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Mineral Compositions and Health Risk Assessment of Date Fruit (*Phoenix dactylifera*) Sold in Dutse, Jigawa-Nigeria.

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Abstract
Date fruits (Phoenix-dactylifera) consumption has significant human health benefits due to the presence of minerals and other constituents. The fruits may be contaminated during transportation and possibly storage. This research aimed at exploring the mineral contents and health risk associated with intake of date fruits sold in Dutse, Jigawa State-Nigeria. The Date fruit sample was obtained from market and scientifically identified. The sample was shade dried and crushed into powder, and the mineral's content of Date fruits (Dan Jigawa) was determined using standard procedure. A mean level of Sodium, Potassium, Calcium, Phosphorous was observed in Dan Jigawa Date fruits as 0.04±0.00, 0.79±0.02, 4.71 ±0.06, 10.00± 0.24mg/kg. The Iron, Copper, Zinc, Manganase and Cobalt levels were 0.47±0.01, 0.68±0.04, 1.45±0.01, 0.61±0.05 and 0.17±0.01mg/kg respectively. The health risk assessment (non-carcinogenic): Iron, copper, zinc, Manganase and Cobalt) showed that all the hazard quotients (HQ) is below 1, with Target Hazard Quotient(THQ) of 0.962, signifying the safety of Dan Jigawa dates fruit cultivar.

Keywords: *Date fruit, Health risk, Hazard quotient (HQ), Minerals, Target Hazard Quotient (THQ).*

INTRODUCTION
Phoenix dactylifera L. (Date palm) is among the most important species in the Palm family (*Arecaceae*) which encompasses about 200 genera and more than 2,500 plant species (El Hadrami and El-Hadarami, 2009). Some of the date species includes *P. Canariensis* (Canary Island Date Palm), *P. Reclinata* (Date Palm) and *P. Sylvestris* (Sugar Palm). It is commonly understood that date palm (Hausa*: Dabino*) introduced into Nigeria in the beginning of 17th century by merchants through trans Sahara way from middle east and north Africa (Okolo, *et al*, 2014). Date palm is one of the highest food producer per hectare, it gives more than 3000 calories/kg compared to cooked rice 1800 calories/kg; meat (without fat): 2,245 calories/kg; banana: 970 calories/kg and orange: 480 calories/kg (Zaid and Wet, 1999). Date fruits consists of approximately 70% carbohydrate mostly invert sugar such as glucose and fructose which are suitable for persons that cannot tolerate sucrose, inverted sugar can easily absorbed by human body without undergoing a normal digestion pattern of ordinary sugar (Zaid and Wet, 1999). Dates are known for numerous other nutritional properties due to their richness in non-starch polysaccharides and lignin (Elleuch *et al*., 2008). Population that consumes dates

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particularly around Sahara areas were known to have the lowest rate of cancer a fact which may likely attributed to substantial quantity of Magnesium in date. Date fruit can be known as mine due to the fact it is wealthy in minerals (Zaid and Wet, 1999).

Mineral and some transition metals play significant role to human health, however surpassing threshold level may imposes toxicity, cancer, and even genotoxicity. Amongst the heavy metals (HMs), chromium (Cr), cadmium (Cd), aluminum (Al), lead (Pb), copper (Cu), zinc (Zn), arsenic (As), boron (B), and metalloids are considered to have terrible effect on health and agriculture.

These heavy metals (HMs) are being extended due to numerous environmental factors like mining, fertilizers applications to soil, industrial emissions, metallurgical operations, and non-biodegradation of several metals. These activities can cause stress in plants leading to augmentation in their tissues conferring negative consequences in consumers (Abass *et al*., 2016). Thus, various part of the edible crops can lead to numerous clinical conditions in humans and animals globally (Abdulaal *et al*., 2017). Human beings are generally presented to heavy metals via assimilation or breathing or topical applications. When the concentration of these metals exceeded WHO/FAO maximum threshold levels, various clinical conditions occurred through mutagenic, teratogenic, and carcinogenic processes. The consequences of heavy metals relative to human exposure is detrimental to wellbeing, which includes renal, brain cells, haemapoetic systems (Kachenko and Singh., 2006). Cellular structure of macromolecules were known to be affected by these metals, thus threatening the existing structure of proteins, DNAs and other tissue structures (Khaled *et al*., 2019).

