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PROXIMATE AND ESSENTIAL ELEMENTS ANALYSES OF SOME FRUITS USED AS ANIMAL FEED IN ARID ENVIRONMENT, NIGERIA

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ABSTRACT

Fruits are one of the oldest forms of food known and present an important part of animal diets. This study was undertaken to analyse the nutritive and mineral elements of some fruits, namely Doum palm (*Hyphaene thebaica*) and Chinese date (*Ziziphus mauritiana*). The results of the proximate analysis revealed the presence of moisture contents of 7.02±0.07% in *Ziziphus mauritiana* and 6.92±0.01% in *Hyphaene thebaica*, ash content 11.78±0.45% in *Ziziphus mauritiana* and 6.85±0.81% in *Hyphaene thebaica*, crude fiber of 14.13±2.86% in *Ziziphus mauritiana* and 11.70±2.43%, in *Hyphaene thebaica*, crude protein of 3.12±0.77% in *Ziziphus mauritiana* and 29.37±0.77%, in *Hyphaene thebaica*, ether extract of 10.92±0.28%in *Hyphaene thebaica* and 6.90±1.13% in *Ziziphus mauritiana*, while carbohydrate in *Hyphaene thebaica was* 60.49±3.48 % and 30.80±5.63% in *Ziziphus mauritiana.* The concentrations of the elements were analyzed by Microwave Plasma Atomic Emission Spectrophotometry (MP-AES). The concentrations of phosphorus in *Hyphaene thebaica was* 2.92±0.73 mg/kg and 2.88±1.95mg/kg *in Ziziphus mauritiana*, sodium in *Hyphaene thebaica was* 0.56±0.19 mg/kg and 0.01±0.47mg/kg in *Ziziphus mauritiana*, Copper in *Hyphaene thebaica was* 0.53±0.29 mg/kg and 0.51±0.32 mg/kg in *Ziziphus mauritiana*, Calcium in *Hyphaene thebaica was* 3.58±1.25 mg/kg and 10.80±1.50mg/kg in *Ziziphus mauritiana*, and Zinc in *Hyphaene thebaica was* 2.85±2.39 mg/kg and 2.88±1.25 mg/kg in *Ziziphus mauritiana*. Hence, consumption of such fruits could improve the nutritional status of the animals.

Keywords: Chinese date, Doum palm, Elements, Essential, Feed

INTRODUCTION

Fruits are ripened ovaries of plants including the seeds within. Many plants produce fruits that are food to animals so that animals will eat the fruits and excrete the seeds. Researches had shown that the fruits are rich in minerals elements, vitamins, dietary fibers, antioxidants and diverse compositions of many nutritional and anti-nutritional factors [1, 2]. A healthy diet should compose of appreciable quantity of fruits and vegetables. Regular consumption of sufficient amounts could help to avert major chronic diseases [3]. Fruits are generally known to be excellent source of nutrients and mineral elements. Mineral ions are of prime importance in determining the fruit nutritional value [4]. Fruits and vegetables are frequently used by animals as sources of food because they provide nutrients that are essential for body building and regulation of body function [5]. Their contribution to the dietary need and nutritional requirements of animals cannot be overemphasized as they are very beneficial to nutritionally marginal population or to certain vulnerable groups within the population [6, 7]. In view of the above, it is essential to conduct research in order to assess the proximate and mineral element composition of the fruits (Doum palm and Chinese date) in Yobe State of Nigeria.

MATERIALS AND METHODS

Sample collection and preparation

Doum palm and Chinese date fruits were collected fromGarin Alkali market in Borsali Local Government Area of Yobe State, Nigeria. The fruits samples were washed in tap water and shades dried for 7 days and ground into powder form. The dried powder samples were collected and labelled accordingly for easy identification and kept for proximate and elemental analyses. The ground samples were passed through a micro sieve (standard test sieve). Prepared samples were labelled: *Hyphaene thebaica* = HT and *Ziziphus mauritiana* = ZM.

Proximate analysis

Moisture content determination

Exactly 1.0g of the well-mixed sample was accurately weighed in an already weighed cleaned and dried porcelain crucible. The crucible was allowed in an oven at 105 ºC for 8 hours until a constant weight was obtained. The crucible was then placed in a desiccator for 30 minutes to cool. After cooling, the crucible was weighed again [8].

$$\%\text{Moisture content} = \frac{W1-W2}{Wo} \times 100$$

Where

W_0= Weight of the sample.

W_1= Initial weight of crucible + sample before drying

W_2= Final weight of crucible + sample after drying.

