Pakistan Journal of Nutrition 10 (8): 786-791, 2011
ISSN 1680-5194

Nutritive and Anti-nutritive Qualities of Mostly Preferred Edible Woody Plants in Selected Drylands of Iringa District, Tanzania

Tairo Vendeline Emmanuel[1], Jesse T. Njoka[1], Lukhoba W. Catherine[3] and Herbert V.M. Lyaruu[1]
[1]Department of Land Resources and Agricultural Technology, University of Nairobi, Kenya
[2]Department of Botany, University of Dar es Salaam, Tanzania
[3]Department of Biological Sciences, Chiromo, University of Nairobi, Kenya

Abstract: Nutritional and anti-nutritional factors of preferred woody plants were evaluated in selected drylands of Iringa District. *Vangueria infausta* (Burch.) and *Vitex mombassae* (Vatke.) identified as source of edible fruits; *Adansonia digitata* (L.) and *Sterculia africana* (Lour.) were preferred for oil products whereas *Opilia amentacea* (Roxb.) and *Maerua angolensis* (DC.) were used as sources of vegetables. The nutrients and anti-nutrients were evaluated using laboratory standard methods. Results show that there were significant differences ($p<0.05$) in percentage moisture content, dry matter, crude protein, crude and carbohydrates in all species used as sources of oils, vegetables and fruits. Percent ash content was different among the preferred species for vegetables and fruits. *S. africana* as oil producing plants had higher protein content (<25%). *O. amentacea* and *M. angolensis* had higher crude protein percent (14-34%) than other species. Crude fiber for all preferred species ranged from 9-27.6% on dry weight basis. The crude lipid content of preferred species ranged from 1.2% for fruit plants to 6.80% for oily plants. *V. infausta* and *A. digitata* had high Carbohydrates whereas all edible plants had higher values of Potassium and low Copper, Iron and Zinc content. *A. digitata* seeds had the highest value of Vitamin C (57.31 mg/100 dry weight) and low levels of tannins and phenols. This study concludes that wild plants are nutritious and have adequate nutrients and levels of anti-nutrients are below the toxic levels. Consequently, use of wild food plants could provide a possible source of food security in Iringa District.

Key words: Edible woody plants, nutritive and anti-nutritive factors, drylands of Iringa District

INTRODUCTION

Thousands of people in semi-arid areas of Tanzania including Iringa District drylands do not have enough food to meet their daily requirements and hence, people are deficient in one or more micronutrients in their diets (URT, 2001). Therefore, rural communities depend on wild edible woody plants to meet their food needs in periods of food crisis. According to IDI (2008) report, Iringa District has about 4,982.2 hectares under District ownership and communal forest reserves, of which 90% are located in the drylands. Many people rely on these forests and woodlands for their daily sustenance of their livelihoods. Earlier studies, for example Ruffo *et al*. (2002) and Hamza (2002) showed that the use of trees and shrubs in times of food scarcity are increasingly used by the majority in rural areas as one of the rural non-farm sector.

According to FAO (1990); Hamza (2002); Kavishe and Mushi (1993) and Ruffo *et al*. (2002) use of wild edible plants in different localities provide optimum source of nutrients. On the other hand Amaechi (2009) revealed that plants serve as an indispensable constituent of human diet supplying the body with minerals salts, vitamins and certain hormone precursors, in addition to protein and energy. Many local vegetables and fruits have higher nutritive values than their exotic analogues commonly sold in markets (Ruffo *et al*., 2002). According to Amaechi (2009) and Mahammad *et al.* (2010), some edible plants contain anti-nutritional factors such as tannins, phenols, saponin and cyanides that may affect availability of other nutrients required by the body.

Despite the fact that wild food plants are widely consumed by various cultural groups in Iringa District, there is only scanty information on nutritional and anti-nutritional qualities of the mostly preferred wild plant species of vegetables, fruits and oils. Studies on nutritional value of wild food plants may help in identifying the forgotten food resources (Amaechi, 2009). Therefore, this study was conducted to assess the levels of nutritional and anti-nutritional qualities of mostly preferred woody plants for the public and dietary awareness of its nutritional status in Iringa District, Tanzania.

