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Comparative Evaluation of the Phytochemical and Proximate Constituents of Oha (*Pterocarpus Soyansii*) and Ntururopa (*Pterocarpus Santalinoides*) Leaves

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Abstract

The study examined the phytochemical and proximate constituents of the leaves of *Pterocarpus soyansii* and *Pterocarpus santalinoides* grown in Abia State Nigeria. The result of the phytochemicals indicates that the concentration of tannins (0.31 ± 0.01) was higher in *P. soyansii* than in *P. santalinoides* which contained (0.23 ± 0.01). *Pterocarpus santalinoides* contained more alkaloids (0.63 ± 0.02), saponins (0.35 ± 0.01), phenols (0.15 ± 0.01), steroids (0.11 ± 0.01) while *P. soyansii* contained (0.41 ± 0.01) of alkaloids, (0.24 ± 0.01) of saponins, (0.15 ± 0.01) of phenols and (0.07 ± 0.01) of steroids. Quantitative estimates of other phytochemicals showed that *P. santalinoides* contained significantly higher concentration of flavonoids (0.74 ± 0.01), phytic acid (0.42 ± 0.01), oxalates (0.38 ± 0.01) and hydrogen cyanide (1.74 ± 0.01) as compared to *P. soyansii*

which contained (0.49 ± 0.01) of flavonoids, (0.34 ± 0.01) of phytic acid, (0.27 ± 0.01) of oxalates and (1.01 ± 0.01) of hydrogen cyanide. These substances may be responsible for the medicinal and nutritional activities of the plants. The result of the proximate analysis clearly shows that the leaves of both species of *Pterocarpus* have high nutritional value. *Pterocarpus soyansii* had higher significant ($p < 0.05$) concentration of moisture content (11.35 ± 0.04), ash content (9.46 ± 0.02), crude fibre (11.52 ± 0.01) and crude protein of (19.74 ± 0.01) as compared to *P. santalinoides* which contained moisture content (10.74 ± 0.02), ash content (7.83 ± 0.052), crude fibre (9.46 ± 0.05) and crude protein (16.32 ± 0.01).

Keywords: Phytochemical, *Pterocarpus Soyansii*, *Pterocarpus Santalinoides*, Proximate, Leaves.

Introduction

Vegetables are generally succulent parts of plants grown in gardens and consumed as a side dish with starchy staples (Guarino, 1995). Green leafy vegetables constitute an indispensable constituent of human diet in Africa generally and West Africa in particular (Chima and Igyor,

2007). The genus *Pterocarpus* which is tropically and sub-tropically distributed belongs to the family Leguminosae. There are about 60 species of the genus of which 20 of these are found in Africa in countries such as Nigeria, Cameroon, Sierra Leone and Equatorial Guinea. Fresh vegetables are highly recommended in any diet virtually without quantitative restriction and the roles of vegetables in maintenance of good health are well known (Osugwe, 2008). The leaves of *Pterocarpus* species, *P. soyansii* known as "Oha" (Ibo) and *P. santalinoides* known as "Nturukpa" (Ibo) are used for soup making in the South Eastern part of Nigeria. Some tribes in the Eastern and Southern Nigeria use the leaf extracts in the treatment of headaches, pains, fever, convulsions, and respiratory disorders and as antimicrobial agents as similarly reported for *Sansevieria trifasciata* (Ogukwe *et al.*, 2004). In addition, green leafy vegetables are used in the diets of postpartum women during which time it is claimed that they aid the contraction of the uterus. It is therefore the objective of this work to determine and compare the phytochemical and proximate composition of *Pterocarpus soyansii* Hams and *Pterocarpus santalinoides* grown in Abia State of Nigeria.

Materials and Methods

The fresh leaves of *P. soyansii* and *P. santalinoides* were collected from Item in Bende local Government Area of Abia State Nigeria. Voucher specimens of the plants have been deposited in Herbarium, Department of Plant Science and Biotechnology, Michael Okpara University of Agriculture for further references. The species *P. soyansii* is locally called "oha" (Ibo), "asunje" (Yoruba) and "alilibi rafii" (Hausa) while *P. santalinoides* is called "nturukpa" (Ibo), "gbengbe" (Yoruba) and "gunduru" (Hausa).