Date fruit have been widely used as food sources for human consumption such as snacks, fruits salad, chocolate and vinegar (Abass *et al*., 2016). It's also used in manufacturing local fan, ropes, basket, bags, bird cages and etc. in addition, dates has the ability to grow in residential sites, along major roads, industrial areas, thus capable of accumulating toxic pollutants in their edible (Abass *et al*., 2016; Abdulaal *et al*., 2017).

Although earlier researchers have found some levels of heavy metals in different varieties of dates, the Dan jigawa date fruit was the focus of this study, which aimed at assessing the date's mineral composition particularly heavy metals, at the same time to investigate on whether the level of heavy metals is high enough to expose consumers at risk of health problems.

MATERIALS AND METHODS

Collection and Sample Preparation

Fruits (*Phoenix dactylifera* L.) were obtained from Shuwarin market in Dutse, Jigawa state, north west of Nigeria.
Dan Jigawa fruit is known to be the most common variety. Identification and authentication of the seed was carried out at botanical laboratory of Bayero University, Kano.
Sample was shade dried at room temperature and then pulverized into powdered form using a laboratory mortar and pestle. This was sieved and used for further work as test samples.

Determination of Mineral Elements (AOAC, 1990):

Sodium, Potassium, Phosphorus, Calcium, Copper, Chromium, Magnesium, Manganese, Zinc, and Iron contents was determined using Atomic Absorption Spectrophotometer (AAS).

Instrumentation:
A spectra A-40 model sample variants was used

Health Risk Assessment of Metal Exposure
In order to ascertain the non-carcinogenic effect of toxicants, previous studies have used this model for the estimation, assessing and implications of the heavy metals to human's health (Cai *et al*, 2015). Hazard quotient in Date fruits are computed according to (USEPA, 2006) and also total hazard quotient (THQ) was determined according to Michael *et al*, 1991.

RESULTS
Some mineral elements and heavy metals were determined from *Dan jigawa* cultivar and the results were presented in table 1. The level of calcium, iron, copper, zinc, magnesium and manganese were 4.71, 0.47, 0.68, 1.45, 0.48 and 0.61 mg/kg respectively (Table 1). Level of sodium was detected (0.04 mg/kg) potassium (0.79 mg/kg) and phosphorus (10.00 mg/kg) in the cultivar. Cobalt was detected to be 0.17 mg/kg (Table 1)

Table 1: Mineral Elements Composition of *Dan jigawa* Fruits (mg/kg)

Minerals	***Ca***	***Fe***	***P***	***Cu***	***Zn***	***Mg***	***Mn***	***Na***	***K***	***Co***
Mean values (mg/kg)	4.71±0.06	0.47±0.01	10.00±0.24	0.68±0.04	1.45±0.01	0.48±0.02	0.61±0.05	0.04±0.00	0.79±0.02	0.17±0.01
RDA mg	2.5	8	4000	0.9	11	400	2.3	1500	3400	10-20

Table 2: depicted the various metal minerals, with their correspondence chronic daily intake (CDI) and oral reference dose values (ORDF). Fe $(7.83x10^{-4})$/ 0.700, Cu $(1.13x10^{-3})$/0.040, Mn $(1.01x10^{-3})$/0.014, Zn $(2.42x10^{-3})$/0.030, Co $(2.83x10^{-4})$/0.0003.

Table 2: The computed CDI and ORF of some minerals

S/N	Metal	CDI	ORDF (Mg/kg/day)
1	***Fe***	$7.83x10^{-4}$	0.700 (US.EPA, 2012)
2	***Cu***	$1.13x10^{-3}$	0.040(U.S.EPA, 2012)
3	***Mn***	$1.01x10^{-3}$	0.014 (Dmello, 2003)
4	***Zn***	$2.42x10^{-3}$	0.030(U.S.EPA, 2012)
5	***Co***	$2.83x10^{-4}$	0.0003(U.S.EPA,2012)

Figure 1 represented a plot of hazard quotients against the various mineral's components of *Dan jigawa* cultivar. The values obtained for Fe, Cu, Mn, Zn and Co are as follows 0.001, 0.003, 0.007, 0.008 and 0.947mg/kg of date fruits respectively.