MATERIALS AND METHODS

The study was conducted in the woodlands of Iringa District which occurs between latitudes 7.00^{o}-8.30^{o}. The soils are generally red brown lateritic, composed of

Corresponding Author: Tairo Vendeline Emmanuel, Department of Land Resources and Agricultural Technology, University of Nairobi, Kenya

loam, silt, sand and gravel in the Miombo woodlands which however are rocky outcrop. A large area of Iringa District is located in the lowland which lies at an altitude of 900-1200 m above sea level and experiences annual rainfall of between 500 and 600 mm and a mean temperature of between 20 and 30°C (IDI, 2008). The population consists of 119,487 and 126,136 are males and female respectively (Census, 2002). It is widely known that agriculture is the most mainstay of the economy of Iringa District, whereby majority of the rural population practicing mixed farming at subsistence level.

Sample collection and preparation for analysis: Six wild plant species were selected for study based on their performance in the preference ranking of the wild food plants in the study area. These were *Sterculia africana*, *Adansonia digitata*, *Vangueria infausta* fruits and *Opilia amentacea* and *Maerua angolensis* leaves.
Parts of the identified plants were collected during the inventory survey in all forest sites and temporarily stored in a labeled polythene bags prior to being brought to the laboratory. *S. africana* and *A. digitata* were collected when dry while drupe of *V. infausta* and *V*. *mombassae* were collected when fleshy because the dried fruits are not consumable. The fleshy fruits were peeled off to get the edible part, dried at a room temperature, then oven dried. The dried fruits of *A. digitata* and *S. africana* were chopped then split open to free the seeds. The seeds were packed in 1 kg paper bag and oven dried. The vegetables were also collected, packed in paper bag and oven dried at 105°C. for 48 h. The dried samples were ground and sieved through 20 mm mesh sieve and stored in airtight containers prior to analysis at Sokoine University of Agriculture.

Chemical analyses: The plant samples were analyzed in triplicate for their moisture, crude protein, crude lipid, crude fibre and ash contents using standard methods as outlined by Association of Official Analytical Chemists (AOAC, 1995). The carbohydrate content was obtained by difference (i.e. subtracting the values obtained for moisture, crude protein, crude lipid, crude fibre and ash from 100) (Bamigboye *et al*., 2010).
Potassium and sodium were determined by using flame emissions spectrophotometer. Phosphorus was determined by vanado-molybdate colorimetric method. Calcium, iron, zinc and manganese were determined spectrophotometrically using Buck 200 atomic absorption spectrometer as described by Essien *et al.* (1992) and the values were compared with absorption of standards of these mineral nutrients. Vitamin C of each sample was determined by an Iodometric Titration method as outlined in AOAC (1995).

Determination of phenols and tannins: Phenols were determined as described by Slinkard and Singleton (1977). This done by heating 500 mg of dried sample with 5 ml of 1.2 M HCl in 50% aqueous methanol for 2 h at 90°C was done and then analyzed by Folin-Ciocalteau micro method. On the other hand tannin was determined using the method outlined by Trease and Evans (1978). One milliliter of the methanolic extract was treated with 5 ml Folin Dennis reagent in a basic medium and hence leading to colour development. The absorbance of the mixture developed for each sample was measured by spectrophotometer at 660 nm.

Data analysis: Proximate composition, minerals, vitamins, antinutritional factors like phenols and tannins were estimated in triplicate and the means were compared in pairwise depending on the use of plants i.e. plants used for vegetables, oils and fruits respectively by using One-Way ANOVA in Statistical Package for Social Sciences (SPSS) ver. 15 (Levesque, 2007).

RESULTS AND DISCUSSION

The study showed that the mostly preferred species were *Vangueria infausta*, *Adansonia digitata*, *Opilia amentacea*, *Maerua angolensis*, *Vitex mombassae* and *Sterculia africana*. Among these woody plants *A. digitata* and *S. africana* seeds were commonly used as a source of oil whereas *V. mombassae* and *V. infausta* were commonly used as fruits. *O. amentacea* and *M. angolensis* were used as an important source of vegetables. All the above named species were identified during the previous preference ranking process. These species predominantly found in the drylands of Iringa District and have varied nutritional and anti-nutritional qualities.