Qualitative analysis of phytochemical *P. soyansii* and *P. santalinoides* leaves

Phytochemical tests were carried out first to establish the presence or otherwise of some specific phytochemicals. The leaves of *Pterocarpus soyansii* and *Pterocarpus santalinoides* were screened for alkaloids, saponins, tannins, flavonoids, phenols, steroids, and cyanogenic glycosides. The methods used and their corresponding inferences were described by Sofowara (1993) and AOAC (2004)

Table 1: The result of qualitative test for phytochemical analysis of *Pterocarpus soyansii* and *Pterocarpus santalinoides* leaves

Species	Phytochemicals Determined	Test carried out	Observation	Inference
<i>P. soyansii</i> <i>P. santalinoides</i>	Saponins	Frothing test	Stable froth emulsion	+ +
<i>P. soyansii</i> <i>P. santalinoides</i>	phenols	Ferric chloride test	Greenish brown precipitate	+ +
<i>P. soyansii</i> <i>P. santalinoides</i>	Alkaloids	Wagner Dragendioff's test	Reddish brown precipitate	+ +
<i>P. soyansii</i> <i>P. santalinoides</i>	Flavonoids	Sodium hydroxide	Yellow colour precipitate	+ +
<i>P. soyansii</i> <i>P. santalinoides</i>	Tannins	Acid test	Reddish brown precipitate	+ +
<i>P. soyansii</i> <i>P. santalinoides</i>	Cyanogenic glycosides	Sodium picrate test	Yellow to reddish	++ ++
<i>P. soyansii</i> <i>P. santalinoides</i>	Steroids	Salkowskis test	Red colour interface	+ +

+ = Present in small quantity

++ = Present in large quantity

Quantitative Determination of the Phytochemicals from Leaf samples

Alkaloids and saponins were determined according to the method of Obadoni and Ohuko, (2001). Flavonoids were determined using the ethyl acetate precipitation method of (Bohm and Kocipai, 1994). Tannin determination was by AOAC (2004) method while determination of Phenols was by Follins method described by Pearson (1976). The steroid, phytic acid and oxalate contents of the samples were determined using the method described by AOAC (2004).

Proximate Analysis of the Leaf Samples

Moisture and ash contents were determined using the furnace incineration method (Lee *et al.*, 2007; Ezeagu *et al.*, 2011). Ash content was estimated by the method of Chavan *et al.* (2010). The dry matter, protein, fat and fibre contents of the samples were determined using standard procedure of AOAC (2004).

Determination of Carbohydrate

The carbohydrate contents were calculated by difference as the nitrogen free extract (NFE), using method separately described by Pearson (1976) and James (1995).

Where: % NFE = 100 - % (a+b+c+d+e)

A=protein, B=fat, C=fibre, D=ash, E= moisture

Data Analysis

All data collected were subjected to T-test analysis using Statistical Package for Social Sciences SPSS, Inc.15.0 software

Results

The result of the quantitative phytochemical analysis of *Pterocarpus soyansii* and *Pterocarpus santalinoides* leaves is summarized in table 2. The results revealed the presence of phytochemicals such as alkaloids, saponins, tannins, flavonoids, steroids, hydrogen cyanide, oxalates and phytic acid as well as the proximate composition such as crude fiber, ash, crude protein, carbohydrate. The result of the phytochemicals indicates that the concentration of tannins (0.31 ± 0.01) was higher in *P. soyansii* than in *P. santalinoides* which contained (0.23 ± 0.01). *Pterocarpus santalinoides* contained more alkaloids (0.63 ± 0.02), saponins (0.35 ± 0.01), phenols (0.15 ± 0.01), steroids (0.11 ± 0.01) while *P. soyansii* contained (0.41 ± 0.01) of alkaloids, (0.24 ± 0.01) of saponins, (0.15 ± 0.01) of phenols and (0.07 ± 0.01) of steroids. Quantitative estimates of other phytochemicals showed that *P. santalinoides* contained significantly higher concentration of flavonoids (0.74 ± 0.01), phytic acid (0.42 ± 0.01), oxalates (0.38 ± 0.01) and hydrogen cyanide (1.74 ± 0.01) as compared to *P. soyansii* which contained (0.49 ± 0.01) of flavonoids, (0.34 ± 0.01) of phytic acid, (0.27 ± 0.01) of oxalates and (1.01 ± 0.01) of hydrogen cyanide. The result of proximate analysis of *Pterocarpus soyansii* and *Pterocarpus santalinoides* is presented in table 3. The result of phytochemical analysis shows that with the exception of tannins which has a significant ($p < 0.05$) higher value of (0.31 ± 0.006) in *Pterocarpus soyansii*, all the other phytochemicals such as saponins (0.35 ± 0.010), phenols (0.15 ± 0.010), steroids (0.11 ± 0.010), are higher in *Pterocarpus santalinoides*. The result of the proximate analysis clearly shows that the leaves of both species of *Pterocarpus* have high nutritional value. *Pterocarpus soyansii* had higher significant ($p < 0.05$) concentration of moisture content (11.35 ± 0.04), ash content (9.46 ± 0.02), crude fibre (11.52 ± 0.01) and crude protein of (19.74 ± 0.01) as compared to *P. santalinoides* which contained moisture content (10.74 ± 0.02), ash content (7.83 ± 0.052), crude fibre (9.46 ± 0.05) and crude protein (16.32 ± 0.01). Other estimates of the nutritional constituents show that *P. santalinoides* contained higher amount of dry matter (89.26 ± 0.02), ether extract (4.25 ± 0.01) and carbohydrate (51.37 ± 0.05) while *P. soyansii* had (88.65 ± 0.04) of dry matter, (3.27 ± 0.01) of ether extract and (44.66 ± 0.06) of carbohydrate.