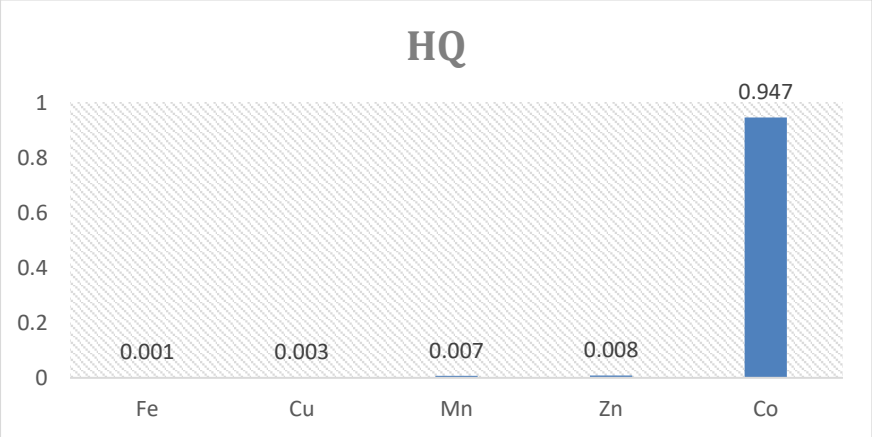

Figure 1: Depicted the hazard quotient of individual metals
Hazard quotient (HQs) and target hazard quotient (THQ) was determined using Michael *et al*.

DISCUSSION:

The mineral content of *Dan jigawa* fruit were evaluated and presented in (Table 1). The date's fruit samples showed some level of essential minerals that are beneficial to human health. The fruits show the presence of copper, iron, zinc, cobalt, manganese, sodium, magnesium and potassium (Table 1). Copper is important mineral that is normally available as a nutritional supplement in some of our food. Copper serves as a cofactor for numerous enzymes recognized as cupro enzymes used in generation of energy, metabolism of iron, neuropeptide stimulation, neurotransmitter synthesis and connective tissue biosynthesis, (Collins *et al*, 2014). Copper deficiency is rare in humans which includes anemia, hypopigmentation, hypocholesterolemia, disorders of connective tissue, osteoporosis and other bone defects (Collins *et al*, 2014). Prolong exposure to high levels of copper may damage liver and cause gastrointestinal signs (e.g., stomach pain, convulsions, nausea, diarrhea, and vomiting) (IMFN, 1998). From the results obtained in table 1 copper concentration was found to be (0.68 ±0.04) mg/kg which is within the permissible limit allowed for human consumption hence health risk assessment for both health quotient (HQs) and target hazard quotient (THQ) were also within the safe range THQ<1 (Prohaska *et al,* 2012).

The mean Calcium value from table 1 was found to be 4.71±0.06 mg/kg which is within the tolerable limit established by food and nutrition board (CRDRIVFNBI, 2010). Tolerable upper intakes for Calcium are as follows for children (1-8) years (2500mg/day), (9-18) years (300mg/day) and (19-50) years (2500mg/day). Calcium requirement usually varies across the sexes.

The mean value obtained from table 1 shows iron content of *Dan jigawa* fruits (0.47±0.01) mg/kg. Iron is a mineral element naturally found in some food, it's an essential component of hemoglobin liable for oxygen transport from lungs to the tissue (Wessling-Resnick *et al*, 2014) also enhances metabolism in muscles as well healthy connective tissue (Aggett, 2012). Serum ferritin drops during the first stage of iron reduction (Taylor *et al*., 2017). The health risk assessment for both health quotient (HQs) and target hazard quotient (THQ) were also within the safe range THQ<1(Fig 1).

The Table 1, shows the result of mean value for Phosphorus (10.0±0.24) mg/kg which is far less compared to the recommended daily allowance. Phosphorus is a key source of energy in the form of adenosine tri phosphate ATP. Phosphorus plays vital role in the regulation of gene transcription, activation of enzyme (Heaney et al., 2012). Recommended daily allowance for phosphorus varies according to age groups: (1-8) years 300mg/day and (9-70) years 4000mg/day. High phosphorus intakes over short period of time may cause hypophosphatemia (Malberti, 2017).