Nutritional qualities

Proximate composition: The result for proximate composition of two mostly preferred species for oil are presented in Table 1. There were significant differences ($p<0.05$) in percentage moisture content, dry matter, crude protein, crude and carbohydrates across the preferred species for oils, vegetables and fruits. Generally the moisture content of species used for oils, vegetables and fruits was <13% indicating that species seemed possess low moisture content. These results are different from those reported by Mahammad *et al*. (2010) on seeds, pulp and peel of pears fruits to be 52.3±1.5%. On the other hand, the values reported in this study concur with those reported by Bamigboye *et al*. (2010) which were 6.4±0.04 and 5.2±0.35% for the whole seed and dehulled, respectively. The low moisture content signifies the higher dry matter yield as reported by Bamigboye *et al*. (2010). The low moisture content also reflects on their long storage because low moisture content do not favour growth and increase of microorganisms.

Table 1: Proximate composition of the highly preferred edible woody plants at Iringa District, Tanzania

	Oil-producing		Fruit-producing		Vegetable-producing	
Parameters (%)	*Adansonia digitata*	*Sterculia africana*	*Vangueria infausta*	*Vitex mombassae*	*Opilia amentacea*	*Maerua angolensis*
Moisture content	9.62±0.67	4.30±0.18	4.16±0.65	12.11±0.32	9.21±0.27	7.90±0.77
Dry matter	88.30±2.27	95.36±0.25	93.65±3.02	88.43±0.29	91.40±0.77	91.77±0.33
Ash	5.43±0.79	5.69±0.28	3.37±0.54	5.75±0.26	21.09±0.45	12.90±0.09
Crude protein	2.45±0.11	24.90±0.63	3.01±0.61	4.94±0.26	14.80±0.11	33.21±0.63
Crude fibre	9.90±0.18	27.55±0.34	10.29±1.04	11.39±0.34	16.06±0.17	14.98±0.48
Crude oil	3.88±0.13	6.84±0.33	1.15±0.23	2.97±0.29	2.45±0.40	3.12±0.29
Carbohydrate	70.74±0.79	34.82±0.21	77.07±259	61.25±0.46	34.94±0.53	28.43±0.34

The percent ash contents was slightly different ($p<0.05$) among the preferred species for vegetables and fruits. As indicated in Table 1, *O. amentacea* and *M. angolensis* which are commonly used as source of vegetables has the highest value ranging from 12-21% while the other species that were used as a source of fruits and oils had the lowest values ranged from 3-6%. The highest values reported not similar to those reported by Olaposi and Adunni (2010) that vegetables of *Cnidoscolus chayamansa*, *Solanium nodiflorum* and *Senecio biafrae* had percent ash content of 1.57, 2.67 and 2.01, respectively.

Results further revealed that *S. africana* which is one of the oil producing plants had higher protein content (24.9%) than *A. digitata* with 2.45%. Leafy vegetables i.e *M. angolensis* had higher crude protein percent (33.21%) than *O. amentacea* (14.8%). The fruits from *V. mombassae* and *V. infausta* had the lowest crude protein ranging from 3-5%.

S. africana and *M. angolensis* had significantly higher crude protein than other than species analyzed. The crude protein of the species used for oil and vegetables had the highest crude protein ranging from 23-34%. Other species had the lowest (<2.4%) crude protein. These results suggests that the crude protein of some plant species are closer to that of soybean which is over 36.6%. These results are in agreement with those reported by Jambunathan (1991) that oily seeds such as groundnuts have crude protein more than 25.2%. Therefore, the seeds of *S. africana* and *M. angolensis* are good sources of proteins in human body.

