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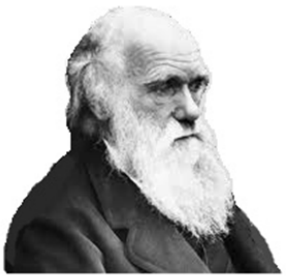

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Investigating the Proximate, Ultimate and Chemical Composition of Four Cultivars of Date Seed, *Phoenix dactylifera* L.

K. Nwaokobia[1,*], **R. O. Ogboru**[2] and **C. A. Idibie**[3]

[1]Department of Agricultural and Bio-Environmental Engineering Technology, Federal Polytechnic, P.M.B 13, Auchi. Edo State Nigeria

[2]Research Coordinating Unit, Forestry Research Institute of Nigeria, P.M.B. 5054, Jericho Hills, Ibadan, Oyo State, Nigeria

[3]Department of Chemical Sciences, Edwin Clark University, P.M.B. 101, Kiagbodo, Delta State, Nigeria

*Corresponding Author: nwaokobia.kingsley@gmail.com
*Tel: +234-8066755184

ABSTRACT

Proximate, ultimate and chemical composition of four varieties of dates, namely Digila, Krikri, Sukur and Trigal were determined in the pulp. In addition, the seed kernel of dika nut (*Irvingia gabonensis*) was assessed on a dry weight basis. The proximate analysis included moisture, volatile matter, Fixed Carbon and ash, respectively, with the pulp of Digila having the highest fixed carbon of 72.73%, while the krikri date pulp contained the highest moisture of 79.22%, Sukur pulp has the highest volatile matter of 59.20%, and Trigal seed contained 88.05% moisture - establishing that its kernel holds the highest moisture content among the four cultivars. Ultimate Analysis showed that Digila and Trigal pulp contained the same amount of total carbon (94.10%), the pulp of Krikri contained the highest amount of hydrogen (3.55%), while the pulp of Sukur has 1.44% Nitrogen, and the dika nut seed contained 9.82% Oxygen - making it the highest. Moreover, Sulpur, Digila, Sukur, Trigal and Krikri have available hydrogen, nitrogen, oxygen, sulphur, sodium, potassium, calcium, magnesium, iron, zinc and phosphorus for the body to absorb for physiological activities, but lacked chlorine, aluminum, and silicon at detectable levels. All these quality food properties make dates a good source of sweetening agent in the food processing industry.

***Keyword*:** Proximate, Mineral Composition, Datepalm, Analysis and Fixed carbon, *Phoenix dactylifera*

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1. INTRODUCTION

The date palm (*Phoenix dactylifera* L.) is one of the oldest cultivated plants and has been utilized as food for over 6000 years. It is a valued food crop in Middle East and is regarded to be one of the most important fruit tree especially in North African, the Middle Eastern and Asian countries. The fruit contributes to the economy and social life within these regions (Bastway, *et al* 2008) and it is considered as an important constituent of their diet (Vayalil, 2002). Date fruits are predominantly known as a basic nutritious food and serves as a medium of wealth creation for many years. As a result of its high nutritional value, great proceeds and its long life, the date palm has been referred to as the "all-purpose tree" (Al-Farsi, *et al* 2006). The fruits of the date palms are eaten throughout the world. Dates are eaten in modern cultures for their nice flavor, smell and their biting texture in addition to their use for flavoring foods, beverages and medication. (Omowunmi and Ayoade, 2013; Taha, 2015; Salajegheh, 2018, Martín-Sánchez, 2017; Roshanfekrrad, 2017)

Date fruits are regarded as major source of carbohydrate which is made up of simple sugars like glucose and fructose and sucrose (Myhera, *et al* 1999) and (Ahmed and Ahmed, 1995).

They are good sources of dietary fibre and some other important minerals which include iron, potassium, selenium, calcium and vitamins and it also contains vitamin C, B1, B2, A, riboflavin and niacin but it is very low in fat and protein contents (Al-Farsi, 2003).

Date farming in Nigeria started since 17th century through the trans-Sahara trade route from North Africa (Jafarpour, *et al* 2017) by Muslim pilgrims on pilgrimage to the Holy cities of Mecca and Medina as it is a major food to break their fast. Although Nigeria is not one of

the leading dates producer in the world, the crop strives in Northern parts of the country especially in regions above latitude 10 North of the equator where the four cultivars popularly known as “Digila”, “Krikri”, “Sukur” and “Trigal” are commonly consumed. Date palm is mainly important for its fruit, that contains pulp, embedded inside of which is a hard kernel (Al-Shahib 2003). Despite the invaluable roles of dates in human life, the Nigerian date palm industry (Production, processing and marketing) has been forced to give up with lack of awareness of the nutritional importance of dates (Jafarpour, *et al* 2017). Below are the images of the krikri, surkur, Trigal and Digila date seed respectively.

