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PROXIMATE AND MINERAL COMPOSITION OF *TAMARINDUS INDICA* WHOLE SEED AND SEED KERNEL IN ZONE A, NIGER STATE NIGERIA.

A. I. Ajai[1], M. M. Ndamitso[1], A. B. Salihu *[2] and N. Y. Nma [2].
1. Department of Chemistry, Federal University of Technology, Minna, Niger State.
2. Science Laboratory Technology, Federal Polytechnic, Bida, Niger State.
* Corresponding author's address: a.bsalihu@yahoo.com

ABSTRACT
The proximate and mineral compositions of Tamarindus indica whole seed and seed kernel were determined using standard methods. The seeds were obtained from five local government areas in Zone A of Niger State, Nigeria. The results obtain in percentages were: moisture, 8.00±0.71, ash, 3.75±0.30, crude lipid 9.80±0.30, crude fibre 3.40±0.10, crude protein 25.17±0.50, carbohydrate, 57.85±0.30, organic matter 96.25±0.02 and dry matter 92.00±0.60 respectively for the whole seed while for the seed kernel, 17.63±0.30, 4.88±0.30, 7.83±0.30, 2.23±0.10, 23.47±0.40, 63.59±0.50, 97.12±0.10 and 82.37±0.10 were recorded for the moisture, ash, crude lipid, crude fibre, crude protein, carbohydrate, organic matter and dry matter respectively. The mineral constituents in mg/100g were sodium, 36.50±0.10; potassium, 44.4±0.20; calcium, 15.00±0.25; magnesium, 20.45±0.23; zinc, 4.00±0.21; iron, 69.00±0.10; manganese, 245±0.38; phosphorus, 10.6±0.15; copper, 1.50±0.02 but lead was not detected. The sodium/potassium ratio was 0.82 while the calcium/phosphorus was 1.42 for the whole seed. The seed kernels on the other hand had14.40±0.15, 55.50±0.12, 20.00±0.13, 169.00±0.42, 6.00±0.04, 97.30±0.42, 240.0±0.11, 18.26±0.15, and 0.20±0.01mg/100g respectively for sodium, potassium, calcium, magnesium, zinc, iron, manganese, phosphorus and copper respectively. The sodium/potassiumand calcium/phosphorus ratios were 0.26 and 1.09 respectively. Lead was not detected in the kernels. The results indicated that, removal of seed coat increased the mineral contents while the whole seeds had higher proximate compositions.
Key words: proximate composition, mineral contents, Tamrindus indica L. whole seed and seed kernel.

INTRODUCTION

Food and Agricultural Organization has projected that, unless the root cause of food insecurity is addressed by 2020, 700-800 million people worldwide will be chronically undernourished and in sub-Sahara Africa alone, the chronically undernourished will increase from 200-300 million people [1]. In 2009, 1,023 million people were estimated to be undernourished worldwide especially people living in developing countries [2] and this proportion remains highest in the sub-Saharan Africa which has been put at about 30% [3]. In addition, at least two billion people, mostly in developing countries, suffer from "hidden hunger" manifested by mineral and vitamin deficiencies [4]. This regional food insecurity will result into global crises, if efforts are not made towards finding cheap and alternative sources of food. This can be achieved by harnessing underutilized indigenous wild plants that are non-conventional as food crops since conventional food plants, though provide most nutrients needed for energy, body building, maintenance and regulation of body processes, they have not been able to meet the world demand as a result of increase in population and demand [5].

Underutilized wild plants have potentials of contributing immensely to the global food security if properly exploited apart from the fact that they also positively contribute to the health demands of the people. They also serve as income generators and environmental protectors [6]. It has been indicated that fruits, leaves and seeds of these plants provide nutrients that are important for several body functions [7] serving as cheap source of protein as well as helping in alleviating protein energy malnutrition (PEM)[8][9] . However, these wild plants have been neglected as a result of unconscious biases which have greatly reduced their development and spread in Africa [10].