The high values of crude protein of mostly preferred vegetables had are not far with the ones reported by Nkafamiya *et al*. (2010) that protein content of 20.27±0.17 and 17.24±0.71% for *F. asperifolia* and *F. sycomorus*, respectively. However, Olaposi and Adunni (2010) had shown very low values of crude protein of the common leaf vegetables, *Solanium nodiflorum* not exceeding 3.1%. Kuti and Torres (1996) reported protein content of 5.71% (wet basis) for *Cnidoscolus chayamansa* vegetable and 11.6-12.3% (dry basis) for two varieties of *Senecio biafrae* vegetables (Adebooye, 2000). Fasuyi (2006) reported crude protein (19.9-35.1 g/kg).

The crude fibre in fruits, vegetables and oils from highly preferred species ranged from 9.90-27.55% on dry basis, of which, *S. africana* seeds which are the sources of oil showed higher value of 27.55% followed by 16.06% for *O. amentacea* which is popular for vegetables and the rest had lower crude fibre (<10%). The crude content recorded in this study are lower for all the species compared with 28.68 and 31.54% for *F. asperfolia* and *F. sycomorus*, respectively (Nkafamiya *et al*., 2010).

The crude lipid content of mostly preferred species within the range of 1.15% for fruits plants to 6.84% for oily plants. These results are lower than those reported by Osman (2004) that *Adansonia digitata* had crude lipid of 18.4%. However the results were higher than the Iranian vegetables with crude lipid of 3.44% (Aberoumand, 2008). Also Aberoumand (2008) reported the lower values crude lipid (5.28%) of *Portulaca oleracia*. On the other hand Ekop (2007) reported crude lipid of *Gentum africanum* seeds of 3.15% which is in line with the oily plants recorded in this study. Hassan *et al.* (2009) showed that crude lipid content of 12% and significantly higher ($p<0.05$) compared to the seed and peel content. Lipids are essential because they provide the body with maximum energy (Dreon *et al*., 1990).

The highest percentage of carbohydrates was found in *V. infausta* fruits (77.07%), followed by *A. digitata* (71%). All other species had lower values of <35% (see Table 1). These results suggest that *V. infausta* and *A. digitata* can be considered as potential source of carbohydrates.

Carbohydrate contents of the two preferred wood plants in this study, fall within the range expected for other renowned staples. Cassava has been reported to have contents ranging from 41.67±4.4 (Sop *et al*., 2008) to 86.3% (Charles, 2005). Sop *et al*. (2008) and Charles (2005) reported the values of the carbohydrate content in different sorghum varieties to vary from 23.55-69.96% which were lower than the amount recorded in this study. Also, Sop *et al*. (2008) recorded the lower amount of carbohydrates potato puree (38.78±1.62). These results suggest that *V. infausta* and *A. digitata* had the higher amount of carbohydrates compared with other conventional staples.

Mineral nutrients composition: The results on mineral nutrients composition are indicated in Table 2. There was a significant difference ($p<0.5$) in mineral

Table 2: Nutrients composition and vitamin C of highly preferred plant species at Iringa District, Tanzania

Parameters mg/100 g dry wt.	Oil-producing		Fruit-producing		Vegetable-producing	
	Adansonia digitata	*Sterculia africana*	*Vangueria infausta*	*Vitex mombassae*	*Opilia amentacea*	*Maerua angolensis*
Iron	21.67±0.76	13.25±0.30	24.43±1.24	13.99±0.37	15.65±0.36	23.24±0.28
Calcium	677.23±0.47	101.59±0.48	186.33±3.99	603.52±785.34	3559.27±1.03	4785.97±0.23
Magnesium	66.49±0.46	180.53±0.92	18.62±0.41	34.61±0.41	675.62±0.37	464.43±0.57
Manganese	0.78±0.25	7.06±0.26	2.91±0.26	7.09±0.32	10.05±0.45	1.88±0.35
Phosphorus	53.59±0.38	532.00±1.24	86.86±1.45	103.22±1.26	163.02±0.76	205.10±0.48
Potassium	1013.41±0.78	1842.93±1.25	747.26±7.20	1382.68±0.50	3590.51±1.08	832.19±0.78
Sodium	127.35±0.75	167.27±0.71	160.81±0.71	96.08±0.28	243.02±0.31	96.11±0.75
Zinc	3.99±0.44	5.75±0.47	7.05±0.33	6.50±0.37	3.47±0.44	3.22±0.21
Copper	6.25±0.48	6.34±0.56	5.91±0.60	5.28±0.18	6.33±0.56	4.73±0.43
Vitamin C	57.31±0.35	5.07±0.40	11.50±0.22	40.95±1.05	12.03±0.55	3.92±0.26

