERN & Sohn GmbH, Germany.
Oven	DZF-6021	
Mortar pestle		Locally made.
Water bath	SB-1100	EYELA Co. LTD., Shanghai.
Spectrophotometer	AE350	ERMA INC, Japan.
Burette		Pyrex, England.
Pipette		Pyrex, England.
Volumetric flask		Pyrex, England.
Kjeldahl Digestion unit		Gerhardt Analytical Systems, Germany
Muffle Furnace		Carbolite Gero, UK
Mortar and Pestle		BCH Lab

3.1.2 Reagents

The list of reagents used are listed in table 3.2.

Table 2. Reagents used.

NAME	GRADE	MANUFACTURER
Sulfuric acid (H ₂ SO ₄)	GPR	BDH chemical company poole, England.
Ferric chloride (FeCl ₃)	GPR	BDH chemical company poole, England.
Hydrochloric acid (HCl)	GPR	BDH chemical company poole, England.
Sodium hydroxide	Analar	BDH chemical company poole, England.
Sodium chloride	Analar	BDH chemical company poole, England.
Potassium permanganate	Analar	BDH chemical company poole, England.
Potassium ferrocyanide	Analar	BDH chemical company poole, England.
Glucose Standard	Analytical standard	Sigma Aldrich
Fructose Standard	Analytical standard	Sigma Aldrich
Sucrose Standard	Analytical standard	Sigma Aldrich
DNS reagent	AR grade	LobaChemie
Boric Acid	AR grade	BDH
Distilled Water		BCH Laboratory

Key: GPR= General Purpose Reagent

3.2 Methods

3.2.1 Sample collection and Preparation

Procedure for Processing Coconut Milk Sugar

Two coconuts were first broken into smaller pieces to facilitate handling. The hard outer shell was carefully removed to expose the edible flesh. The coconut flesh was then cut into smaller

pieces. The coconut pieces were subsequently ground into a fine consistency, after which the ground material was bound in a clean muslin cloth and pressed to extract the coconut milk. The expressed milk was further strained through a fine mesh sieve to eliminate residual fiber and impurities. It was then boiled and evaporate to collect the thick solution formed.

Procedure for Processing Date Sugar

Fresh date fruits were washed thoroughly under running water to remove dirt and surface contaminants. The cleaned dates were then dried completely to reduce moisture content and facilitate grinding. After drying, the fruits were grinded into a fine powder using a clean mortal and pestle.

The powdered date material was spread evenly in a clean airtight glass jar to prevent moisture absorption. The processed date sugar was then stored at room temperature and used as needed for further analysis.

3.2.3 Sugar Content Analysis

The principles for determining the total sugar content in a fruit sample involve sample preparation (extraction), hydrolysis to convert all di- and oligosaccharides into monosaccharides, and quantification using a specific analytical method.

3.2.3.1 Principle using spectrophotometric method

Involves a colorimetric reaction where sugars react with a reagent (phenol or anthrone) in the presence of concentrated sulfuric acid to form a colored complex. The intensity of the color, measured by a spectrophotometer, is proportional to the sugar concentration.

3.2.3.1 Glucose content

Principle

The determination of glucose content is based on the principle that glucose reacts with a DNS reagent to produce a colored complex whose absorbance is directly proportional to the glucose concentration.

Thus: $A \propto C$

Where:

A = absorbance at 540 nm

C = glucose concentration

A calibration curve is generated from known glucose standards, and the glucose concentration in the samples (date and coconut) is calculated from the linear regression equation.

Equation..... (1)

Absorbance of Sample
Glucose Concentration [mg/mL] = $\frac{\text{Absorbance of Sample}}{\text{Absorbance of Standard}} \times \text{Concentration of standard}$

Procedure:

Approximately 0.1g of the Dates and coconut sample was dissolved in 10 mL of distilled water. The resulting supernatant was collected and used as the test sample, with further dilutions prepared as necessary.

