Quality Assessment of Date Fruit (as Sweetener) and Date Seed Powder (as an alternative to Coffee)

Authors

SUNMONU Basirat Afolake[1] TAIWO Toyin Victoria [2] ABDULSALAM Zainab Olaitan[3]

1, 2, 3. Department of Food Technology: School of Applied Sciences.

Federal Polytechnic, Offa, Kwara State, Nigeria.

Correspondence

SUNMONU Basirat Afolake

Department of Food Technology: School of Applied Sciences.

Federal Polytechnic, Offa, Kwara State, Nigeria.

E-mail:foliekay@yahoo.com

Abstract

Purpose*:* The objective of this study was to produce and investigate the quality of date fruit powder (as sweetener) and date seed (as alternative to coffee).

Methodology*:* Date fruit was dried and compared with other sweeteners and coded; date fruit SWD, honey SWH and sugar SWS. These were analysed for mineral content (Fe, Ca, K, Mg and Zn) and sugar (Glucose, Fructose and Sucrose). Date seed sample were roasted using oven and traditional method and compared with a commercial brand coffee and coded as follow: oven method ROD, traditional method RTD and Nescafe RTN, Mineral content (Fe, Ca, K, Mg, Mn and Zn) and phytochemical profiling (Caffeine, Flavonoid and Alkaloid) was conducted on the samples.

Findings:The result for the mineral content of date fruit powder and other sweeteners showed that date fruit had the highest content of potassium and appreciable amount of other minerals except magnesium. Values are Fe 6.53-14.39mg/100g, Ca 0.61-1.16mg/100g, K 0.57-1.31mg/100g and Zn 1.21-1.56mg/100g. Sugar content values are Sucrose 5.23-99.32%, Glucose 0.01-37.54% and Fructose 0.01-29.21%. Date seed powder phytochemical profiling showed that commercial brand (RTN) had the highest amount of caffeine and alkaloids while the ROD (oven roasted) had the highest value of phenol. Mineral content for date seed samples and commercial brand ranged as follows Fe 2.45-3.45 mg/100g, Ca 5.18- 28.32mg/100g, K 56.19 – 83.19mg/100g, Mg 2.02 – 4.31 mg/100g, Mn 4.13 – 5.37mg/100g and Zn 8.77 – 18.33 mg/100g. ROD had the highest values for Fe and Mg while RTD scored high in Ca, K and Zn compared to commercial brand.

Unique contribution to theory, practice and policy: Date fruit can be adopted as sweetener in place of other natural sweeteners while date seed powder can be used in place of coffee with lesser caffeine content and improved mineral content.

Keywords: *Date fruit, Sweetener, Coffee, Date Seed, Mineral contents, Phytochemicals.*

INTRODUCTION

Date palm (*Phoenix dactylifera* L.) is one of the oldest primary staple crops in Southwest Asia and North Africa. Date palms are also grown in Australia, Mexico, South America, Southern Africa, and the United States, especially in Southern California, Arizona, and Texas. Date fruit is a high nutritional value food that is rich in carbohydrates, dietary fibers, proteins, minerals and vitamin B complex such as thiamine (B_1), riboflavin (B_2), niacin (B_3), pantothenic acid (B_5), pyridoxine (B_6), and folate (B_9). Carbohydrates comprise 70% of date fruit mainly as fructose and glucose. Minerals in date fruits are calcium, iron, magnesium, selenium, copper, phosphorus, potassium, zinc, sulfur, cobalt, fluorine, and manganese. Date fruits are highly nourishing and may thus confer numerous potential health benefits. In recent years, a huge interest in the abundant health promoting properties of date fruits has led to the need to develop new food products using dates as a source of nutrients (Aljaloud *et al*., 2020).

Palm dates are considered to be a nutritional component of the diet and a staple food source in most Middle Eastern and North African regions. Dates can be consumed either in a fresh form or as a derivative product, such as date-syrup, date-honey, date-jam, date-vinegar, and date-paste. In 2016, the global production of palm date fruits was approximately 8.5 million tons (FAO, 2018). It was reported that the average percentage of the date seeds is approximately 10% of the total weight of the whole date fruit in the tamr “fully ripening” stage. Date seeds are generated during direct consumption or from the date processing industries (Siddiq and Greiby, 2013). Presently, these byproducts are generally discarded leading to environmental problems, or instead, are utilized as animal fodder.

The lack of uses for this by-product for human food constitutes a real economic loss since it is rich in dietary fiber, phenolic compounds and antioxidants, which can also be extracted and used as therapeutic components (Al-Farsi and Lee, 2008). It has been reported that dietary fiber has important therapeutic implications for certain conditions, such as diabetes, hyperlipidaemia, and obesity, and may provide a protective effect against hypertension, coronary heart disease, high cholesterol, colorectal and prostate cancers, and intestinal disorders (Anderson *et al*., 2009).

Additionally, antioxidants and phenolic compounds could protect against major chronic diseases, such as different types of cancer, cardiovascular disease, coronary heart disease, atherosclerosis and neurological problems, as well as aiding in treating renal stones, bronchial asthma, coughing, hyperactivity and poor memory, helping to reduce blood pressure, relaxing the intestinal and uterine musculature, growing body protein by reducing fat, normalizing blood sugar, and comforting the pancreas (Hossain *et al*., 2014).

Due to the foregoing mentioned benefits, several potential uses of date seeds have been identified and reported in the literature. These included date seed powder as an ingredient in food products such as ground beef (Amany *et al*., 2012), bakery products (Platat *et al*., 2015), chocolate (Bouaziz *et al*., 2017) and non-caffeinated drinks (Venkatachalam and Sengottian, 2016; Ghnimi *et al*., 2015). Virtually, roasted date seed powder is being used in the Arabian region, including the Kingdom of Saudi Arabia (KSA) and the United Arab Emirates (UAE), for preparation of an alternative brew to coffee (Ghnimi *et al*., 2015;Rahman *et al*., 2007) to avoid negative health impacts, such as raising blood pressure,
panic attacks, hypertension, gout, insomnia, indigestion, infertility, and inhibition of collagen creation in the skin, as well as depression and anxiety symptoms resulting from the high content of caffeine in coffee (20–40%) (Bouaziz *et al*., 2017).

Sugar, which is usually referred to as sucrose, is natural and nontoxic, sweet tasting, water soluble crystalline carbohydrates, and every 1 gram of sugar provide body 4 kcalories (Cseke *et al*., 2016). The main source for sugar is the beet sugar or cane sugar; also there are several sources such as honey, corn syrup, fruits, and vegetables, etc (Erdal *et al*., 2007). The primary function of sugar in food products is to provide sweetness and energy, in addition, sugar plays a very important role in preservation, fermentation, colour and texture (Rosa *et al*., 2009). In recent years, there has been increase in consumption of sugar which could lead to several diseases especially obesity, cardiovascular disease and diabetes type 2, so food organizations issued strict instructions about determining the sugar intake in diets (Hu, 2013).

Honey is produced by honey bees, especially by the species of *Apismellifera* (Havsteen, 2002) as blossom honey by secreting nectars of flowers and honeydew honey (forest honey) is a type of honey made from honeydew secreted by plant-sucking insects such as aphids (Adebiyi *et al*., 2004).