composition of the preferred woody plants. As indicated in the table all the edible plants that are commonly used as fruits, vegetables and crude oil had higher values of Potassium, for example *V. infausta* (747.26 mg/100 g), *A. digitata* (1013.41 mg/100 g), *O. amentacea* (3590.51 mg/100 g) and *S. africana* (1842.93 mg/100). However, copper, zinc, iron and manganese were very lower (<25 mg/100) for all the species producing oil, vegetables and fruits. Iron and zinc are among the essential elements for humans and their daily requirements for adult are 15 and 18 mg respectively (Hassan and Umar, 2006). A study by Nkafamiya *et al*. (2010) indicated that the level of iron in *Ficus asperifolia* to be 14.56±0.22 mg/100 g whereas *F. sycomorus* had 11.65±0.15 0.67 mg/100 g. Therefore, the values reported in this study are within the acceptable range.

Other nutrients including sodium, magnesium, phosphorus and calcium were slightly higher in all preferred species than in other wild food plants. Vegetables from *O. amentacea* and *M. angolensis* had highest values of calcium and magnesium that ranged from 3500-4800 mg/100 g and 464.43-675.62 mg/100 g respectively, whereas the other preferred species showed Calcium of more than 100 mg/100 g and magnesium less than 180 mg/100 g. Sodium content for all preferred food plants ranged from 96-243 mg/100 g. Values of Potassium in wild food plants were found to be higher than in the domesticated vegetables. According FNIC (2011), the domesticated vegetables had the following levels of K; cabbage -147 mg/100 g, broccoli -229 mg/100 g, carrot -183 mg/100 g, Chinese cabbage -268 mg/100 g and spinach -167 mg/100 g. Also, the minerals potassium and calcium were found to be higher in *A. digitata* [K (1013.41 mg/100 g) and Ca (677 mg/100 g)]. Osman (2004) recorded minimum and maximum values of 726 and 3272 mg/100 g of K, respectively in *A. digitata* which is within the range of values recorded in this study. On the other hand, Osman (2004) recorded in *A. digitata* pulp an average of 302 mg/100 K which is similar to the values indicated in this study. FNIC (2011) have documented foods with the highest levels of K to be watermelon (320 mg/100 g), pineapples (180 mg/100 g), papaya (360 mg/100 g) and orange (237 mg/100 g). Also in line with this study, K is the most abundant Mineral in most of the samples. These results are in agreement with those reported by Ilelaboye and Pikuda (2009) that potassium dominates in seeds of lesser- know crops. Also Olaofe and Sanni (1980) that potassium is the predominant nutrient in Nigeria agricultural products.

Vitamin C (ascorbic acid): The levels of vitamin C across all the plant species tested are recorded in 2. There was significant difference (p<0.05) in Vitamin C among the species. The results show that *Adansonia digitata* seeds that were highly preferred for oils had the highest value of Vitamin C (57.31 mg/100 dry weight) followed by fruit plant (*Vitex mombassea*) with 40.95 mg/100 dry weight. Abitogun (2010) reported an average of 110±0.01 mg/100 g of dry weight in ripe fruits of *Vitex gandiflora* which is higher the value reported in this study. Vitamin C is of the most important of all as it acts as an anti-oxidant (Barminas *et al*., 1998). FNIC (2011) recorded higher values of vitamin C in commonly used fruits such as mango (57.3 mg/100 g), pineapple (78.9 mg/100), Orange (69.7 mg/100 g), papaya (86.5 mg/100 g) and strawberry (84.7 mg/100). However FNIC (2011) indicated lower values of other fruits including tomato (15.6 mg/100 g), watermelon (23.2 mg/100 g) and olives (0.1 mg/100 g).