Seven test tubes were arranged and properly labeled. In five of the test tubes, varying volumes of standard glucose solution (0.2, 0.4, 0.6, 0.8 and 1.0 mL) were pipetted to prepare the standard concentrations. In the remaining two test tubes, 2 mL of the sample extract were introduced.

To each of the test tubes, 1 mL of DNS reagent was added, and the contents were mixed thoroughly. The final volume in each tube was made up to 5 mL with distilled water. The tubes were then cotton-plugged and placed in a boiling water bath for 5 minutes to allow for color development. After heating, the test tubes were removed and allowed to cool to room temperature under running tap water.

The absorbance of each solution was measured at 540 nm using a spectrophotometer. A standard calibration curve was then prepared using the absorbance values of the glucose standards.

3.2.3.2 Fructose content

Principle

The determination of fructose content is based on the principle that glucose reacts with a DNS reagent to produce a colored complex whose absorbance is directly proportional to the fructose concentration.

Thus: $A \propto C$

Where:

A = absorbance at 540 nm

C = fructose concentration

A calibration curve is generated from known glucose standards, and the fructose concentration in the samples (date and coconut) is calculated from the linear regression equation.

Equation..... (2)

$$\frac{\text{Absorbance of Sample}}{\text{Absorbance of Standard}} = \frac{\text{Fructose Concentration [mg/mL]}}{\text{Concentration of standard}}$$

Procedure:

0.1g of the Dates and coconut sample was dissolved in 10 mL of distilled water. The resulting supernatant was collected and used as the test sample, with further dilutions prepared as necessary.

Seven test tubes were arranged and properly labeled. In five of the test tubes, varying volumes of standard fructose solution (0.2, 0.4, 0.6, 0.8 and 1.0 mL) were pipetted to prepare the standard concentrations. In the remaining two test tubes, 2 mL of the sample extract were introduced. To each of the test tubes, 1 mL of DNS reagent was added, and the contents were mixed thoroughly. The final volume in each tube was made up to 5 mL with distilled water. The tubes were then cotton-plugged and placed in a boiling water bath for 5 minutes to allow for color development. After heating, the test tubes were removed and allowed to cool to room temperature under running tap water.

The absorbance of each solution was measured at 540 nm using a spectrophotometer. A standard calibration curve was then prepared using the absorbance values of the fructose standards.

3.2.3.3 Sucrose content

Principle

The total sucrose content in a dates and coconut sample is determined by hydrolysis of sucrose into its constituent monosaccharides, glucose and fructose. This is based on the principle that sucrose is a non-reducing sugar, while glucose and fructose are reducing sugars.

Equation.... (3)

$$\text{Sucrose (mg/100 g)} = \left(\frac{A_h - A_u}{m} \right) \times \frac{DF}{W} \times 0.95 \times 100$$

Where:

A_h = absorbance after hydrolysis

A_u = absorbance before hydrolysis

m = slope of standard curve

DF = dilution factor

W = sample weight

0.95 = correction factor for converting invert sugar to sucrose

Procedure

The determination of sucrose content was carried out using acid hydrolysis followed by reducing sugar estimation with DNS reagent. The procedure was conducted as follows:

First, a drop of concentrated hydrochloric acid was added to 1 mL of the sucrose solution. Specifically, one drop of concentrated HCl was introduced into the sample solution. The mixture was then heated at 90°C for 5 minutes to allow for the hydrolysis of sucrose into glucose and

fructose. This hydrolysis step ensures that all sucrose present is converted into reducing sugars that can be detected by the DNS method.

After hydrolysis, three drops of KOH were added to the mixture. This neutralized the acid and created the alkaline condition necessary for color development. Following neutralization, the DNS reagent was added to the solution, and the mixture was processed following the standard DNS method. Finally, a calibration curve was generated using standard sucrose solutions treated under the same conditions. The absorbance values obtained from the samples were compared to the calibration curve to determine the concentration of sucrose in each sample.