Preference for sweet taste at a range of intensities is characteristic of human species. In the fetus, taste buds are developed by the 16th week of gestation, and the new born infant is able to respond favorably to sweetened solutions. Sugar is a natural sweetener that provides 4 calories per gram. It is acknowledged that excess sugar ingestion amounts to increased energy intake which, in turn, can lead to weight gain and chronic diseases associated with obesity and dental caries. Many synthetic sweeteners, which are widely used are proved to be carcinogenic and are non-nutritive. Hence demand greatly increased for natural sweetening agents, especially for non-sacchariferous sweetening agents, because they are highly potent, useful, safe and low-calorie sugar alternatives. Recently it was found that Himalayan forests are good sources of plants containing non-saccharide sweetening agents. Therefore, there is need for sugar substitutes, which can help reduce caloric intake, particularly in overweight individuals (Kim and Kinghorn, 2002) The demand for new alternative “low calorie” sweeteners for dietetic and diabetic purposes has increased worldwide.

Food waste is considered as "one of the great paradoxes of our times", with an increasing interest in the valourization of food products, utilization of its less used parts is urged as a necessity (Scott-Thomas, 2013). Food industries are interested in the economic utilization of food waste as valuable resources for other potential uses. Date pits are generally utilized as poultry and animal feed, encompassing high levels of dietary fibers which makes them suitable for preparing fiber based foods (Hamada *et al.,* 2002). An additional novel utilization includes roasting date pits for preparing a caffeine-free beverage to be used as coffee substitute. It was reported that a brew made from roasted palm date seeds can be safely consumed and served to people who are sensitive to caffeine and prefer to enjoy the characteristic flavor and aroma of caffeine-free coffee without the adverse effects (Al-Farsi *et al*., 2007; Baliga *et al*., 2011; El Sheikh *et al*., 2014). Interestingly, roasted palm date seeds have similar aromatic compounds (alcohols and aldehydes) that exist in Arabica coffee brews (Saafi-Ben *et al*., 2012). Therefore, the focus of this research work is to produce a natural sweetener from date fruit and a coffee- like powder from date seed and determine nutritional quality from substitute for coffee from date pits and natural sweetener from date fruit.

Materials and Methods

Source of Materials

Dates fruits, sugar and honey were purchased from Owode Market in Offa local government area of Kwara State, Nigeria.

Source of Equipment

Equipment required for the successful conduct of this research were made available for usage by the Food Processing Laboratory of the Food Technology Department, Federal Polytechnic Offa, Kwara State, Nigeria.

Preparation of date fruit powder

The date flour was produced according to the method of Manickavasagan (2012). Briefly, the date fruits were sorted out and washed to remove dirt and unwanted materials. Afterwards, the date fruits were de-seeded (de-pitting) manually and cut into small pieces with the aid of knife, cleaned and weighed. The pulp with the pericarp was then dried in hot air oven at 60^{o}C for 72 hours and was subsequently milled into flour with a blender and sieved through a 0.35mm mesh sieve to obtain flour (Figure 1). The date palm flour was sealed in an airtight container and stored at room temperature.

Preparation of date seed powder

The coffee like powder was produced according to the procedure described by Fikry *et al.* (2019) with modification. The date fruits were sorted out and washed to remove dirt and unwanted materials. Afterward, the date fruits were deseeded (de pitting) manually then the date pits were washed and dried in hot air oven at 60oC for 30 min. It was then roasted at 220oC for 6 min, grinded and packaged until further analysis.

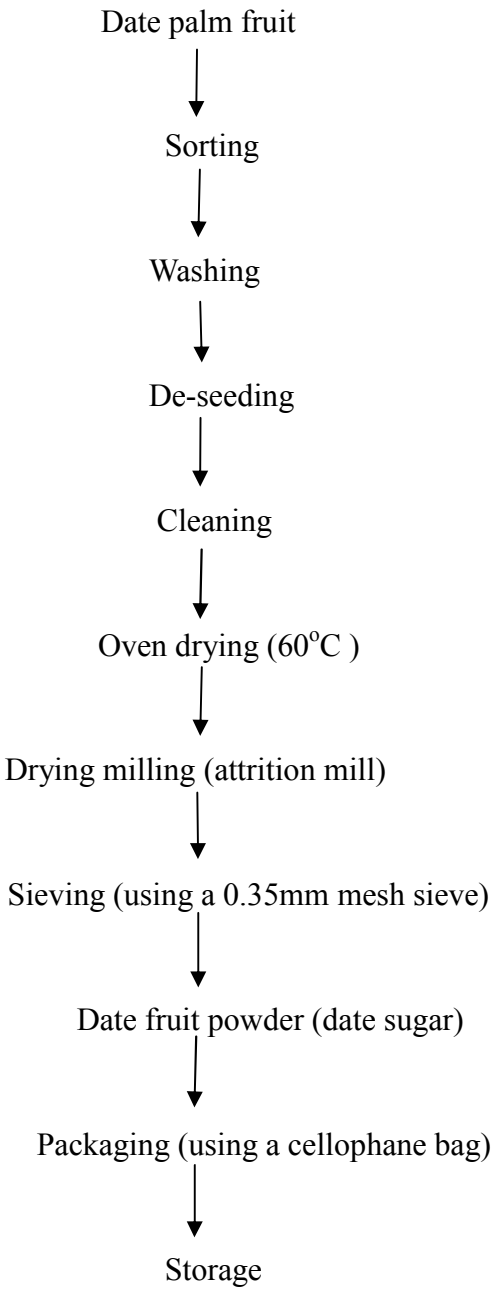

Figure 1: Flow chart for the preparation of date fruit powder

Source: Manickavasagan (2012)

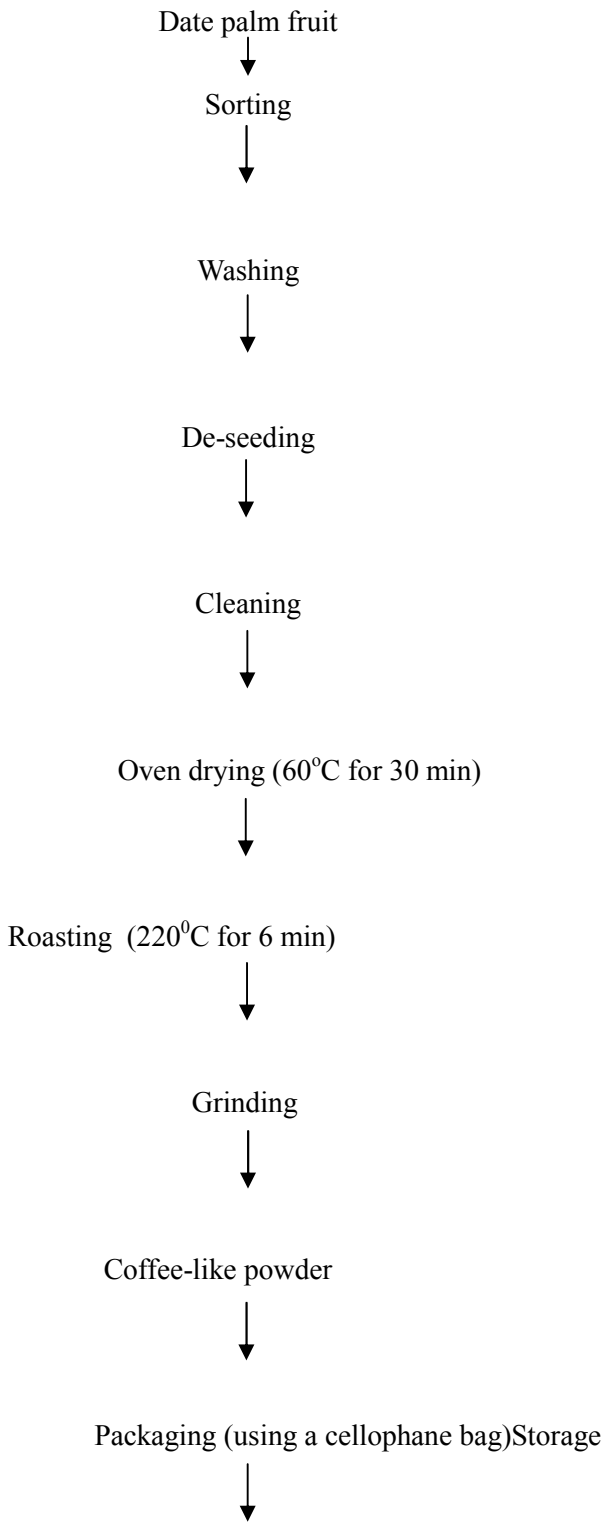

Figure 3.2: Flow chart for the preparation of date seed powder (Oven method)