Antinutritional levels of mostly preferred woody plants: The levels of the anti-nutritional factors are shown in Table 3. The results showed that tannins were highest in all the preferred species compared to phenols. *A. digitata* seeds had tannin not exceeding 19 mg/100 g and also phenols seemed to be very low (<2 mg/100 g) whereas the *S. africana* seeds seemed to have almost the same levels of tannin and phenols (Table 3). The fruit and vegetable plant species had the highest levels of tannin ranging from 12.6-19.02 mg/100 g whereas the phenols were less than 5 mg/100. As shown in the figure, *V. mombasae* had high level of phenols (4.33 mg/100 g) while *V. infausta* had the lowest value

Table 3: Some of anti-nutritional qualities of highly preferred plant species in Iringa District, Tanzania

Anti-nutrients mg/100 gm dry wt	Mostly preferred plants					
	Adansonia digitata	*Sterculia africana*	*Vangueria infausta*	*Vitex mombassae*	*Opilia amentacea*	*Maerua angolensis*
Phenol	1.97±0.13	1.06±0.24	0.95±0.06	4.33±0.36	1.85±0.25	1.95±0.26
Tannin	18.54±1.18	1.05±0.34	12.60±123	19.02±5.95	17.20±0.62	17.20±0.62

(0.95 mg/100 g). *Vitex mombassae* had highest level of tannins (19.02 mg/100 g) followed by *A. digitata* with 18.54 mg/100 g. Vegetable species i.e *O. amentacea* and *M. angolensis* had the same level of tannins (17.20 mg/100 g). Lowest level of tannins was recorded in *S. africana* with (1.05 gm/100 g). These results suggest that, all levels of anti-nutrition determined in the samples are all below the recommended toxic levels caused by the presence of anti-nutritional factors (Birgitta and Caroline, 2000). According to Andy and Eka (1985) tannin levels in baobab are 17.8 mg/100 g and 19.8 mg/100 g. Hossain and Becker (2001) reported values of phenols 2.96-5.95% and 1.97-2.25% of tannins in Sesbania seeds. Lower values of <2 mg/100 g by Rathod and Valvi (2011) for wild edible plants in India. In line within this Umaru *et al*. (2007) reported the tannins levels of various wild fruits to range from 5.9-7.4%. These values are below the known toxic levels but may interfere with nutrients and possibly decrease their digestibility and availability. However, even the slightly inflated tannins levels 17-19 mg/100 in the preferred species was probably caused by analysis of from the raw samples and can be reduced when treated for example cooking processes. Similar results were obtained by Vijayakumari *et al*. (1998) for *Vigna aconitifolia* and *Vigna sinensis*. Soaking and cooking processes were in reducing and tannins.

Conclusion and recommendations: Based on the results and subsequent discussion this study revealed that wild plants are nutritious having adequate vital nutrients. Although, there is no single plant that can provide all adequate level of nutrients required by human being, yet the wild food plants contain many essential nutrients like carbohydrate, protein, ash, crude fibre and moisture content. The preferred plant species showed that *V. infausta* and *A. digitata* contain high percentage of carbohydrate 77.07% and 70.74% respectively. *M. angolensis* which is commonly used as vegetables has highest protein (33.21%) followed by *S. africana* with protein (24.9%) and crude fibre of 27.55% which makes it a good source of energy for human nutrition. The commonly plants for used fruits, vegetables and crude oil had higher values of Potassium, for example *V. infausta* (749.3 mg/100 g), *A. adansonia* (1013.41 mg/100 g), *O. amentacea* (3590.51 mg/100 g) and *S. africana* (1842.93 mg/100). Additionally, wild food plants contain anti-nutritive factors including tannins and phenols which are toxic and interfere with digestion and absorption, but all analyzed were below the toxic levels acceptable daily intake. Therefore, most of the highly preferred species have low anti-nutritional factors and could serve as potential source in food formulation. In some cases where the toxic levels are higher, pretreatment either through soaking, germination and cooking reduce the high levels of anti-nutritional factors.