3.3 Proximate Analysis of Dates and Coconut

The proximate composition of dates and coconut (moisture, ash, protein, fat, fiber, and carbohydrate) was determined following standard analytical procedures as described by Ibrahim (2024) and modified by Khalil *et al.* (2024).

The functional attributes of dates and coconut, which are largely influenced by their carbohydrate, fiber, and minor protein components, play an essential role in determining their suitability as natural sweeteners and their performance in product formulation. Therefore, both samples were evaluated for their functional and nutritional properties. The protein content was determined using the micro-Kjeldahl method ($N \times 6.25$). Carbohydrate content was calculated by difference, based on the subtraction of moisture, ash, protein, fat, and fiber values from the total sample mass.

3.3.1 Determination of moisture content

The moisture content was measured using the oven-drying method. Initially, clean and dry Petri dishes were weighed (W_1) using a balance. Approximately 0.2 g of dates and coconut as sample

A and B was placed into a separate the dishes (W2) and spread evenly. These dishes was then be placed in an oven set at 105°C and dried for about 3 hrs. After drying, the dishes was cooled in a desiccator and weighed again. This process was repeated until a constant weight (W3) is achieved. The percentage of weight loss during drying was considered the percentage moisture content, calculated using the equation provided by Khalil *et al.* (2024).

Moisture Content (%): $\frac{W_1 - W_3}{W_1} \times 100$

W_2

Where W_1 = Sample Wet

W_2 = Sample dry

W_3 = Empty dish

3.3.2 Ash determination

Approximately 0.2g of dates and coconut as sample A and B was placed into a separate clean, dried, pre-weighed crucibles with lids (W1). The organic matter will initially be burned off with an open flame until the sample became charred. The crucibles, with lids removed, will then be placed in a muffle furnace set to 550°C until a light grey or white ash is formed. The ash content will then be calculated using the equation provided by Khalil *et al.* (2024).

The crucibles were then cooled in a desiccator and weighed (W2):

Ash Content (%): $\frac{W_3 - W_1}{W_2} \times 100$

W_2

Where: W_1 = Sample Wet

W_2 = Sample dry

W_3 = Empty crucible

3.3.3 Crude fat determination

Cleaned and dried thimble was weighed as (W_1) and 0.2g of dates and coconut as sample A and B oven-dried sample was added and reweighed (W_2). Round bottom flask was filled with petroleum ether (b.pt 40-60°C) up to $\frac{3}{4}$ of the flask. Soxhlet extractor was fixed with a reflux condenser and adjusted the heat source so that the solvent boiled gently. The thimble plus the sample was inserted into the Soxhlet apparatus and extraction under reflux was carried out with petroleum ether (40-60°C) for over 6 hrs. The thimble will then be removed and taken into the oven at 100°C for 1 hr and later cooled in the desiccator and weighed again (W_3). The percentage fat content was calculated using the following equation as cited by Khalil *et al.* (2024).

$$\text{Fat (\%)} = \frac{W_1 - W_3}{W_2} \times 100$$

Where:

W_1 = Initial weight of the empty thimble

W_2 = Weight of the thimble plus sample before extraction

W_3 = Weight of the thimble plus sample after extraction

3.3.4 Crude protein determination

Approximately 0.2g of dates was placed into a micro Kjeldahl digestion flask. 1g of selenium catalyst tablet and 15 mL of concentrated H₂SO₄ was added. The mixture will then be digested on an electro-thermal heater inside a fume cupboard until a clear solution is obtained. After cooling, the solution was diluted with distilled water to 50 mL. A 10 mL portion of this solution was transferred into a distillation apparatus and 10 mL of 2% boric acid was pipetted into a 100 mL conical flask (receiver flask). The 50% NaOH will gradually be added to the digested sample until it became cloudy, indicating alkalinity. Distillation was performed into the acid solution in the receiver flask, with the delivery tube submerged below the acid level. As distillation proceeded, the pink solution in the receiver flask turned blue, indicating ammonia presence. Distillation continued until the round bottom flask contained approximately 50 mL of solution, after which the condenser's delivery tube was rinsed with distilled water. The resulting solution in the conical flask will then be titrated with 0.1 M HCl. The protein content percentage was calculated using the method cited by Khalil *et al.* (2024). The same procedure was repeated for coconut.