Source: Modified method of Fikry *et al.* (2019)

Method of Analysis

Digestion of samples for Mineral Contents determination

3 g of each sample was accurately weighed after pulverization and homogenization. The homogenized samples were weighed into the digestion tubes. 10cm^3 concentrated H_2SO_4 and 5cm^3 concentrated HNO_3 was added. The samples, each was digested and its volume was reduced to 2 cm^3. The digestion was continued until the solution was colourless. This ensured the removal of all HNO_3.The sample was allowed to cool and 15cm^3 of water was added with gentle swirling. 1M NaOH was added drop-wise until a pink tinge, brown or colourless solution was produced. The solution was filtered using a Whattman filter paper No.42, followed by dilution to the mark in a 25cm^3 volumetric flask. The digested date fruit flour samples were analysed for Ca, Mg, Mn, K, Zn and Fe concentration using Atomic Absorption Spectrophotometer (AAS). All determinations were carried out in duplicate and reported as mean mineral content in mg/kg.

Sugar content analysis

Standard Sugar Preparation

Standard sugar solutions were prepared separately by dissolving ±0.5 g in 50 mL volumetric flask then homogenized. About 1 µL of these solutions were subjected to the HPLC analysis. (Seal, 2019)

Samples Preparation

About 10 g of the sample test were transferred to a 125 mL Erlenmeyer flask and dissolved with 50 mL of distilled water. The sample was extracted using ultrasonic for 10 minutes, filtered. The concentrated extract was dissolved volumetrically with distilled water into a 10 mL measuring flask. The test sample was injected into HPLC for analysis.

Determination of Alkaloids content of the samples

This was done by the alkaline precipitation using the gravimetric method described by AOAC (2000). Two grams (2g) of each of the sample was weighed and dispersed in 10% acetic acid solution in ethanol to form a ratio of 1:10 (10%). The mixture was allowed to stand for 4 hours at 28 °C. It was later filter via Whatman No. 42 grade of filter paper. The filtrate was concentrated to one quarter of its original volume by evaporation and treated with drop-wise addition of concentrated aqueous NH_4OH until the alkaloid was precipitated. The precipitated alkaloid was received in a weighed filter paper, washed with 1% ammonia solution and dried in the oven at 80 °C. Alkaloid content was calculated and expressed as a percentage of the weight of sample analyzed.

Determination of Phytate content of the sample

This was determined according to the method of AOAC (2000). One gram of sample material was added with 0.2N HCl such that it was 3-30µg ml phytate solution; 0.5ml of extract was pipetted into a test tube fitted with a ground glass stopper, then, add 1mL of

the solution, the test tube was covered with the stopper and fixed with a clip. The tube was heated in a boiling water bath for 30 minutes. Care was taken to ensure that for the first 5 minutes the tube remained well stoppered. After cooling in ice water for 15 minutes, allowed to adjust to room temperature. The tubes were allowed to reach the room temperature. The content was then mixed and centrifuged for 30 minutes at 3000g. 1 ml of the supernant was transferred to another test tube and 1.5ml of solution was added. The absorbance was measured at 519nm against distilled water.
Preparation of the calibration curve is carried out by plotting the concentrations of the reference solutions against their corresponding absorbance. Then the absorbance of the test sample is used to obtain the concentration from the calibration curve.

Preparation of standard solutions

The phenolic acids (gallic acid, caffeic acid, catechin and P-coumaric acid), flavonoids (epigallocatechingallate, rutin, myricetin, quercetin, kaempferol and naringenin) were determined. The solvents such as glacial acetic acid, HPLC grade acetonitrile and HPLC grade methanol were used. The stock solution of concentration 1 mg/mL (w/v, 1000 ppm) was prepared by dissolving 1 mg of standard in 60% (v/v) methanol. The standard working solution (v/v, 20 ppm) was then prepared by further dilution of the stock solution with 60% (v/v) methanol. The standards were then filtered through a 0.45µm PVDF-syringe filter (Thermo Scientific, Massachusetts, USA).(Seal, 2016)

Chromatographic analysis of phenolic acids and flavonoids of the samples

Chromatographic analysis of phenolic acids and flavonoids were carried out using a modified method of Mohd Zainol *et al.* (2009) and Seal (2016). Approximately 1% (v/v)aqueous acetic acid solution (solvent A) and acetonitrile (solvent B) were used as the mobile phase. The flow rate was adjusted to 0.7 mL/min, the column was thermostatically controlled at 28°C, and the injection column was kept at 20 µL. Gradient elution was performed by varying the proportion of solvent B to solvent A. The gradient elution was then changed from 10% to 63% B in a linear fashion for 11 minutes, 63% was maintained for 10 minutes. The elution was increased to 90% in 26 minutes. The composition back to the initial condition (solvent B: solvent A: 10: 90) was achieved in 31 minutes and allowed to run for another 5 minutes before the injection of the next sample. Total analysis time per sample was 36 minutes. HPLC chromatograms were detected using a photodiode array UV detector at 272 nm.

Determination of caffeine in the samples by High Performance Liquid Chromatography (HPLC)

HPLC chromatographic analysis was carried out on an Agilent HPLC-DAD 1200 series system equipped with a G1312B Binary pump SL (Agilent), manual injector (Agilent manual syringe, P/N5190-1501, 50µl - FN, LC tip) with a 20 µl loop volume, Diode array detector (G1315C DAD SL). A reversed-phase C18 column (Phenomenex, 125 mm × 4.6

mm i.d, 5µm) was used for the separation. The aqueous mobile phase used was freshly prepared, filtered (membrane filter, 0.45 µm × 44 mm, Millipore) and sonicated with an ultrasonic water bath. Separation was via isocratic mode with methanol and 1% acetic acid in water (35:65). The flow rate was at 1.0 ml/min and the wavelength of detection was set at 278 nm with a run time of 7 minutes. Data was acquired and evaluated with the Chemstation® software.

Statistical analysis

Study results were subjected to statistical analysis using the statistical package for social sciences (SPSS) version 20 for windows with Duncan being used to determine the statistical variation between the samples.