Tamarindus indica Linn. is a wild plant underutilized in Nigeria. Its fruits are called "dara" in Nupe, "tsamiya" in Hausa, in Yoruba "ajadbon" and in "Igbo icheku oyibo". It grows naturally in many tropical and sub-tropical African regions. In Niger State, *Tamarindus indica* grows wild in back yards, road sides or waste lands and bears fruits when common fruits are not available [11]. It provides seeds during dry season, the time when most households are often faced with food insecurity [12]. During this time, its fruits are frequently consumed directly or used for making local foods or drinks while the seeds are discarded. Hence, among other wild plants, *T. indica* can offer a convenient and cheap means of food diversification to meet up the challenges of food insecurity particularly in Niger State and Nigeria in general. The pulp, leaves and seeds of this plant have been documented to provide opportunity to people of the tropics with adequate supply of minerals, fats, proteins and carbohydrates [13].

In Nigeria, the ever increasing population and urbanization, coupled with the inadequate importation of essential commodities, have resulted in food shortage for man and his livestock. These have thus necessitated this study in order to investigate and document the potentials of this wild underutilized plant for its nutritional qualities.

by [13] but lower than 1308.00mg/100g documented by [19]. Research has also reported that potassium plays a principal role in neuro-muscular function in addition to the maintenance of body p^H, normal blood pressure, the consumption of dietary potassium reduce the incidence of hypertension [21]. Potassium helps to regulate osmotic pressure of the cell contents. The deficiency results in the wakening of muscle, nausea, loss of appetite and drowsiness [22]. Daily intake of 18g or more of potassium could be toxic with attendant effect of increasing blood levels which could result into kidney failure, acidosis, serious infections, gastrointestinal hemorrhages and severe muscle trauma. Signs of hyperkalemia (excessive level of potassium) with effect similar to those listed above including kidney failure [23].

Calcium concentration of this work was found to be 15.0±0.24 and 20.0±0.13mg/100g with seed kernel having the highest value. The value is lower than 36.60mg/100g reported by [14]. Calcium is essential for the formation of bone and teeth, essential for blood clothing; it regulates permeability of capillary walls, essential for the contraction of heath and muscles and regulates the excitability of nerve fibers and nerve centers [23]. The inadequate calcium intake or absorption resulted in complication commonly known as osteoporosis [22]. Osteoporosis is a condition of which calcium is reabsorbed from bones and jaw (decalcification) [23]. Regular weight-bearing and vigorous exercise are reported to reduce the effects of osteoporosis because stressed bone stimulate the production of new once via osteoporosis [23].

Magnesium concentration from this work was found to be 204.5±0.23 and 169.0±0.42 mg/100gwith whole seed having the highest value of magnesium was reduced with removal of the seed. The value is higher when compared with 15.0±0.05 and 13.2±0.01mg/100g for whole and seed kernel [13].Magnesium is reported to be an important part of nutrient and help to prevent muscle degeneration, growth retardation, alopecia, dermatitis, immunologic dysfunction and congenital malformations and bleeding disorders [24]. The recommended datary Allowance for infant below 1 year as described in research of [25] stated that, the adequate in take is 30mg, from 0-6month, 75mg from 7-12 month. Tamarin seed is good source magnesium.

Manganese is essential for the skeleton structure, reproduction, growth and normal functioning of the nervous system of animals and its deficiency in man and animals results in depressed reproductive function, abnormal skeletal and nervous systems [26]. The manganese levels in the whole seed and the kernel were 245.0±0.38 and 240.0±0.11mg/100g respectively with the seed kernel having a lower value than the whole seed. The values obtained in this work were higher than the respective 14.27±0.07 and 15.83±0.23mg/100g reported for brown and white beans [14]. The values of manganese in these two samples indicated *Tamarindus indica* is a good source of manganese.