$$\frac{A-B \times 1.4007}{\text{Weight of sample}}$$

Nitrogen (wet %) = Weight of sample x 100

Where: A = Vol (mL) StdHCl × normality of StdHCl

B = Vol (mL) StdNaOH × normality of StdNaOH

Nitrogen (wet %)

$$\text{Nitrogen (dry \%)} = \frac{\text{Nitrogen (wet \%)} \times 100}{100 - \text{Moisture (\%)}}$$

3.2.5 Determination of carbohydrate content

The percentage of carbohydrate content was calculated using the following equation as cited by Khalil *et al.* (2024).

$$\text{Carbohydrate (\%)} = 100 - (\text{protein} + \text{fat} + \text{ash} + \text{moisture content (\%)})$$

CHAPTER FOUR

4.0 Results, Discussions, Conclusion and Recommendations

4.1 Results

4.1.1 Physical characteristics of the coconut samples

The collected coconuts were fresh, mature, and clean, with hard brown shells and firm white endosperm characteristic of well-developed fruits. The coconuts exhibited a natural nutty aroma, and the flesh was thick and compact, indicating suitability for milk extraction and further processing. After grating and grinding, the coconut flesh was converted into a fine, white to cream-colored meal, free from impurities and uniform in texture. This prepared sample was appropriate for extraction procedures, proximate analysis, and additional laboratory evaluations.

4.1.2 Physical characteristics of the Dates samples

The collected date fruits were clean, mature, and uniform in appearance, with each sample exhibiting its natural brown coloration and characteristic sweet aroma. The dates were firm to touch, displaying a naturally dry and slightly wrinkled texture typical of low-moisture. Each fruit contained an intact oblong seed enclosed within a consistent layer of edible flesh.

After drying and grinding, the dates were transformed into a fine, brownish powder that retained the natural sweetness of the fruit. The powdered form was smooth, free-flowing, and suitable for extraction, analytical testing, and further laboratory evaluation.

4.1.3 Proximate Composition of the two Samples

Table 4.1 shows that sample A is predominantly carbohydrate-rich (80.99%) with higher moisture content. In contrast, Sample B contains significantly higher lipid (45.32%), ash

(1.58%), and crude protein (2.63%). Overall, Sample A is more energy-dense, while Sample B is more nutrient- and protein-dense.

Table 3. Proximate composition of dates and coconut

Parameters (%)	Dates	Coconut
Ash Content	0.68 ± 0.08	1.58 ± 0.06
Moisture Content	16.90 ± 0.05	7.63 ± 1.89
Lipid Content	0.33 ± 0.23	45.32 ± 0.08
Crude protein Content	1.31 ± 0.44	2.63 ± 0.44
Carbohydrate Content	80.99 ± 0.42	42.84 ± 2.34

Values are mean ± S.D of three readings

4.1.4 Sugar Contents Analysis

Presented in Table 4.1 is the Sugar contents of dates and coconut samples that was determined by spectrophotometric method. Table 4.1 presents the sugar composition of two samples: Sample A (Dates) and Sample B (Coconut), expressed as mean values ± standard deviations from three independent measurements. The results indicate notable differences in the glucose, fructose, and sucrose levels between the two natural sweeteners.

Table 4: The Sugar contents of dates and coconut

Parameter (mg/ml)	Dates	Coconut
Glucose	6.9±0.17	4.58±0.05
Fructose	7.27±0.31	6.13±0.31
Sucrose	5.63± 0.21	7.2 ± 0.3

The values were mean standard ±deviations of three independent readings.