Results and Discussion

Table 1: Results for the mineral composition of natural sweetener samples

Parameters (mg/100g)	SWH	SWD	SWS
Iron	14.39±0.01^{c}	9.65±0.01^{b}	6.53±0.01^{a}
Calcium	0.71±0.00	0.61±0.00	1.16±0.00
Potassium	0.74±0.04^{b}	1.31±0.00^{c}	0.57±0.01^{a}
Magnesium	0.92±0.01^{a}	0.91±0.01^{a}	0.91±0.00^{a}
Manganese	0.96±0.00	0.00±0.00	0.00±0.00
Zinc	1.56±0.01^{b}	1.23±0.01^{a}	1.21±0.00^{a}

Values are mean ± standard deviation. Data with different superscripts in the same row are significantly different at $p < .05$

Keys:

SWH = Honey

SWD = Date

SWS = Granulated Sugar

The results for the mineral composition of sweetener samples are presented in Table 1. The mean results for the iron contents of the sweetener samples ranged from (6.53 – 14.39) mg/100g. The highest iron content (14.39 mg/100g) was observed in honey (SWH) while granulated sugar (SWS) had the least value (6.53 mg/100g). There were significant differences ($p < .05$) between the iron contents of the sweetener. The highest iron contents obtained for honey in the current study could be attributed to nutrient-dense nectar or material from which the bees obtain for honey production. Similar observation had been reported Tuzen *et al.* (2007) for honey from different regions of Turkey and those of Coolborn and Adetoun (2016) for honey from different regions in southwestern Nigeria. The values obtained in the current study are higher than 0.46 – 2.52 mg/100g reported for iron contents of different date varieties by Nadeem *et al.* (2019), 3.6 – 4.11 mg/100g for different honey by Coolborn and Adetoun (2016).

Calcium is needed as structural proportion of teeth and bones with its daily recommended intake for reduction of blood pressure and risk of colon cancer (Jackson *et al*., 2006).The mean score values for the calcium contents of the sweetener samples were of range (0.61 – 1.16 mg/100g). Sample SWH (honey) had the highest value (0.71 mg/100g) while the least value (0.61 mg/100g) was observed in SWD sample (date). These values are lower than the recommended daily allowance (RDA) for calcium in adults (800 mg/day) and teenagers (1200 – 1800 mg/100g) (Otten *et al*., 2006). The calcium contents of the sweetener samples in this study are lower than 12 – 187 mg/100g for dried dates reported by Ayad *et al.* (2020) and 186.55 mg/100g for date palm fruit by Siddeeg *et al.* (2019) but higher than (0.06 – 0.1 mg/100g) for calcium contents of honey from different eco-zones in Nigeria by Adeonipekun *et al.* (2016).

The potassium content of the sweetener samples differed significantly ($p < .05$) with values ranging between (0.57 – 1.31 mg/100g). The highest potassium content (1.31 mg/100g) was observed in sample SWD (date) while the least value (0.57 mg/100g) was observed in sample SWS (granulated sugar). The potassium contents of the sweeteners in this study are falls short of the daily recommended amount of potassium per day for adults (2000 mg) (Nadeem *et al.*, 2019). Highest potassium content for dates powder in the current study conform to the claim of United States Department of Agriculture (USDA) (2007) that dates are rich source of potassium (864 mg). However, the low potassium contents of the sweeteners in the current work is an indication that they may not suffice for ameliorating constipation, irregular heart beat and muscle cramps. The values obtained for potassium contents of sweeteners in this study are lower as compared to (475.46 – 486.18 mg/100g) for potassium contents of honey from farmers in Western states of Nigeria studied by Coolborn and Adetoun (2016) and 533.9 – 1013±0.86 mg/100g for potassium contents of different date fruits varieties by Nadeem *et al.* (2019). Potassium functions as electrolyte and helps in functioning of kidneys, muscle cell contraction and nerve impulse (Youn and McDonough, 2008).

Magnesium is an activator of many enzymes systems which helps in maintenance of the electrical potential in nerves of the body system (Olatidoye *et al.*, 2017). The magnesium

contents of the sweetener samples ranged from 0.91 to 0.92 mg/100g with sample SWH (honey) having the highest magnesium content (0.92 mg/100g) while the least value (0.91 mg/100g) was observed in sample SWD (date) and SWS (granulated sugar) respectively. No significant differences ($p > .05$) were observed between the magnesium contents of the sweetener samples. Values here are below 0.06 – 0.34 mg/kg reported for honey from different eco-zones in Nigeria by Adeonipekun *et al.* (2016) and 54 – 150 mg/100g for dried dates reported by Ayad *et al.* (2020).

The mean scores for the manganese contents of the sweetener samples were of range (0.00 – 0.96 mg/100g) with SWH (honey) having the highest manganese content (0.96 mg/100g) while the least value (0.00 mg/100g) was observed in sample SWD (date) and sample SWS (granulated sugar).The value for the manganese content of honey in the current study are in agreement with the report of Nageh *et al.* (2020) for clover honey (0.8 mg/100g). However, the findings of Dghaim *et al.* (2021) for manganese contents 2.39 – 5.07 mg/kg of different date fruits varieties are higher than the report of the current work. Manganese is helpful in carbohydrate metabolism, in coordination with enzymes in the body. Manganese is used by the body as a co-factor for the antioxidant enzyme, superoxide dismutase (Dias, 2012; Yadav, 2020).

The zinc contents of the sweeter samples ranged from (1.21 – 1.56 mg/100g) with sample SWH (honey) significantly ($p < .05$) having the highest value (1.56 mg/100g) while the least value (1.21 mg/100g) was observed in sample SWS (granulated sugar).These values fall short of the recommended dietary zinc per day for adult male 15 mg/day and female 12 mg/day (Rubio *et al.*, 2009; Nadeem *et al.*, 2019). There were no significant differences ($p > .05$) between the zinc contents of sample SWD (date) and SWS (granulated sugar). Our values are higher than 0.06 – 0.08 mg/kg reported for zinc contents of honey reported by Bektashi *et al.* (2021) but in conformity with the range of values 1.64 – 2.06 mg/kg obtained by Coolborn and Adetoun (2016) for different honey types. Zinc boosts the health of our hairs, plays a role in the proper functioning of some sense organs such as ability to taste and smell, helps in carbohydrate and protein metabolism and also assists in metabolism of vitamin A from its storage site in the livers and facilitates the synthesis of DNA and RNA necessary for cell production (Jacob *et al.*, 2015).

Table 2: Results for sugar contents of sweetener samples

Parameters (%)	SWH	SWD	SWS
Sucrose	5.23±0.01[a]	92.96±0.00[b]	99.32±0.00[c]
Glucose	37.54±0.02[c]	2.22±0.01[b]	0.01±0.00[a]
Fructose	29.21±0.04[c]	3.66±0.00[b]	0.01±0.00[a]

Values are mean ± standard deviation. Data with different superscripts in the same row are significantly different at $p < .05$