The objective of the present study was to investigate the proximate, ultimate and chemical composition of four cultivars of African date seed in Nigeria as a means to the possible use in date paste, syrup or powder as ingredients in some food formulations.

2. MATERIALS AND METHODS

Sample Preparation

Bulk quantities of the four African cultivars of date palm fruit namely Digila, Trigal, Krikri and Sukur was used in this study. Digila and Krikri were purchased at the Hausa market in Ring road, Benin city, Edo State, Nigeria. And the Trigal and Sukur were bought at the Monday market in Kaduna, kaduna state, Nigeria. The samples were manually cleaned to remove foreign materials, broken or immature fruits and kernels. Samples were spread on mat in thin layer at room temperature for 3 days after which their moisture contents were determined. Moisture content was determined following the procedure adopted by Aviara et al. (2007). This involved oven drying at 105 ±2 °C until a constant weight was reached.

All chemicals used during the present study were of the analytical reagent grade. All the analysis was carried out at the Central Laboratory Services, department of Animal Production and Health, Federal University of Technology, Akure, Ondo state, Nigeria. Samples were analyzed chemically according to the official methods of analysis described by the Association of Official Analytical Chemist (A.O.A.C.)

Analysis of Datepalm Seed

There are two methods: ultimate analysis and proximate analysis. The ultimate analysis determines all seed component elements, solid or gaseous and the proximate analysis determines only the fixed carbon, volatile matter, moisture and ash percentages.

Determination of Proximate Composition of Datepalm Seed

The routine analysis of food is termed the proximate or Wende analysis (after the Wender- experimental station, Germany. determines only the fixed carbon, volatile matter, moisture and ash percentages

Determination of Moisture in Datepalm seed.

Determination of moisture is carried out by placing a sample of grounded date seed of size 200-micron size in an uncovered crucible and it is placed in the oven kept at 108 ±2 °C for one hour. Then the sample is cooled to room temperature in a desiccator and weighed

again. The process of heating, cooling and weighing is repeated a number of times till the constant weight of the sample is reached. The percentage moisture is given by:

$$\text{Moisture in date} = \frac{\text{Loss in weight of date}}{\text{Weight of sample initially taken}} \times 100\%$$

Determination of Volatile Matter of Date seed

It is the loss in weight of moisture free grounded date when heated in a covered crucible in a muffle furnace at 950 °C for 7 minutes.

Volatile matters are the methane, hydrocarbons, hydrogen and carbon monoxide, and incombustible gases like carbon dioxide and nitrogen found in date. Thus the volatile matter is an index of the gaseous fuels present. Typical range of volatile matter is 20 to 35%.

Volatile Matter

- Proportionately increases flame length, and helps in easier ignition of date palm seed.
- Sets minimum limit on the furnace height and volume.
- Influences secondary air requirement and distribution aspects.
- Influences secondary oil support

$$\text{Volatile matter} = \frac{\text{Loss in weightof moisture free date}}{\text{Weight of moisture free date}} \times 100\%$$

Determination of Ash content

It is the weight of residue obtained after burning a weighed quantity o datepalm seedin an open crucible (i.e in the presence of air)at 750 °C in a muffle furnance till a constant weight is achieved.

$$\text{Ash in date palm} = \frac{\text{Weight of residue ash formed}}{\text{Weight of date palm initially taken}} \times 100\%$$

Determination of fixed carbon

It is determined indirectly by deducting the sum total of moisture, volatile matter and ash percentage from 100.

% fixed carbon in datepalm = 100 - (% moisture + % volatile matter + % ash).

Determination Ultimate Analysis of Datepalm Seed

The ultimate analysis indicates the various elemental chemical constituents such as Carbon, Hydrogen, Oxygen, Sulphur, nitrogen etc. It is useful in determining the quantity of air required for combustion and the volume and composition of the combustion gases.

This information is required for the calculation of flame temperature and the flue duct design etc.

Determination of carbon and hydrogen

A known amount of date palm is burnt in current of dry oxygen thereby converting C and H of datepalm into CO_2 ($C + O_2 = CO_2$) and H_2O ($H_2 + \frac{1}{2} O_2 = H_2O$) respectively. The product of the combustion (CO_2 and H_2O) are passed over weighed tubes of anhydrous calcium chloride and potassium hydroxide which absorbs H_2O and CO_2 respectively. The increase in weight of $CaCl_2$ tube represents the weight of water (H_2O) formed while increase in the weight of KOH tube represents the weight of CO_2 formed.

% of H and C in date palm can be calculated as follows:

Let, $x =$ weight of date palm sample taken
Z = increase in the weight of KOH tube.