Zinc is present in all tissues of the body and promo wound healing, prevents attacks in sickle cell anae and also assists in the control of hereditary diseases addition, it plays an important role in the taste a appetite of man [14]. Zinc is also believed to be component of more than 50 enzymes [26]. T concentrations of zinc in the samples were found to 4.00±0.21 and 6.00±0.04mg/100g for whole seed a seed kernel respectively showing that removal of se coat increased the zinc concentration. These values we however, comparable with the 5.66±0.23 and 4.47±0.0 mg/100g reported for brown and white beans [14] whic are the commonest leguminous crops eaten in the stud area. Since the daily ration of a fortified complementar food should contain between 4 to 5 mg zinc [27] tamarind is expected to be good source of zinc.

Copper concentrations in the samples were found to be 1.50±0.02 and 0.20±0.01mg/100g respectively for the whole seed and the kernel with the whole seed having a higher value showing that the removal of seed coat reduced copper concentration. In comparison the value of the seed kernel was close to the respective 0.60±0.00 and 0.58±0.07mg/100g reported for brown and white beans [14].

Iron plays an important role in the formation of haemoglobin, cytochrome and enzymes essential for life. It also plays a chief role in the transportation of oxygen to the tissues and oxidation in the cells. In addition about 30% of iron is reported to be stored in the spleen, liver and bone marrow as ferritin and haemosiderin [23].The iron concentrations in the samples were 69.00±0.01 and 97.30±0.42mg/100g respectively for the seed kernel and the whole seed which revealed that seed coat removal also increases iron concentration. In comparison the value obtained in this work were higher than the 2.67, 9.09 and 45.50mg/100g documented in literature [28, 16, 19].

Phosphorus is the second most abundant mineral after calcium in the body and it has been asserted that about 85% of it is found in the bone with the remaining 15% being metabolically active and found in everybody cell [23]. Phosphorus also regulates acid-base balance metabolizes energy and provides structures to the cell membrane. In addition it has been stated that this element, like calcium, is important for the growth and maintenance of teeth and muscles. It also serves as an essential component of the nucleic acids, regulates the activities of hormones and co-enzymes, aids the absorption of fat and facilitates the absorption of glucose [29]. The respective phosphorus levels in the whole seed and seed kernel of *Tamarindus indica* were recorded as and 18.26±0.15mg/100g and these also showed that the removal of seed coat improved the concentration of this mineral in the seed kernel. In comparison these values

Manganese	245.0±0.38	240.00±011
Phosphorus	10.60±0.15	18.26±0.15
Copper	1.50±0.02	0.20±0.01
Lead	ND	ND
Na/k	0.82	0.26
Ca/P	1.42	1.09

Results are Means± standard deviations (SD) of triplicate values; ND = Below detection limit

DISCUSSION OF RESULTS

The results of the proximate composition of the samples as presented in Table 1 above indicated that the moisture contents of the whole seed and seed kernels were 8.00±0.71and 17.63±0.30% respectively thus showing that the seed kernel had a higher value. This meant that the whole seeds which had lower moisture content could be stored for a longer period of time than the seed kernels since this high amount of water content predisposes them to bacterial and fungal attack. These values were found to be lower than the respective 11.75±0.25 and 19.90±0.90% reported for the whole seed and seed kernel of *Tamarindus indica* [13].

The respective 57.85±0.30 and 63.59±0.50% carbohydrate contents obtained for the whole seed and seed kernels in this study showed that the kernel had a higher value than the whole seed with its coat which indicated that the removal of seed coat improved the carbohydrate content of the sample. This higher value of carbohydrate was also an indication that the consumption of this seed would provide the energy needed for the biochemical processes within the body most especially the processes required for the promotion of growth and development. These values were close to the respective carbohydrate contents of 56.80±0.72 and 60.47±0.33% reported for white and brown beans in literature [14]. They were also close to the respective literature values of 61.70 14and 59.35% reported for *T. indica* whole seeds [15,16].