Keys:
SWH = Honey
SWD = Date
SWS = Granulated Sugar

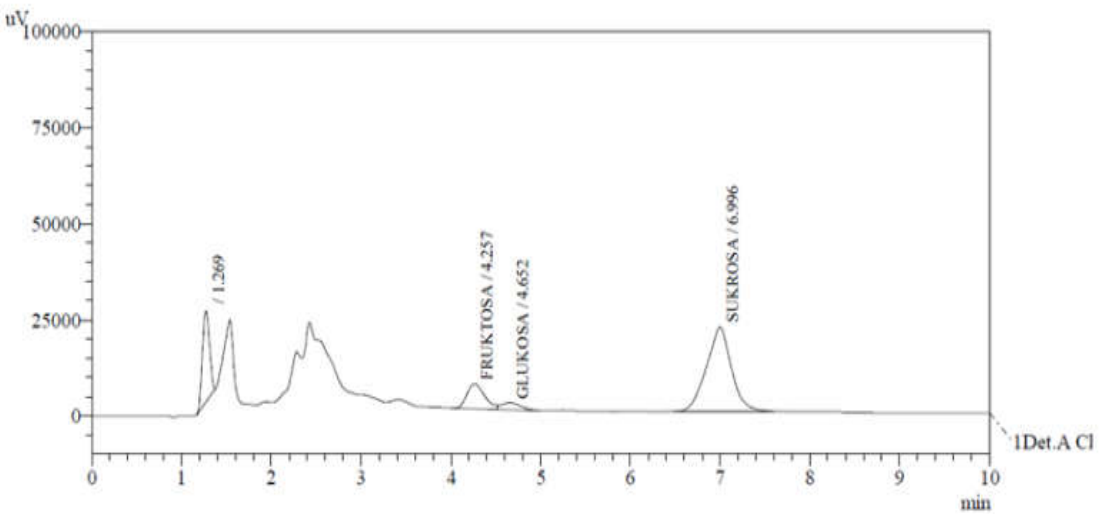

Figure 3: Simple sugar content chromatogram on the SWH

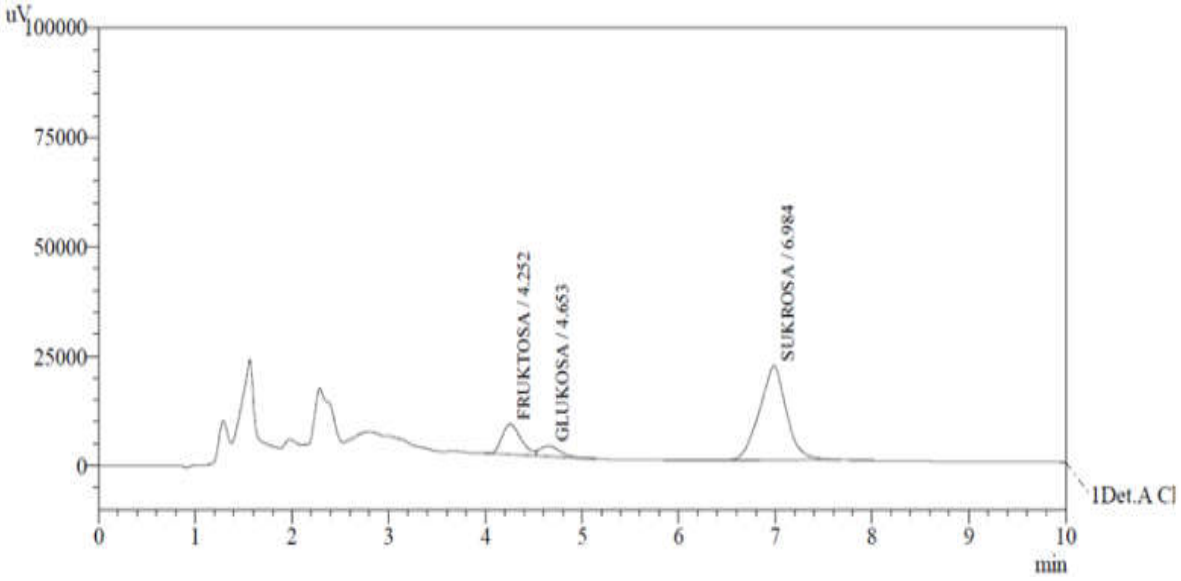

Figure 4: Simple sugar content chromatogram on the SWD

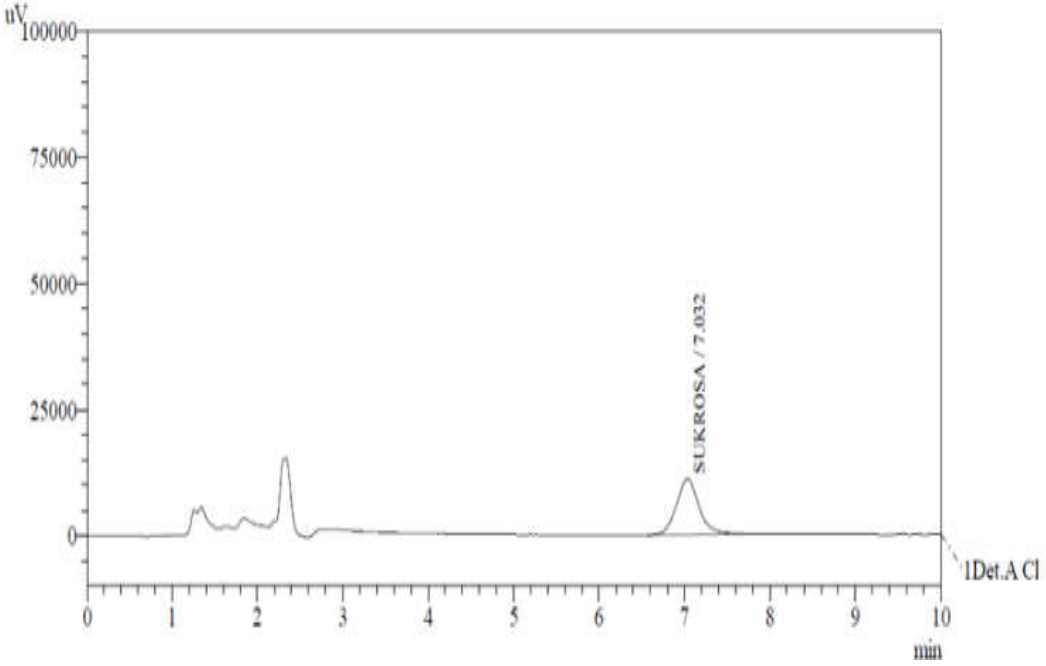

Figure 5: Simple sugar content chromatogram on the SWS

Sugar Contents of the Sweeteners

The results for the sugar contents of the sweetener samples are as shown in Table 2. The simple sugar chromatogram on the sweetener samples are presented in figure 3 – 5 respectively. The mean results for the sucrose, a disaccharide, of the sweetener samples differed significantly ($p < .05$) with values ranging between (5.23 – 99.32%). Sample SWS (Granulated sugar) had the highest sucrose (99.32%) while the least sucrose content (5.32%) was observed in sample SWH (honey). The highest sucrose content observed in the granulated sugar is in conformity with the findings of Maryani *et al.* (2021) for sucrose content (94.75%) of sugar from sugar cane. High sucrose content in table sugar, as observed in this study, makes it a widely used sweetener in major carbonated drinks, confectioneries and other home-made foods. However, Margaret *et al*. (2018) opined that sucrose present in sweet soft drinks and foods can increase the risk of type 2 diabetes since it is easily absorbed. Studies have shown that honey is a low sucrose sweetener 0.5 – 3% (Ioannidou *et al*., 2005; Cano *et al.,* 2006); hence, a justification to the low sucrose content observed in the honey of the current study. The sucrose content of date in the current study are not in conformity with 3.20 g/100g for sucrose content of date by Siddeeg *et al*. (2019).

Glucose is caught up in the gastrointestinal villi through transportation alongside sodium particles then, at that point, enters capillary blood to be at last moved to the liver. It is the main source of fuel for cellular metabolism in the body system (Maryani *et al.*, 2021).The glucose contents of the sweetener samples were of range (0.01 – 37.54%). Sample SWH (honey) had the highest glucose content (37.54%) while the least value (0.01%) was observed in the granulated sugar (SWS). There were significant differences ($p < .05$) between the glucose contents of the sweetener samples. The value obtained for the glucose content of the honey align with 25 – 37% reported for glucose content of honey by Ioannidou *et al*. (2005) and Cano *et al.* (2006). Nandi *et al.* (2011) also contributed that glucose, a monosaccharide, is part of the sugar mainly contained in honey. The values 31.3 – 47.4% reported for glucose contents of selected date varieties reported by Ahmad *et al.* (2014) and Assirey (2015) are not in agreement with the value obtained for dates in the current work. Varietal differences or agronomical distinction could have resulted in variation in glucose contents.