ACKNOWLEDGEMENT

I am very grateful to the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) through its PhD Programme in Dryland Natural Resources Management for supporting me to undertake this research.

REFERENCES

Aberoumand, A., 2008. Comparison of protein values from seven wild edible plants of Iran. Afr. J. Food Sci., 2: 73-76.

Abitogun, A.S., 2010. Nutritional and chemical compositions of ripe and unripe *Vitex glandifolia*. J. Res. Natl. Dev., Vol. 8.

Adebooye, O.C., 2000. An assessment of cultural practices for cultivating a wild but edible leaf vegetable: Crassocephalum biafrae (Asteraceae): Emphasis on propagation technique. In: Proceedings of the third Workshop on the Sustainable Use of Medicinal and Food Plants. September 15-17, University of Karachi, Pakistan, pp: 132-138.

Amaechi, N.C., 2009. Nutritive and anti-nutritive evaluation of wonderful kola (*Buccholzia coricea*) seeds. Pak. J. Nutr., 8: 1120-1122.

Andy, E.O.H. and O.U. Eka, 1985. Nutritive value of leaves of baobab tree (*Adansonia digitata*). West Afr. J. Biol. Applied Chem., 30: 3-10.

AOAC, 1995. Official Methods of Analysis. Association of Official Analytical Chemists, 15th Edn., Washington, DC.

Bamigboye, A.Y., A.C. Okafor and O.T. Adepoju, 2010. Proximate and mineral composition of whole and dehulled Nigerian sesame seed. Afr. J. Food Sci. Technol., 1: 76-81.

Barminas, J.T., M. Charles and D. Emmanuel, 1998. Mineral composition of non-conventional leafy vegetables. Plant Foods Hum. Nutr., 53: 29-36.

Birgitta, G. and G. Caroline, 2000. Exploring the Potential of Indigenous Wild Food Plants in Southern Sudan. Proceedings of a Workshop Held in Lokichoggio, Kenya, pp: 22-25.

Census, 2002. United Republic of Tanzania: Population and Housing Census.

Charles, A.L., 2005. Influence of amylopectin structure and amylose content on the gelling properties of five cultivars of cassava starches. J. Agric. Food Chem., 53: 2717-2725.

Dreon, D.M., K.M. Uranizan, R.M. Krauss, M.A. Austin and P.D. Wood, 1990. The effects of polyunsaturated fat and monounsaturated fat on plasma, lipoproteins. J. Am. Med. Assoc., 263: 2462-2466.

Ekop, A.S., 2007. Determination of chemical composition of *Gnetum africana* (AFANG) seeds. Pak. J. Nutr., 6: 40-43.

Essien, A.I., R.U.B. Ebana and H.B. Udo, 1992. Chemical evaluation of pod and pulp of the fluted pumpkin *(Telfairia occidentalis*) fruit. Food Chem., 45: 175-178.

FAO, 1990. The Major Significance of Minor Forest Product. The Local Use and Value of Forest in the West. African Humid Forest Zone. Community Forestry Note 6 Rome.

Fasuyi, A.O., 2006. Nutritional potential of some tropical vegetable meals. Chemical characterization and functional properties. Afr. J. Biotech., 5: 49-53.

FNIC, 2011. Food and Nutrition Information Centre. National Agricultural Library, Unitesd states Department of Agriculture. www.fnic.gov/nal_display /27th March 2011.

Hamza, K.F.S., 2002. Contribution of some Non-Timber Forest Products (NTFPs) to household food security and income generation. A case of villages around Mgori forest in Singida, Tanzania.

Hassan, L.G., B.B. Usman, A.S. Kamba and S.W. Hassan, 2009. Nutritional compositions of Vegetable sphaghetti (Hastala pasta). Nig. Food J., Vol. 27.

Hassan, L.G. and K.J. Umar, 2006. Nutritional value of balsam apple (*Momordica balsamina L).* leaves. Pak. J. Nutr., 5: 522-529.