$\therefore$ Amount of carbon in the date palm seed sample $= \frac{12}{24} \times z$

Since, 44 grams of CO_2 is produced from 12g of carbon and 32g of oxygen

$\rightarrow C + O_2 = CO_2$
12 32 44

$\therefore$ % carbon in Datepalm seed $= \frac{12 \times z}{44 \times x} \times 100$

Similarly, amount of hydrogen in date palm seed sample $= \frac{2}{18} \times y$

Since 18 grams of water is formed by 2 grams of hydrogen and 16 grams oxygen

$\Rightarrow H_2 + ½\ O_2 = H_2O$
2 16 18

$\therefore$ % Hydrogen in date palm seed $= \frac{2 \times y}{18 \times x} \times 100$

Determination of Nitrogen

Nitrogen estimation in date palm is done by Kjeldahal`s method. A known weight of powered date palm seed is heated with concentrated sulphuric acid in the presence of potassium sulphate in a long necked flasked (called Kjeldahal`s flask) thereby converting nitrogen of datepalm to ammonium sulphate. When clear solution is obtained (i.e when whole nitrogen is converted to ammonium sulphate) it is treated with 50% NaOH solution. The ammonia thus formed is distilled over and absorbed in a known quantity of standard sulphuric acid solution. The volume of unused sulphuric acid is then determined by titrating against standard NaOH solution. Thus, the amount of acid neutralized by librated ammonia (from datepalm) is determined.

$$\% \text{ of nitrogen in date palm} = \frac{\text{volume of acid used} \times \text{Normality}}{\text{Weight of date palm taken}} \times 1.4$$

Since, $(NH_4)_2SO_4 + 2NaOH = Na_2SO_4 + 2NH_4OH$

One litre of N/10 H_2SO_4 consumed is equivalent to 0.1gm mole of ammonia or 1.4gm of nitrogen.

$$\text{Volume of acid used} = V_1 - V_2$$

where: V_1 = Volume of H_2SO_4 neutralized in blank, c.c.

V_2 = Volume of H_2SO_4 neutralized in determination, c.c.

Determination of Sulphur

A known quantity of datepalm is burnt completely in a current of oxygen. Ash, thus obtained contains surphur of the datepalm as sulphate which is extracted with diluted hydrochloric acid. Extract is treated with barium chloride solution to precipitate the sulphate as barium sulphate.

The precipitate of $BaSO_4$ is filtered, washed, dried and weighed from which the sulphur in date palm can be computed as follows:

32 grams sulphur in the date palm seed will give 233 grams $BaSO_4$

If x = weight of date palm seed sample taken and, y = weight of $BaSO_4$ precipitate formed then, amount of sulphur in date palm seed are sample:

$$= \frac{32y}{233} = 0.1374y$$

So, % of sulphur in date palm $= \frac{0.1374y}{X} \times 100$

A known quantity of date palm is heated with Eschka mixture (which consists of 2 parts of MgO and 1 part of anhydrous $NaCO_3$) at 800 °C. The sulphate formed is precipitated as $BaSO_4$ (by treating with $BaCl_2$) and it is weighed as done in previous method of sulphur determination.

$$\% \text{ of sulphur in date palm seed} = \frac{0.1374y}{X} \times 100$$

where: x = weight of date palm seed sample taken

y = weight of $BaSO_4$ precipitate formed.

Determination of oxygen in Datepalm seed

It is deduced indirectly as follows:

% oxygen in date palm = 100 – (% of C + H +N + S + ash)

Determination of Mineral Composition

About 50g dried and ground sample of date palm seed was put into a burning cup and 15 ml of pure HNO_3 were added. The sample was incinerated in MARS 5 Microwave Oven at 200 °C temperature and the Solution was diluted to the desired volume with water. Concentrations were determined with a PFP7 Flame photometer.

3. RESULT AND DISCUSSION

Proximate Analysis of Digila, Krikri, Sukur and Trigal cultivars of date palm fruits.

SAMPLE	ASH (%)	MC (%)	VM (%)	FC (%)
Digila (pulp) (Seed)	4.42 6.38	6.98 78.98	30.67 4.44	72.73 11.24
Krikri (pulp) (Seed)	4.24 7.14	79.22 45.97	3.23 9.19	16.36 9.24
Sukur (pulp) (Seed)	7.74 15.44	45.97 66.46	45.33 11.23	59.20 15.24
Trigal (pulp) (Seed)	3.02 3.22	2.89 88.05	24.33 2.36	9.77 6.45

Ultimate Analysis of Digila, Krikri, Sukur and Trigal cultivars of date palm fruits.