The percentage ash of a food substance is a measure of mineral elements in the food. The respective ash contents of 3.74±0.30 and 4.88±0.30% for the whole seed and seed kernel obtained in this work showed that the seed kernel had a slightly higher value than the whole seed. These values were within the range of values of 4.20 and 2.58% given in literature for tamarind whole seed [14,16]. The lower value obtain for the whole seed in this work indicated that its mineral element was smaller than that of the seed kernel.

Dietary proteins are useful for the building of new cells, replacement of worn out tissues, enzymes, hormones, antibodies and other substances required for healthy functioning and development of the body. The crude protein value of the whole seed obtain was 25.17±0.50% which was higher than the 23.47±0.40% obtained for the seed kernel. These values indicated that the removal of seed coat form *T. indica* seed reduced its protein content and these values were lower than the 26.93% earlier reported literature value for tamarind whole seed [17] but higher than the respective 17.91±0.09 and 15.62±0.09% reported for brown and white beans [14]. This result showed that *T. indica* seed is a rich source of protein.

The fibre content of foods of great importance since it plays major functions on metabolism of gastrointestinal track, slows down the release of glucose into the blood and decreases inter-colonic pressure thus reducing colon cancer. The diatry of fibre in foods is reported to be associated with appendicitis, diverticular diseases and haemorrhoids [18]. The crude fibre value of 2.22±0.10% for the kernel was lower than the 3.40±0.10% obtained for the whole seed and these values were in range to the respective reported values of 2.33 and 3.32% for the kernel and whole seed of tarmarind [13], but lower than the 18.0% for the whole seed of *Tamaringus indica* [19]. These were also lower than 13.54±0.07 and 14.15±0.06% respectively reported for brown and white beans [14]. The crude fibre contents of both whole seed and kernel in this work were below the respective recommended dietary allowances (RDA) of 19-25% and 29% for children and lactating mothers [20]. Thus the two food samples could not be good sources of dietary fibre.

The lipid is responsible for the transfer of soluble vitamins such as vitamin A, D, E, and K [19]. The respective lipid contents of 9.80±0.30 and 7.83±0.30% for the whole seed and seed kernel indicated that the oil of the seed was reduced by removal of the seed coat but these values were close to the 7.10% reported for tamarind seed [15] but were higher than 4.2±0.11% reported for Nigerian leguminous Jack bean seed (*Canavalia ensiformis*) [21]. However, these values were lower than the 11.75% crude fat value reported for tamarind whole seed nut [13].

The mineral contents of the samples were as presented in Table 2. The concentration of sodium was found to be 36.50±0.10 and 14.40±0.15mg/100g. This reveals that the concentration of sodium is higher in the whole seed than in the seed kernel. The function of Sodium ion is to regulating acid-base balance in the body, regulating osmotic pressure of plasma in tissue fluids and plays a special role in originating and maintaining the heart beat. The value of potassium was found to be 44.4±0.20 and 55.5±0.10mg/100g this reveal that the removal of seeds coat increases the concentration of potassium. The values are higher than 21.0±0.02 and 41.0±0.01mg/100g

by [13] but lower than 1308.00mg/100g documented by [19]. Research has also reported that potassium plays a principal role in neuro-muscular function in addition to the maintenance of body p^H, normal blood pressure, the consumption of dietary potassium reduce the incidence of hypertension [21]. Potassium helps to regulate osmotic pressure of the cell contents. The deficiency results in the wakening of muscle, nausea, loss of appetite and drowsiness [22]. Daily intake of 18g or more of potassium could be toxic with attendant effect of increasing blood levels which could result into kidney failure, acidosis, serious infections, gastrointestinal hemorrhages and severe muscle trauma. Signs of hyperkalemia (excessive level of potassium) with effect similar to those listed above including kidney failure [23].