Hossain, M.A. and K. Becker, 2001. Nutritive value and anti-nutritive factors in different varieties of Sesbania seeds and their morphological fractions. Food Chem., 73: 421-431.

IDI, 2008. Iringa District Investment profile, pp: 46.

Ilelaboye, N.O.A. and O.O. Pikuda, 2009. Determination of minerals and anti-nutritional factors of some lesser-known crop seeds. Pak. J. Nutr., 8: 1652-1656.

Jambunathan, R., 1991. Groundnut quality characteristics. Uses of tropical grain legumes. Proceedings of a consultants meeting 27-30 Mar 1989, ICRISAT Centre, India.

Kavishe, F.P. and S.S. Mushi, 1993. Nutrition Related Actions in Tanzania. TFNC 30 monography series NO1; UN ACC/SCN country Case study Supported by UNICEF: A Case study for XV congress international Union of Nutritional Sciences.

Kuti, J.O. and E.S. Torres, 1996. Potential nutritional and health benefits of tree spinach. pp: 516-520. In: J. Janick (Ed.), Progress in new crops. ASHS Press, Arlington, VA.

Levesque, R., 2007. Programming and Data Management: A Guide for SPSS and SAS Users, Fourth Edition (2007), SPSS Inc., Chicago Ill. PDF ISBN 1568273908.

Mahammad, M.U., A.S. Kamba, L. Abubakar and E.A. Bagna, 2010. Nutritional composition of pear fruits (P*yrus communis*). Afr. J. Food Sci. Technol., 1: 76-81.

Nkafamiya, I.I., S.A. Osemeahon, U.U. Modibbo and A. Aminu, 2010. Nutritional status of non-conventional leafy vegetables, *Ficus asperifolia* and *Ficus sycomorus*. Afr. J. Food Sci., 4: 104-108.

Olaofe, O. and O. Sanni, 1980. Mineral content of Agricultural products*.* Food Chem., 30: 73-77.

Olaposi, A.R. and A.O. Adunni, 2010. Chemical composition of three traditional vegetables in Nigeria. Pak. J. Nutr., 9: 858-860.

Osman, M.A., 2004. Chemical and nutrient analysis of baobab (*Adansonia digitata*) fruit and seed protein solubility. Plant Foods Human Nutr., 59: 29-33.

Rathod, V.S. and S.R. Valvi, 2011. Antinutrional factors of some wild edible fruits from Kolhapur District. Rec. Res. Sci. Technol., 3: 68-72.

Ruffo, C.K., A. Birnie and B. Tengrias, 2002. Edible Wild plants of Tanzania. RELMA technical Handbook Series 27. Nairobi, Kenya: Regional land management unit (RELMA), Sida, pp: 766.

Slinkard, K. and V.L. Singleton, 1977. Total phenol analysis: Automation and comparison with manual methods. Am. J. Enol. Vitic., 28: 49-55.

Sop, M.M.K., M. Fotso, I. Gouado, E. Tetanye and P.H.Z. Amvam, 2008. Nutritional survey, staple foods composition and the uses of savoury condiments in Douala, Cameroon. Afr. J. Biotechnol., 7: 1339-1343.

Trease, G.E. and N.C. Evans, 1978. A Test book of Pharmacognosy. 11th Edn., Bailliere-Tindall, London.

Umaru, H.A., R. Adam, D. Dahiru and M.S. Nadso, 2007. Levels of antinutritional factors in some wild edible fruits of Northern Nigeria. Afr. J. Biotechnol., 6: 1935-1938.

URT (United Republic of Tanzania), 2001. Forest Policy. Ministry of Natural Resources and Tourism, Forestry and Beekeeping Division, Dar-es-Salaam, Tanzania.

Vijayakumari, K., P. Siddhuraju, M. Pugalenthi and K. Janardhanan, 1998. Effect of soaking and heat processing on the levels of antinutrients and digestible proteins in seeds of *Vigna aconitifolia* and *Vigna sinensis*. Food Chem., 63: 259-264.