Ash content determination

An empty, cleaned and dried porcelain crucible was placed a muffle furnace at 600 ºC for an hour, cooled in a desiccator and weighed. Exactly 1.0 g of the sample was measured in the crucible. The crucible and its content were placed in a muffle furnace at 550 ºC to 2-4 hours. The appearance of gray white ash indicated the complete oxidation of all organic matter in the sample. After the formation of the ash, the crucible together with the ash was cooled in a desiccator and weighed [8].

$$\%\text{Ash content} = \frac{W2-W1}{WO} \times 100$$

Where;

W_O= Weight of the sample.

W_1= Weight of crucible + sample.

W_2= Weight of crucible + ash

Ether extracts determination.

A 500 cm^3 quick fit round bottom flask was washed and dried in an oven at 103 ºC for 25 minutes. It was then allowed to cool to room temperature. Exactly 3.0 g of the sample was weighed in a free weighed thimble. The thimble containing the sample was inserted into the extraction column of a soxhlet extractor with a condenser connected to it. About 250 cm^3 of the extracting solvent (petroleum ether) was poured into the round bottom flask that was fitted into the extracting unit. The flask was heated using an electro thermal heater at 60 ºC for hours until a clear distillate of the extracting solvent was obtained. After the extraction, the thimble containing the fat free sample was removed from the extracting column and allowed to dry at 60 ºC in an oven until a constant weight was obtained. The weight was recorded and the fat content was expressed as a percentage of the initial weight of the sample [8].

$$\%\text{Crude fat} = \frac{W2-W3}{W1} \times 100$$

Where;

W_1= Weight of empty thimble

W_2= Weight of thimble + sample before extraction

W_3= Weight of thimble + sample after extraction.

Crude fiber determination

Exactly 2.0 g of the defatted sample was weighed in a washed, cleaned and dried 500 cm^3 Erlenmeyer flask. About 200 cm^3 of boiling 1.25% sulphuric acid was added into the mask and the flask was set on a hot plate and a condenser was connected to it. The sample was digested for 30 minutes. After the 30 minutes, the flask was removed from the hot plate and its content was filtered through a linen cloth in a funnel. The residue was washed subsequently with boiling water until he washing was no longer acidic. The residue was completely washed back into the flask with 200 ml 1.25 % boiling NaOH solution. The condenser was connected to the flask gain and the content was boiled for 30 minutes. The content was filtered through a linen cloth and washed thoroughly with boiling water until the washing was no longer basic. The residue was completely transferred to a cleaned dried crucible using a spatula. The content of the crucible was dried in an oven over night and cooled in a desiccator. The crucible and its content were weighed. The content of the crucible was ignited in a muffle furnace at 600 ºC for 30 minutes, cooled and reweighed. The loss in weight gives crude fiber contents of the samples.

$$\%\text{Crude fiber} = \frac{W1-W2}{Wo} \times 100$$

Where;

W_o= Weight of sample taken

W_1= Weight of crucible + residue before ignition

W_2= Weight of crucible + residue after ignition.

Crude protein determination

About 0.5g of the dried powdered sample was accurately weighed and completely transferred to a cleaned and dried 500 cm^3 macro-kjeldahl flask and 20 cm^3 of distilled water was added. The flask was swirled for a few minutes and allowed to stand for 30 minutes. About 0.5 g of selenium catalyst and 3.0 g of potassium sulphate (K_2SO_4) was added. About 30 ml of concentrated sulphuric acid (H_2SO_4) was added through an automatic pipette. The flask was shook to mix the contents. The flask was then placed on the digestion burner and the digestion was started until the mixture became bluish-green in colour. The heating during this boiling was regulated so that the sulphuric acid (H_2SO_4) condensed about middle of the way up the neck of the flask. The flask was allowed to cool and the digested sample completely transferred to a cleaned 100 cm^3 volumetric flask. The digest was diluted to the mark with distilled water. About 25 cm^3 of boric acid was pipetted into a 250 cm^3 Erlenmeyer flask and 2 drops of modified methyl red indicator was added. The 500 cm^3 macro-kjeldahl flask was attached to the distillation apparatus and 15 cm^3 of 40% boric acid was poured into the decomposition chamber of the distillation apparatus. 10cm^3 of the digested sample was introduced into the kjeldahl flask. The end of condenser was placed at about 3 cm above the surface of the boric acid (H_3BO_3) solution. The condenser was left to cool (below 30 ºC) by allowing sufficient cold water to flow through and regulate heat in order to minimize frothing and prevent suck back. The ammonia produced as ammonium hydroxide (NH_4OH) was distilled into the boric acid until the boric acid solution changed completely too bluish-green. The distillate was titrated with 0.025 N hydrochloric acid (HCl) solution until the bluish-green color change completely to pink. The titer value was recorded and the percentage crude protein content of the samples was calculated.