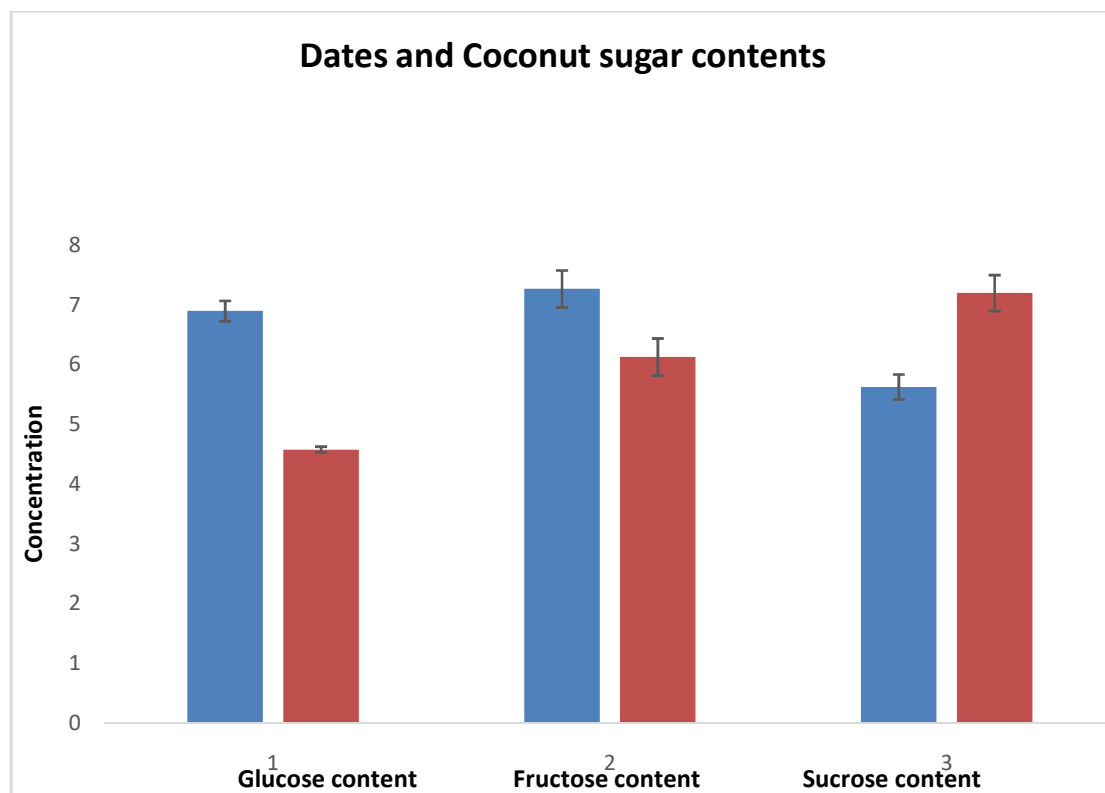


Figure 1.0: A chart showing glucose, fructose and sucrose content level respectively in dates and coconut

Key:

■ = Date

■ coconut

4.2 Discussions

4.2.1 Proximate Composition of Dates and Coconut

The proximate composition results highlight fundamental nutritional contrasts between the two samples. Sample A (Dates) exhibited a markedly higher carbohydrate content ($80.99 \pm 0.42\%$) compared to Sample B ($42.84 \pm 2.34\%$), confirming dates as an energy-dense fruit predominantly composed of natural sugars and dietary fiber. This agrees with recent compositional studies showing that dates contain high carbohydrate concentrations due to natural sugar accumulation during ripening. Such elevated carbohydrate levels further support the traditional use of dates as quick energy boosters and natural sweeteners in food systems.

Sample B (Coconut), however, showed significantly higher levels of lipids ($45.32 \pm 0.08\%$), crude protein ($2.63 \pm 0.44\%$), and ash content ($1.58 \pm 0.06\%$) relative to dates. These results are consistent with recent findings that coconut flesh is rich in fats particularly medium-chain triglycerides as well as essential minerals and moderate protein content. The higher ash value suggests that coconut contributes more to mineral intake, aligning with reports identifying coconut as a source of potassium, magnesium, and trace minerals.