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were lower than the respective 25.5 and 25.0mg/100g reported for tamarind whole seed and seed nut [13]. The Na/K ratio was found to be 0.82 and 0.26mg/100g for tamarind seed and seed kernel, these values indicate that both tamarind whole seed and seed kernel are useful for the prevention high blood pressure, Na/K ration of less than is recommended [30]. In addition the concept Ca/P is considered to avoid to loss of calcium in the urine [31]. Research have shown that if Ca/P ratio is above one the sample is considered a good food but not when the ratio less than 0.5 [32]. The Ca/p ratio was found to be 1.42 and 1.09mg/100g respectively this indicate that Ca/P ratio of whole seed is more than that of the seed kernel with both greater than one their consumption would help in absorption of calcium

Lead was not detected (ND) either of the samples which indicated that the sample may not pose any health hazard on the consumers.

CONCLUSION

The results obtained in this work revealed that most of parameters determined were enhanced by the removal of seed coats although it is expected to have a poorer storage quality because of its high moisture content. The results also showed that Tamarindus indica seeds could be a good source of such nutritional elements as potassium, iron, calcium, zinc, phosphorus, magnesium and manganese and copper.

REFERENCES.

1- FAO (2005). Agricultural and International Dialogue. *Memo* on 2005 Old Food Day.

2- FAO (2010a). Benin - monitoring progress towards hunger reduction targets of the World Food Summit and the Millennium Development Goals. *Technical report*, FAO - Food and Agriculture Organization of the United Nations, Rome, Italy.

3- FAO (2010b). Benin: Country profile: Food security indicators. Technical report, FAO Food and Agricultural Organization of the United Nations, Rome, Italy. Biscuits, Forest, Tree and livelihood 12(1): 105-117

4- Micronutrient Initiative (2009). Investing in the future. A united call to action on vitamin and mineral deficiencies. Technical report, The Micronutrient Initiatives, The Flour Fortification Initiative. USAID, GAIN, WHO, The World Bank & UNICEF.

5- Hassan, L. G., Umaru, K. J and Tijani, Z. (2007) preliminary investigation on the feed quality of *monechmacilition* seeds. *Chem. Class J.* Zaria. 4-83.

6-Jaenicke H. & H oschle-Zeledon I. (2006). Strategic framework for underutilized plant species research and development, with special reference to Asia and the Pacific, and to sub-Saharan Africa. Technical report, ICUC - International Centre fo Underutilised Crops, Colombo, Sri Lanka & GFU - Global Facilitation Unit for Underutilized Species, Rome, Italy.

7-Oliveira A. L., Eduardo A., Fernand R. D., and Virgilio F. N. F.(2006) Elemental Contents in Exotic Brazilian Tropical Fruits Evaluated by Energy Dispensive X-ray Fluorescence. *J. of science and Agriculture (Piracicaba Brazil)*, 63 (1): 82-84..

8- Blench, R. (2006)Tree on the march: th dispersal of economic tree in the prehistory of west-central Africa presented at Safa Conference Cambrige :1-13.

9-Nadro, M.S.& Umaru, H.A., Comparative Chemical Evaluation of Lucost Bean (*parkia biglobosa)* Fruit pulp a vested During the Dry and Wet Season. *Nigeria journal Biotecnology* 15(4): 42-47.

10-Pugalenthi, M., Vadivel V., Gurumoorthi and Janarhanan K. (2004). Comparative Nutritional Evaluation of little Known Legumes. *Tamarindus indica, Erythrina incdica, and sesbania bispinosa. Tropical and subtropical Aroecosystem* 4: 107-123.

11-Waterlow, J.C. (1994). Childhood malnutrition in developing nation; Lookig back and looking forward. Annal Review of Naation. 14: 1-14

12-AOAC (2005). Official Method of Analysis. Association of Official Analytical Chemist, Washington D.C. USA.

13-Yusuf, A.A., B.M. Mofio and A.B. Ahmed, 2007. Proximate and Mineral Composition of T. indica L 1753 Seeds. Science World Journal, 2(1):1-4.