%Crude protein= 6.25×%

$$\%N= \frac{TV \times 0.014 \times VD}{VA \times WS} \times 100$$

Where

TV= Titer value of the sample

VD= Volume of the digest after dilution

N= Normality of HCl

VA= Volume of aliquot taken

W.S= Weight of the sample used

0.014= Mili-equivalent weight of nitrogen.

Carbohydrate determination

Total percentage carbohydrate was determined by different methods as reported by Onyeiki *et al* [9]. This method involves adding the total values of crude protein, crude fiber, crude fat, moisture and ash contents of the sample and subtracting it from 100.

Percentage carbohydrate= 100-(%moisture + %ash + %crude protein + % crude fat+ %crude fibre).

DETERMINATION OF MINERAL ELEMENTS

In order to determine the mineral content of the sample analyzed, 0.5g of each of the labeled ground samples were weighed, oven dried at 50 O ºC for 60 minutes and the sample was allowed to cool at room temperature. *Aqua regia* was used to extract the content of each sample for further determination of individual selected elements.

Microwave Plasma Atomic Emission Spectrophotometer (MP-AES) Agilant 4200 at the Centre for Dry L and Agriculture, Bayero University Kano, was used to determine Copper (Cu), Calcium (Ca), Zinc (Zn), Sodium (Na) and Phosphorus (P).

STATISTICAL ANALYSIS

Data obtained with respect to proximate, fiber constituents and mineral elements were subjected to analysis of variance (ANOVA). The LSD was used to separate means at 5% level of probability using the SAS (2013) statistical software.

RESULTS AND DISCUSSION

Proximate composition

The results for the percentage proximate compositions of different fruits are presented in Table 1. The moisture content in *Ziziphus mauritiana was* 7.02±0.07% and 6.92±0.01% in *Hyphaene thebaica;* ash content in *Ziziphus mauritiana was* 11.78±0.45% and 6.85±0.81% in *Hyphaene thebaica,* crude fiber in *Ziziphus mauritiana* was 14.13±2.86% and in *Hyphaene thebaica* it was 11.70±2.43%, crude protein in *Ziziphus mauritiana* was 3.12±0.77% and in *Hyphaene thebaica it was* 11.70±2.43%, ether extract in *Ziziphus mauritiana* was 6.90±1.13% and in *Hyphaene* *thebaica it was* $10.92 \pm 0.28\%$ and carbohydrate in *Hyphaene thebaica was* 60.49 ± 3.48 and in *Ziziphus maurutiana it was* $30.80 \pm 5.63\%$. Keta [10] worked on *Ziziphus mauritiana* and reported $5.16 \pm 0.29\%$ as moisture content which is below the result obtained in this work. The result also shows that these fruits have low moisture content which is an indication of low water activity of a food. The low moisture content of the sample is an indication of good storage quality with minimal fungal or microbial activity which does not permit the growth of mold in the sample or sample product [11]. The high moisture content in fruits provides part of the medium for normal function of enzymes and general metabolic processes [12].