The fructose contents of the sweetener samples differed significantly ($p < .05$) with values ranging between (0.01 – 29.21%). Sample SWH (honey) had the highest fructose content (29.21%) while the least value (0.01%) was observed in sample SWS (granulated sugar).The highest fructose observed in the honey conform to 25 – 45% reported for fructose content of honey in the researches of Ioannidou *et al*. (2005) and Cano *et al.* (2006). The report of Ismail *et al.* (2016) for fructose content 36.2 – 39.5% of dates are higher than the findings of the current study.

Table 3: Results for the mineral composition of roasted date seeds powder and commercial brand

Parameters (mg/100g)	RTD	ROD	RTN
Iron	2.45±0.01[a]	3.45±0.00[c]	2.66±0.01[b]
Calcium	28.32±0.47[c]	8.06±0.01[b]	5.18±0.06[a]
Potassium	83.19±0.04[b]	56.19±0.04[a]	68.18±0.02[b]
Magnesium	2.02±0.00[a]	4.31±0.00[c]	2.58±0.04[b]
Manganese	4.32±0.00[b]	5.37±0.01[c]	4.13±0.01[a]
Zinc	18.33±0.03[c]	8.77±0.01[a]	12.25±0.00[b]

Values are mean ± standard deviation. Data with different superscripts in the same row are significantly different at $p < .05$
RTD= Roasted date seed (Traditional method)
ROD = Roasted date seed (Oven method)
RTN = Nescafe®

Mineral Compositions of Roasted Date Seeds Powder and Commercial Brand

Table 3 presents the results for the mineral composition of roasted date seeds powder and Nescafe® samples. The iron contents of the roasted date seeds powder and Nescafe® differed significantly ($p < .05$) with values ranging between (2.45 – 3.45 mg/100g). Sample ROD (oven method roasted date seed) had the highest iron content (3.45 mg/100g) while the least value (2.45 mg/100g) was observed in sample RTD (traditionally roasted date seed). These values are lower than 18.1 – 79.4 mg/kg for iron contents of roasted date seeds powder by Ghnimi *et al.* (2015) and 12 – 617 mg/kg for Arabian coffee by Pohl *et al.* (2013).

The calcium contents of the roasted date seeds powder and Nescafe® samples ranged from 5.18 – 28.32 mg/100g with sample RTD (traditionally roasted date seed) having the highest calcium content (28.32 mg/100g) while the least value (5.18 mg/100g) was observed in sample RTN (Nescafe®). There were significant differences ($p < .05$) between the calcium contents of the roasted date seeds powder and Nescafe ®. Higher calcium contents for date seeds 95.12 mg/100g and coffee 566.66 mg/100g have been reported by Ali-Mohamed and Khamis (2004) which are higher than the findings of the current work.

The means score values for the potassium contents of the roasted date seeds powder and Nescafe® samples were of range 56.19 – 83.19 mg/100g. The highest potassium (83.19 mg/100g) was observed in sample RTD (traditionally roasted date seed) while the oven roasted date seed sample (ROD) significantly ($p < .05$) had the least potassium content (56.19 mg/100g). No significant differences ($p > .05$) were observed between the potassium contents of sample RTD (traditionally roasted date seed) and sample RTN (Nescafe ®). These values are lower than 2147 – 2396 mg/kg reported for roasted date seeds powder and 11400 – 29100 mg/kg for Arabian coffee by Ghnimi *et al.* (2015) and Pohl *et al*. (2013) respectively. Variation in values could be attributed to the different varieties and possibly, varying roasting operations adopted in the cited literatures.

The magnesium contents of the roasted date seeds powder and Nescafe® samples differed significantly ($p < .05$) with values ranging between (2.02 – 4.31 mg/100g). Sample ROD (oven roasted date seed) had the best magnesium content (4.31 mg/100g) while the least value (2.02 mg/100g) was observed in sample RTD (traditionally roasted date seed). Values in this work are lower as compared to 78.90 mg/100g reported for roasted dates by Rahman *et al.* (2007) and 51.7–58.4 mg/100g for raw date seeds by Besbes *et al.* (2004) and Assirey (2015).

The mean results for the manganese content of the roasted date seeds powder and Nescafe ® samples ranged between (4.13 – 5.37 mg/100g). Sample ROD (oven roasted date seed sample) had the highest manganese content (5.37 mg/100g) while the least value (4.13 mg/100g) was observed in RTN (Nescafe®). There were significant differences ($p < .05$) between the manganese contents of the roasted date seeds powder and Nescafe® samples. Ghnimi *et al.* (2015) reported 10.6 – 12.6 mg/100g for manganese contents of roasted date seeds powder which are higher than those obtained in the current work. Contrarily, findings in this work are higher than 0.60 mg/100g reported for manganese content of roasted dates by Rahman *et al.* (2007)

The zinc contents of the roasted date seeds powder and Nescafe® samples differed significantly ($p < .05$) with values varying between (8.77 – 18.33 mg/100g). Sample RTD (traditionally roasted date seed) had the best zinc content (18.33 mg/100g) while the least value (8.77 mg/100g) was observed in oven roasted date seed powder sample (ROD). These values are higher than zinc content 0.20 mg/100g of roasted dates reported by Rahman *et al.* (2007) and 0.69 – 0.72 mg/100g for raw dates by Parvin *et al.* (2015) but in conformity with 14.6 – 15.7 mg/100g for roasted date seeds powder by Ghnimi *et al.* (2015).

Table 4: Results for caffeine, phenol and alkaloid contents of roasted date seeds powder and Nescafe ® samples

Parameters (ppm)	RTD	ROD	RTN
Caffeine	5.95±0.00[b]	3.07±0.01[a]	6.08±0.00[c]
Phenol	0.29±0.01[c]	0.06±0.01[b]	0.00±0.00[a]
Alkaloid	0.00±0.00[a]	0.02±0.01[a]	0.15±0.00[b]

Values are mean ± standard deviation. Data with different superscripts in the same row are significantly different at $p < .05$

Keys:

RTD= Roasted date seed (Traditional method)

ROD = Roasted date seed (Oven method)