14-Alayande, L. B, Mustapha, K. B, Dabak, J. D and Ubom, G. A (2012) Comparison of nutritional values of brown and white beans in jos North Local Government markets *Africanjournal of Biotecnology vol.11(43):10135-10140.*

15- Siddhuraju, P., Vijayakumari, K., Janardhanan, K. (1995). Nutritional and Antinutritional Properties of the Underexploited Legumes *Cassia laevigata* Willd. and *Tamarindus Indica* L. *Journal of Food Composition and Analysis, 8, 351-162.*Colombo, Sri Lanka & GFU - Global Facilitation Unit for Underutilized Species,Rome, Italy.

16-Lockett, C.T., Calvert C.C., Grivetti, L.E. (2000). Energy and micronutrient composition of

dietary and medicinal wild plants consumed during drought. Study of rural Fulani, Northeastern Nigeria. *International Journal of Food Sciences and Nutrition*, 51, 195-208.

17- Ishola, M.M., Agbaji, E.B., Agbaji, A.S. (1990). A Chemical Study of Tamarindus indica (Tsamiya) Fruits Grown in Nigeria. *Journal of the Science of Food and Agriculture*, 51, 141-143.

18- Gibney MJ (1989). Nutrition diet and health, New York. Chester Melbourne Sydbey, Cambridge University Press. P. 168.

19-Ajayi, I.A., Oderinde, R.A., Kajogbola, D.O., Uponi, J.I. (2006). Oil content and fatty acid composition of some underutilized legumes from Nigeria. Food Chemistry, 99, 115-120.

20-Ishida, H., Suzunno, H., Sugiyama, N., Innami., Todokoro. T. and Maekawa A. (2000). Nutritional evaluation of chemical components of leave stalks and steam of sweet potatoes (*Ipomea batata poir*). Food chemistry, 68: 359-369.

21- Doss, A., Pugalenthi, M., Vadivel, V.G., Subhashini, G. and Subash, A. R. Effects of processing technique on the nutritional composition and aninutrients content of nuder-utilized legume *Canavalia ensiformis* L. DC. *Journal of International food Research 18(3):965-970.*

22-Swaminathan, M. (2006). Handbook of Food and Nutrition. Bangalore pub. Pp21-64

23- Wendy, S. (2006)The Encyclopedia of Vitamins and Minerals 2nd pp 142-324.

24- Vetter T. and Lohse MJ (2002). Magnesium and the parathyroid. *Curr Opin Nephrol Hypertens11: 403-10.*

25-Oyarekua M. A (2013). Comparative studies of fermented maize/pigeon pea and maize/muc as infants complementary foods. *Wudpec journal of food technology* 1(1): 001-008.

26-Bender, A. (1992). Meat and Meat Products Human Nutrition in Developing Countr FAO Nutrition Paper 53. FAO Rome, It *69:70*

27- Rosado JL (2003). Zinc and copper: propo fortification levels and recommended z compounds. J. Nutr.. 133:2985S-2989S.

28- Glew, R.H., VanderJagt, D.J., Lockett, C., Grive L.E., Smith, G.C., Pastuszyn, A., Millson, (1997). Amino Acid, Fatty Acid, and Mine Composition of 24 Indigenous Plants Burkina Faso. *Journal of Food Composit and Analysis*, 10: 205-217.

29- Turan, M., Kordis, S., Zeyin, H., Dursan, A. a Sezen, Y. (2003) macro and micro mineral Content of some wild edible leaves consume in eastern Anatolia Tailors and Francis, pp:129 130.

30- Atasie, V. N. Akinhanmi, T. F and Ojide, C. C (2009). Proximate analysis and physic chemical properties of Ground nut (*Arachi hypogaea* L.) Pakistan journal of Nutrition 8:194-197.

31- Shills, M. Y.G and Young V. R (1992). Modern nutrition in health and disease. In Niema, D. C, Butterworth, D. E and Niema, C. N (eds) . Nutrition Wm C. Brownpublishers, USA 276-282.

32- Aremu, M.O., Olaofe O. and Emmanuel A. (2005). Compositional evaluation of cowpea (*vigna unguiculata*) and scarlet runer bean (*phaseolus coccineus*) varieties grown in Nigeria.