Mineral element contents

Mineral contents of the fruits were determined and the results of the analysis are presented in Table 2. Phosphorus functions as constituent of bone and teeth, nucleic acids and also a phosphorylated metabolic intermediate [13]. Reproduction and milk production are the measures of success in dairying, and these will be influenced by P availability, but all aspects of the animal's health will be affected [14]. The permissible limit of phosphorus as suggested by IOM [15] is 800 mg/kg. The accumulation of phosphorus in *Hyphaene thebaica was* 2.92 mg/kg and in *Ziziphus mauritiana it was* 2.88 mg/kg. Statistical analysis of variance (ANOVA) showed that there is a significant difference at (P<0.05) between the fruits. The results obtained indicated that the concentrations of phosphorus in the fruits analyzed are within recommended limits. Similarly, Bala and Bashir [16] analyzed the nutritive content of some Nigerian fruits where they reported the concentration of phosphorus range from 48.6 mg/kg to 139 mg/kg which is also within the permissible limit [15]. Sodium is an important macro element which is used for generation of nerve impulses, maintenance of electrolyte balance and fluid balance [17]. Sodium content may add value in osmotic regulation of the body fluids and transmission of nerve impulses [18]. Sodium is involved in the maintenance of osmotic pressure of the body fluids and that change in osmotic pressure largely depends on sodium concentration [19]. It has been reported that animals have an important ability to preserved sodium content, but prolonged deficiencies can cause weight loss or the loss of appetite, decreased growth and reduce milking [20]. The concentration of sodium in *Ziziphus mauritiana was* 0.10 mg/kg while in *Hyphaene thebaica it was* 0.56 mg/kg. Among the investigated browse species, sodium level was significantly low. Sodium is within the recommended limit 500 mg/kg [15]. Dimari and Hati [21] reported nutritional analysis of date fruit where they obtained the concentration of sodium range from 0.6 mg/kg to 1.0 mg/kg. Calcium is a mineral that the body needs for numerous functions, including building and maintaining bones and teeth, blood clotting, the transmission of nerve impulses, and regulation of the heart's rhythm [22]. The lower values of calcium, phosphorus and potassium in fruits do not mean they are totally absent but lower amount could act as a good source of the mineral elements in the metabolic system of the body in the case of potassium and potential source of calcium and phosphorus for good formation of bones and teeth [23]. The concentration of calcium in *Ziziphus mauritiana was* 10.80 mg/kg while in *Hyphaene thebaica it was* 3.85 mg/kg. The daily limit recommended by IOM [15] is 800 mg/kg. Bala and Bashir [16] analysed the nutritive content of some Nigerian fruits and reported that calcium in pulp orange as 0.277 mg/kg, also Ozioma *et al* [24] determined the proximate and mineral composition of some Nigerian fruits and reported calcium in *Carica papaya L* as 84.90 mg/kg. Copper is also an important trace element and a vital dietary nutrient, although only small amounts of the metal are needed for well-being [25]. Copper is present in every tissue of the body, but is stored primarily in the liver, with fewer amounts found in the brain, heart, kidney, and muscles [26]. It also accumulates in the liver and brain. Copper toxicity is a fundamental cause of Wilson's disease [27]. High concentration of copper causes metal fumes fever, hair and skin decorations, dermatitis, respiratory tract diseases, and some other fatal diseases [28]. The mean concentration of Cu recorded in *Ziziphus mauritiana was* 0.51mg/kg while in *Hyphaene thebaica it was* 0.53mg/kg. Statistically, all the fruits samples showed significant difference at $P<0.05$. The results obtained in this work were below the permissible limit of 2-3 mg/kg [29]. WHO [30] reported nutritional analysis of date fruit *(phonixdactylifera L.)* for copper as 0.36 mg/kg. Zinc is an essential mineral that is naturally present in some foods, added to others and available as a dietary supplement, it is also involved in numerous aspects of cellular metabolism [31]. Zinc recommended daily allowance (RDA) is 8 – 11 mg/kg [32]. Most fruits contain a small amount of zinc as the zinc in whole grain products and plant proteins is less bio-available due to their relatively high content of phytic acid, a compound that inhibits zinc absorption [33]. *Ziziphus mauritiana* recorded 2.88 mg/kg of Zn while in *Hyphaene thebaica it was* 2.85 mg/kg. There is significant difference at $P<0.05$. Ozioma *et al* [24] determined the proximate and mineral composition of *Irvingia gabonensis* with zinc concentration reported as 1.26 mg/kg.

Table 1: Proximate Composition of Fruits Samples analyzed

S/NO. Parameters (%)	*Hyphaene thebaica* (%)	*Ziziphus mauritiana* (%)
Moisture content	6.92±0.01a	7.02±0.07*a*
Ash content	6.85±0.81*a*	11.78±0.45*a*
Crude fiber	11.70±2.43*c*	14.13±2.86*d*
Crude protein	3.12±0.77*a*	29.37±0.77a
Ether extract	10.92±0.28c	6.90±1.13d
Carbohydrate content	60.49 ± 3.48*a*	30.80 ± 5.63a

Mean ± standard deviation with different letters in the same row is significantly different at $P< 0.05$.

Table 2: Mineral elements content of the fruits samples analyzed (mg/kg)

Element	HT (mg/kg)	ZM (mg/kg)	FNB/WHO/USDA (mg/kg)
1. P	2.92±0.73*c*	2.88±1.95*d*	800
2. Na	0.56±0.19*a*	0.01±0.47*a*	500
3. Ca	3.58±1.25*a*	10.80±1.50*a*	800
4. Cu	0.53±0.29*c*	0.51±0.32*d*	2-3
5. Zn	2.85±2.39*c*	2.88±1.25*d*	11

Mean ± standard deviation with different letters in the same row is significantly different at $P< 0.05$.

CONCLUSION

The nutritive analysis of some Nigerian fruits from arid environment shows that the fruits contained considerable carbohydrate, appreciable amount of crude fiber, protein, ether extract and low moisture and ash contents. Furthermore, the concentrations of essential elements obtained in this study are within the normal range of recommendations and therefore, their consumption should be encouraged.

RECOMMENDATION

Studies for propagation of forage species as additional source of feed to animals in the region should be conducted and further research should be undertaken to evaluate the composition of anti – nutritional factors of these fruits.

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