Moisture content also differed significantly between the samples. Sample A recorded higher moisture ($16.90 \pm 0.05\%$), whereas Sample B had lower moisture ($7.63 \pm 1.89\%$). The elevated moisture level in dates is typical of semi-soft cultivars and results from their hygroscopic nature due to high sugar content. In contrast, the lower moisture level in coconut flesh reflects its dense, oil-rich structure, which reduces free water availability and enhances shelf stability. Literature supports that lower moisture in coconut-based products prolongs storage life, while higher moisture in dates may increase susceptibility to microbial spoilage if storage conditions are inadequate.

4.2.2 Sugar Content Analysis

The sugar profile of the two samples dates and coconut reveals significant nutritional and functional differences between both natural sweeteners. The findings indicate that Sample A (Dates) contained higher levels of the reducing sugars glucose (6.9 ± 0.17 mg/mL) and fructose (7.27 ± 0.31 mg/mL) than Sample B (Coconut), which recorded 4.58 ± 0.05 mg/mL and 6.13 ± 0.31 mg/mL, respectively. This pattern aligns with recent literature indicating that dates are naturally rich in simple, readily absorbable sugars primarily glucose and fructose due to enzymatic conversion of stored polysaccharides during ripening. These findings also support earlier reports that dates are dominated by invert sugars and are known for their rapid energy-releasing potential, strong sweetness, and high glycemic availability.

Conversely, sucrose, a non-reducing disaccharide, was more abundant in Sample B (7.2 ± 0.3 mg/mL) than in Sample A (5.63 ± 0.21 mg/mL). This observation is consistent with established reports that coconut flesh and coconut-derived sweeteners typically contain higher proportions of sucrose relative to monosaccharides. The dominance of sucrose in coconut may be attributed to metabolic processes within the coconut endosperm, where sucrose functions as a principal storage carbohydrate. This higher sucrose concentration also explains why coconut sugar produced from coconut flesh is commercially valued for its mild caramel-like flavor and thermal stability.

Overall, these results demonstrate that dates serve as excellent sources of reducing sugars, while coconut provides higher levels of sucrose, making both fruits desirable for different sweetening applications. Dates may be more suitable for products requiring immediate sweetness and rapid fermentation, whereas coconut may be preferred for formulations where sucrose-type sweetness, caramelization, and stability are required.

4.3 Conclusion

This study evaluated the sweetening components and nutritional profiles of dates and coconut to determine their potential as natural alternatives to refined sugar. The findings showed that dates contain higher levels of the reducing sugars glucose and fructose, making them a rapid energy source with strong sweetness intensity. Coconut, on the other hand, demonstrated a higher sucrose concentration, along with greater lipid, protein, and mineral contents. These results confirm that the two natural sweeteners offer different biochemical forms of sweetness and provide distinct nutritional qualities, which influence their functional properties in food formulations.

Overall, the research concludes that both dates and coconut are suitable natural sweeteners but serve best in different contexts. Dates are ideal for applications requiring quick sweetness release and high carbohydrate content, while coconut is more appropriate for products that benefit from sucrose-based sweetness, creaminess, and added nutritional richness. Their contrasting profiles present valuable opportunities for healthier sugar-replacement strategies in food processing.

4.4 Recommendations

Based on the findings of this study, several recommendations are proposed to enhance the utilization and further investigation of dates and coconut as natural sweeteners. Firstly, food manufacturers and small-scale processors should explore the incorporation of dates and coconut into beverages, baked goods, and functional foods as healthier alternatives to refined sugar. Their distinct sweetness profiles reducing sugars in dates and sucrose-dominant sweetness in coconut allow for tailored applications depending on product requirements. Dates may be best suited for high-energy snacks and natural syrups, while coconut can be used in creamy formulations, confectioneries, and natural sweetener blends.

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