RTN = Nescafe®

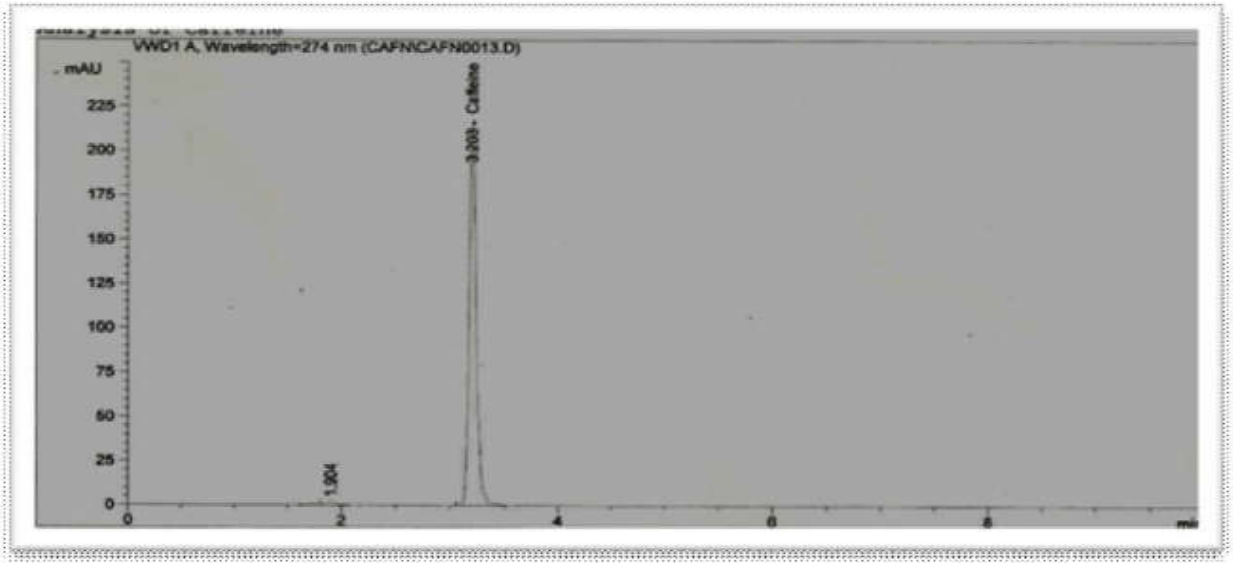

Figure 6: Chromatogram on SWH sample

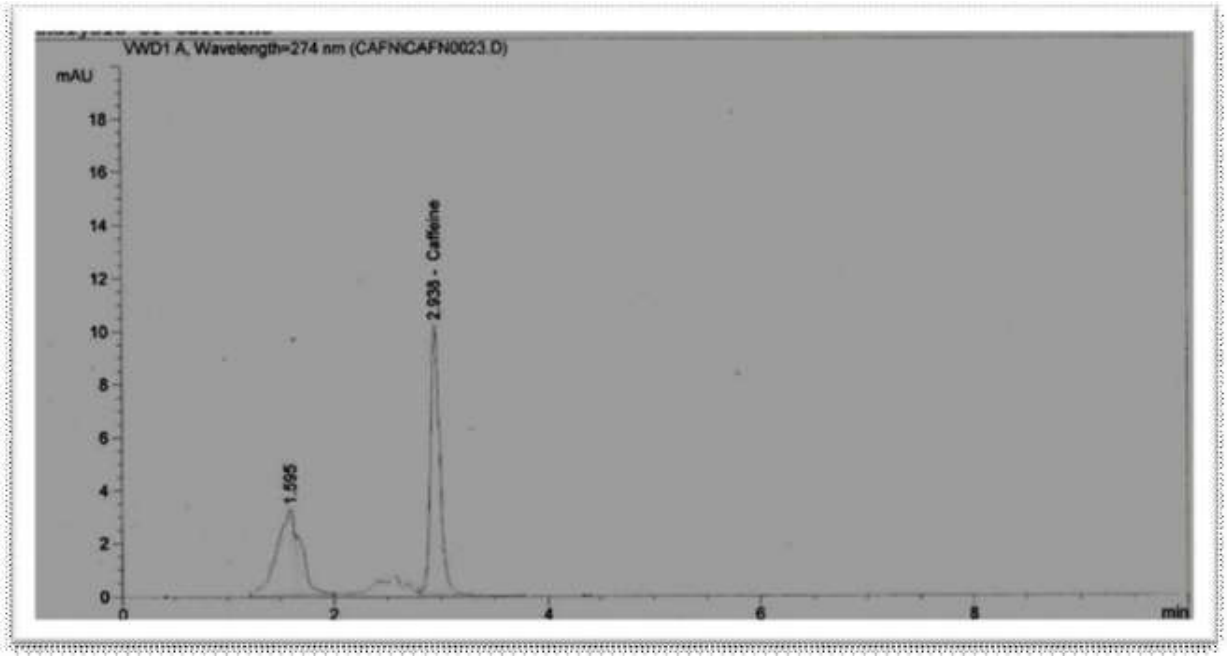

Figure 7: Chromatogram on SWD sample

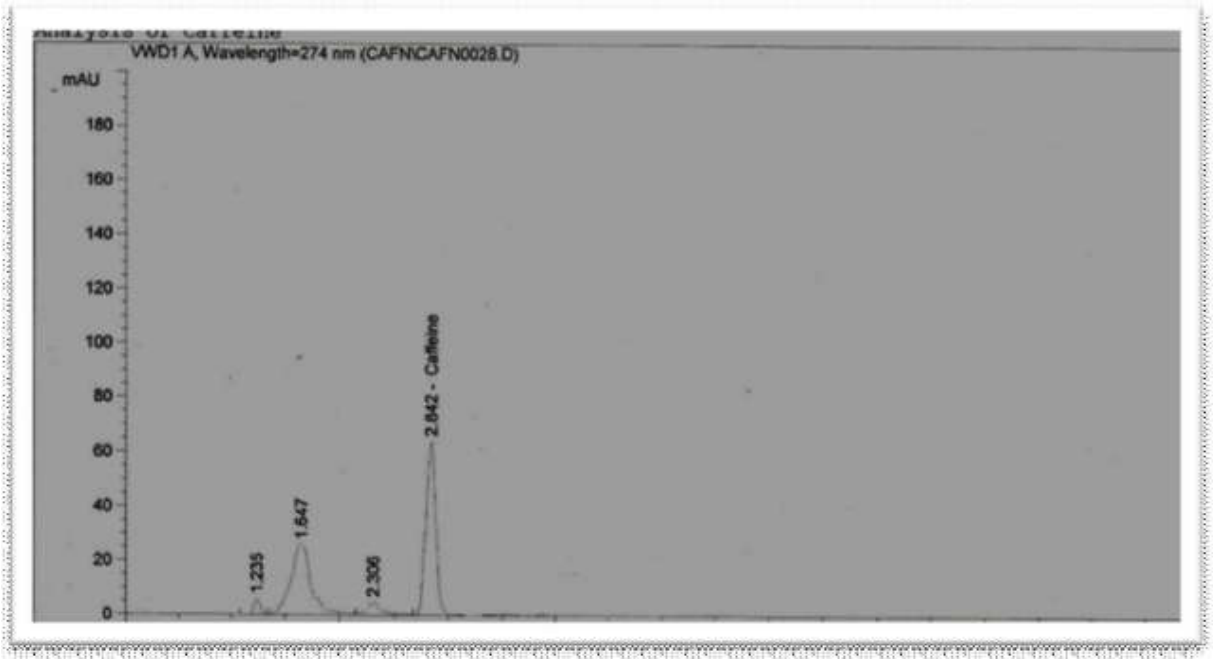

Figure 8: Chromatogram on SWS sample

Caffeine, Phenol and Alkaloid Contents of Roasted Date Seeds Powder and Nescafe ® Samples

Table 4 indicates the caffeine, phenol and alkaloid contents of roasted date seed powder and Nescafe® samples. The chromatogram of caffeine is as shown in figure 4.Caffeine is also a common ingredient in many painkillers and anti-migraine pharmaceuticals (Dinc and Baleanu, 2002; Yao *et al.*, 2004).The caffeine contents of the roasted date seed powder and Nescafe® samples differed significantly ($p < .05$) with values ranging between (3.07 – 6.08 ppm). The highest caffeine content (6.08 ppm) was observed in the Nescafe® while the least value (3.07 ppm) was observed in oven roasted date seed powder (ROD). Paranthaman *et al.*(2012) reported 34.72 mg/gm for caffeine in roasted date seeds which is higher than those obtained in the current work. Contrarily, Warnasih *et al.* (2019) reported 0% for caffeine content of date seed coffee which are lower than the values of the present study. Venkatachalam and Sengottian (2016) affirmed that date seeds coffee contains 0% caffeine unlike normal coffee beans which contains about 20 – 40% caffeine.Caffeine is a psychoactive substance that is frequently linked to adverse health effects. For instance, pregnant women who consume caffeine are more likely to experience symptoms of depression and anxiety (Diego *et al*.. 2008; Kristjansson *et al* .,2013).