The mean value for Zinc from this study 1.45±0.01mg/kg was found within acceptable values for all the age categories (Table 1), hence Dan jigawa fruits may functions as good source of Zinc, health risk assessment for both health quotient (HQs) and target hazard quotient (THQ) were also within the safe range THQ<1(Table). Zinc enhances catalytic activity of various enzymes (Stanstead *et al*., 1994) also serves as component of immune function (Solomons *et al*., 1998). Synthesis of protien, wound healing and DNA synthesis (IMFNB, 2001). Zinc was found to enhance cell division (Prasad, 1995). Human body lacks specialized zinc storage system therefore daily intake of Zinc is required to maintain a steady state (Rink, 2000). Zinc deficiency is associated with growth retardation, appetite loss, and decreased immune function (Maret, 2006). The mean value for Manganese obtained from table 1, (0.61±0.05) mg/kg shows Dan jigawa date fruits as good source of Manganese and health risk assessment

for both health quotient (HQs) and target hazard quotient (THQ) were also within the safe range THQ<1(Table).

Human body contains substantial amount of Manganese in bone (Nielsen *et al*., 2012).
Mean value for Magnesium from table 1 was found to be 0.48±0.02 kg/mg, suggesting low Magnesium concentration in Dan jigawa fruits compared to the stipulated value on RDA. Functionally Magnesium serves as cofactor in various enzyme systems that regulate different biochemical reactions in the body (IMO, 1997). Magnesium contributes to the structural development of bone and is required for the synthesis of DNA, RNA, and the antioxidant glutathione. Magnesium also plays a role in the active transport of calcium and potassium ions across cell membranes, a process that is important to nerve impulse conduction, muscle contraction, and normal heart rhythm (Rude *et al*, 2012).

The Potassium level of the fruits from table 1 was found to be 0.79±0.02 mg/kg which signifies low potassium content in Dan jigawa fruits. Most Potassium lives intracellularly and only small amount found in extracellular fluid (Stone *et al*, 2016). Large amount of ingested Potassium is absorbed and utilized in maintaining normal intracellular and extracellular concentrations (Bailey *et al*, 2014). The RDA for Potassium varies across age groups (Nasem, 2019).

The concentration of Cobalt in Dan jigawa fruits was 0.17±0.01 mg/kg (Table 1). Cobalt has significant biochemical role in homeostasis of DNA, fatty acids, amino acids, heme as well Vitamin B12. It is used for medical, scientific and recreational purposes. Medically it is used as alloys and super-alloys in orthopedic implants (Michel, 1999).

Health Risk Assessment
Hazard quotient (HQ) values for Fe, Cu, Mn, Zn and Co were low and target hazard quotient (THQ) is less than one THQ<1, suggesting all the values fall within the acceptable range and doesn't pose any hazard risk, this could be as a result Jigawa has a little population so that pollution due to road traffic, mining and industrial activities are also very low. This study agreed with findings of Salama *et al.* (2019) which heavy metals in seven varieties of fruits collected from different locations of Saudi Arabia with the exception of As, Pb, and Cd are within safe limit with respect to maximum allowable levels (MAL) in some fruits cultivars. However the hazard risk index was found to be higher for both As and Pb as opposed to the study above, this may likely pose potential health hazards to fruits consumers in Saudi Arabia. The health hazard could be attributed to the high pollution due to road traffic, mining and industrial wastes in those locations.

In a separate study conducted by (Harmanescu *et al*., 2011) that assess the levels of heavy metals and their potential harmful effects in which consumption shows high level of total hazard quotient (THQ) which contradicts our finding were the total hazard quotient is below (1) one which is consequently as a result of low metal concentration in the fruit (table 1).
Another study corroborating our finding conducted by Manea *et al*. (2020); shows a non-carcinogenic assessment of fruits and vegetables grown in two different mining sites of southern Carpathians (Romania). The TTHQs for all areas of study were found to be above one for leafy vegetables and root vegetables, respectively, however the high THQ and TTHQ contradicts my finding suggesting a high risk of adverse health effects for diets for all areas of study.

A similar local study conducted by Babandi *et al*. (2019) The concentrations for both carcinogenic and non-carcinogenic metals were found to be high for some, while others are within the safe range stipulated by WHO the high values could potentially exposed the consumer population to health risk

CONCLUSION

The findings of this research shows high proportion of important mineral elements like Calcium, phosphorus, and Zinc in Dan jigawa fruit. Thus Dan jigawa fruit may serves as good source of these important mineral elements. Health risk index shows Dan jigawa cultivar within acceptable values, hence no apparent human health risk and is safe for human consumption.

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Conflict of interest

None declared

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