Samples	TC	H	N	O	S
Digila (pulp)	94.10	0.25	1.11	1.51	0.025
(Seed)	4.42	0.25	1.27	0.05	0.045
Krikri (pulp)	66.13	3.55	2.91	1.06	5.02
(Seed)	83.41	2.31	3.23	3.21	4.92
Sukur (pulp)	45.19	3.22	1.44	2.19	4.19
(Seed)	62.11	2.00	1.45	2.15	1.04
Trigal (pulp)	94.10	0.25	1.11	1.51	0.25
(Seed)	85.41	0.25	1.27	9.82	0.045

Mineral composition of Digila, Krikri, Sukur and Trigal cultivars of date palm fruits

Samples	TC	H	N	O	S	Na	K	Ca	Mg	Fe	Zn	P
Trigal												
Seed	85.41	0.25	1.27	9.82	0.045	32.12	412.06	121.57	102.46	55.39	47.68	211.12
Pulp	94.10	0.25	1.11	1.51	0.025	342.15	421.42	85.62	75.43	48.48	45.21	195.41
Digila												
Seed	72.15	0.32	2.13	1.76	0.23	219.62	301.35	45.39	92.82	40.11	62.11	103.19
Pulp	102.1	2.10	2.11	1.73	1.21	109.21	213.19	30.26	102.12	20.03	51.21	98.33
Sukur												
Seed	71.08	3.23	3.87	2.11	1.08	79.77	190.53	51.95	101.23	30.17	71.23	172.01
Pulp	80.19	0.13	1.25	2.12	1.06	308.27	299.13	78.22	72.20	42.12	42.18	195.42
Krikri												
Seed	91.23	0.48	1.36	2.32	0.09	243.20	473.40	84.22	75.12	48.23	43.43	204.15
Pulp	39.91	0.45	1.99	3.12	2.12	134.12	209.55	67.22	25.20	20.11	58.54	189.68

NOTE: Cl, Al, and Si were not detectable (ND)

Proximate Analysis of Date Palm Seed

Results obtained showed that Digila pulp contained 6.98% moisture, 30.67% volatile matter, 72.73% Fixed Carbon and 4.42% ash respectively. The seed contained 78.98% moisture, 4.44% volatile matter, 11.24% Fixed Carbon and 6.38% ash respectively. The krikri date palm pulp contained 4.24% ash, 79.22% moisture, 3.23% volatile matter, 16.36% Fixed Carbon respectively. The seed contained 7.14% ash, 45.97% moisture, 9.97% volatile matter and 9.24% Fixed Carbon respectively.

Sukur pulp contained 7.74% ash, 45.97% moisture, 45.33% volatile matter, 59.20% Fixed Carbon respectively. The seed contained 15.44% ash, 66.46% moisture, 11.23% volatile matter and 15.24% Fixed Carbon respectively. Trigal pulp contained 3.02% ash, 2.89% moisture, 24.33% volatile matter, 9.77% Fixed Carbon respectively. The seed contained 3.22% ash, 88.05% moisture, 2.36% volatile matter and 6.45% Fixed Carbon respectively.

Ultimate Analysis of Date Palm Seed

Results obtained showed that Digila pulp contained 94.10% total carbon, 0.25% hydrogen, 1.11% Nitrogen, 1.15% Oxygen and 0.025% Sulpur. The seed contained 4.42% total carbon, 0.25% hydrogen, 1.27% Nitrogen, 0.05% Oxygen and 0.045% Sulphur.

The pulp of Krikri contained 66.13% total carbon, 3.55% hydrogen, 2.91% Nitrogen, 1.06% Oxygen and 5.02% Sulphur. The seed contained 83.41% total carbon, 2.31% hydrogen, 3.23% Nitrogen, 3.21% Oxygen and 4.92% Sulpur.

Sukur pulp contained 45.19% total carbon, 3.22% hydrogen, 1.44% Nitrogen, 2.19% Oxygen and 4.19% Sulpur. The seed contained 62.11% total carbon, 2.00% hydrogen, 1.45% Nitrogen, 2.15% Oxygen and 1.04% Sulpur. The pulp of Trigal contained 94.10% total carbon, 0.25% hydrogen, 1.11% Nitrogen, 1.51% Oxygen and 0.25% Sulpur. The seed contained 85.41% total carbon, 0.25% hydrogen, 1.27% Nitrogen, 9.82% Oxygen and 0.045%

Sulpur. Digila, Sukur, Trigal and Krikri has hydrogen, nitrogen, oxygen, sulphur, sodium, potassium, calcium, magnesium, iron, zinc and phosphorus but chlorine, aluminum, and silicon were not detectable.

4. CONCLUSION

Dates are cheap to produce and are very rich in nutrition. Considering sugar, fibre and protein contents of date flesh, the food scientist could be encouraged to develop new source of food supplements. Also, the mineral contents in the date sample have the potential to provide a good source of zinc, potassium, calcium and sodium in the diet.

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