The mean results for the phenol contents of the roasted date seed powder and Nescafe® samples were of range (0.00 – 0.29 ppm). There were significant differences at 95% confidence level between the phenol contents of the samples. Traditionally roasted date seed powder (RTD) had the highest phenol content (0.29 ppm) while the least value (0.00 ppm) was observed in the Nescafe® sample (RTN). Our findings are lower than 340.65 mg GAE/100g reported for total phenol content of date seed coffee by Warnasih *et al.* (2019) and 500 TAE/100g for date coffee by Ghnimi *et al.* (2015). Phenolic compounds have been reported to be inherently higher 3100 – 4400 mg GAE/100g in date seeds by Larrauri *et al.* (1995). Lower phenolic content of the date coffee in the current study as compared to other cited literatures could be attributed to variation in varieties of date fruit seeds, roasting operations employed among others. Therefore, the lower phenolic content of the date fruit seed coffee in the present study is an indication of weaker antioxidant activity. Habib *et al.* (2014) further added that phenolic compounds in date palm seeds are mainly proanthocyanidin, which are classified as condensed tannins.

Alkaloids are phytocompounds that interact with deoxyribonucleic acid in the body (Olapadeand Ajayi, 2016). The alkaloid contents of the roasted date seed powder and Nescafe® samples varied from (0.00 – 0.15 ppm). The highest alkaloid (0.15 ppm) was significantly ($p < .05$) observed in the Nescafe® (0.15 ppm) while the least value (0.00 ppm) was observed in the traditionally roasted date seed powder sample (RTD).The findings of Olapadeand Ajayi (2016) for alkaloids contents (20 – 13.0%) of roasted *Sennaoccidentalis* Seeds are higher than those obtained in the current study.

Table 5: Results for concentration of phenolics and flavonoids of the roasted date seeds powder and Nescafe ® samples

Parameters (ppm)	RTD	ROD	RTN
Gallic acid	0.16±0.01[a]	0.18±0.02[a]	0.17±0.02[a]
Catechin	1.83±0.17[a]	9.90±0.33[b]	13.21±0.06[c]
Epigallocatechingallate	7.95±0.01[a]	10.12±0.01[b]	13.20±0.04[c]
Rutin	4.23±0.03[b]	4.84±0.06[c]	2.94±0.01[a]
P-Coumaric acid	1.18±0.03[a]	1.58±0.07[a]	3.80±0.30[b]
Myricetin	0.33±0.01[a]	0.79±0.01[b]	5.68±0.01[c]
Quercetin	0.23±0.01[a]	0.34±0.04[b]	0.46±0.01[c]
Kaempferol	0.03±0.02[a]	0.10±0.03[ab]	0.13±0.02[b]

Values are mean ± standard deviation. Data with different superscripts in the same row are significantly different at $p < .05$

Keys:

RTD= Roasted date seed (Traditional method)

ROD = Roasted date seed (Oven method)

RTN = Nescafe®

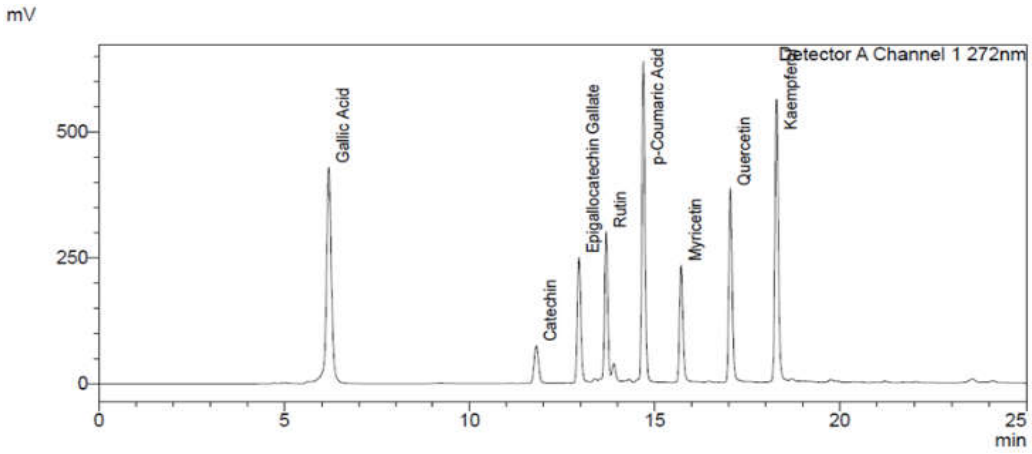

Figure 9: Chromatogram of phenolic acid and flavonoid standard mixture

Phenolics and Flavonoids Concentrations of the Roasted Date Seeds Powder and Nescafe® samples

The chromatogram of the phenolic and flavonoids concentration standard mixture are presented in figure 9. By adjusting the elution program until a satisfactory result was obtained, the resolution and analysis time were increased. Additionally, the study found that gradient and isocratic elution in combination produced superior results. The investigation likewise discovered that the mix of inclination and isocratic elution gave an improved outcome. With 63% acetonitrile, the majority of the flavonoids were eliminated within 11 to 21 min. Each sample's total analysis time was 36 minutes. Gallic acid (4.78 mins), catechin (10.09 mins), epigallocatechingallate (11.32 mins), rutin (12.07 mins), P-coumaric acid (12.86 mins), myricetin (14.16 mins), quercetin (15.58 mins), and kaempferol (16.88 mins) were all observed in the chromatograms. Using 1% (v/v) acetic acid and acetonitrile as the mobile phase, the combination of gradient and isocratic elution resulted in their successful elution at various retention times. Phenolic acids (gallic acid and P-coumaric acid), flavan-3-ols (catechin and epigallocatechingallate), and flavonols (rutin, myricetin, quercetin, and kaempferol) are the targeted phenolic compounds in this study.

Table 5 presents the concentration of phenolics and flavonoids of the roasted date seeds powder and Nescafe® samples. There were no significant differences ($p > .05$) between the gallic acid which is an indication that roasting had no effect the gallic acid. However, there were significant differences ($p < .05$) between the Catechin, Epigallocatechingallate, rutin, myricetin and quercetin of the roasted date seeds powder and Nescafe®. The highest amount of flavonoids detected was catechin (13.21 ppm), followed by epigallocatechingallate (13.20 ppm) in Nescafe® (sample RTN) and

accompanied by rutin (4.84 ppm) in oven roasted date seeds powder (ROD). The highest amount of P-Coumaric acid (3.80 ppm), myricetin (5.68 ppm), quercetin (0.46 ppm) and kaempferol (0.13 ppm) were observed in Nescafe® (sample RTN). Certain flavonoids in high concentrations in methanolic extracts demonstrated the efficiency of the 60% methanol extraction. In previous studies, approximately 60% methanol was used as an extraction solvent for plant phenolic compounds because it was found to efficiently extract the phenolic compounds (Mohd Zainol *et al*., 2009; Pyrzynska and Sentkowska,
2015) and was also mentioned as a good solvent for extracting phytochemicals (Chigayo *et al*., 2016).

Conclusion

Comparative study on sugar, honey and date powder as sweeteners revealed the mineral, total sugar, fructose, glucose content and phytochemical properties of the samples. The result showed that date fruit powder had high amount of mineral content, sugar sample had high amount of total sugar, fructose and glucose. The result showed that only date sample contain phytochemicals among other sweeteners. The result also revealed that coffee-like powder produced from date seed had the highest nutritional value while phytochemical properties profiling showed that commercial coffee had the high amount of terpenoid, tannin, flavonoid, alkaloid and saponin. This study showed that date as a sweetener has nutritional benefit over other sweeteners, date seed powder had similar characteristics with branded coffee however lower in caffeine.

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