Table3: Result of quantitative analysis of *P. soyansii* and *P. santalinoides* leaves

Phytochemical	<i>P. soyansii</i>	<i>P. santalinoides</i>
Alkaloids	0.41 ^b ±0.01	0.63 ^a ±0.02
Flavonoids	0.49 ^b ±0.01	0.74 ^a ±0.01
Saponins	0.24 ^b ±0.00	0.35 ^a ±0.01
Phenols	0.08 ^b ±0.01	0.15 ^a ±0.01
Steroids	0.07 ^b ±0.01	0.11 ^a ±0.01
Tannins	0.31 ^a ±0.01	0.23 ^b ±0.01
Hydrogen cyanide	1.01 ^b ±0.01	1.74 ^a ±0.01
Oxalates	0.27 ^b ±0.01	0.38 ^a ±0.01
Phytic acid	0.34 ^b ±0.01	0.42 ^a ±0.01

^{a-b} Means in the same row with different superscripts are significantly different (P < 0.05)

Table 3: Result of proximate composition of *P. soyansii* and *P. santalinoides* leaves

Proximate	<i>P. soyansii</i>	<i>P. santalinoides</i>
Moisture content	11.35 ^a ±0.04	10.74 ^b ±0.02
Dry matter	88.65 ^b ±0.04	89.26 ^a ±0.02
Ash	9.46 ^a ±0.02	7.83 ^b ±0.02
Crude fibre	11.52 ^a ±0.01	9.46 ^b ±0.05
Crude protein	19.74 ^a ±0.06	16.32 ^b ±0.01
Ether extract	3.27 ^b ±0.01	4.25 ^a ±0.06
Carbohydrate	44.66 ^b ±0.06	51.37 ^a ±0.05

^{a-b} Means in the same row with different superscripts are significantly different (P < 0.05)

Discussion

The results indicate that some of the phytochemical and nutritive constituents vary (p<0.05) significantly. Various studies have shown that saponins although non toxic can generate adverse physiological responses in animals that consumes them. They exhibited growth inhibition against a variety of cells making them have anti-inflammatory and anti cancer properties. They also show tumor inhibiting activity on animals. Tannins exhibited antimicrobial activities by iron deprivation, hydrogen bonding or specific interactions with vital protein interaction. Leaves that have tannins are used for the treatment of intestinal disorders such as diarrhea and dysentery (Akindahunsi and Salawu, 2005). Tannins have astringent properties, hasten the healing of wounds and inflamed mucous membranes. Phenols protect plants from predators and pathogens. They produce poisons that protect the plants. The presence of phenolic compounds in the plants indicates that these plants may be anti-microbial agents. Phenols are used to eliminate bacteria and also used as poisons to burn up parasites (Sofowora, 1993). Steroidal compounds are of importance and interest in pharmacy due to their

relationship with such compounds as sex hormones. Sterols are used to lower cholesterol (Edeoga *et al.*, 2005). Flavonoids have been shown to have antibacterial, anti-inflammatory, anti allergic and anti tumour and protect organisms from free radicals attack. Flavonoids, are potent water-soluble antioxidants and free radical scavengers, which prevent oxidative cell damage and have strong anticancer activity. (Flavonoids in intestinal tract lower the risk of heart disease (Okwu, 2004). This may be the reason for the use of the two *Pterocarpus* species in the treatment of intestinal trouble when consumed in soup. Apart from saponins, other secondary metabolite constituents of *P. soyansii* and *P. santalinoides* detected include the alkaloids and flavonoids. Pure isolated alkaloids and their synthetic derivatives are used as basic medicinal agents for their analgesic, antispasmodic and bactericidal effects (Stray, 1998; Okwu and Okwu, 2004). The low phytate level may not cause adverse effect on digestibility as when present in high level (Nwokolo and Bragg, 1977). Phytic acid may lower the incidence of colonic cancer and protect against other inflammatory bowel disease. The oxalate content of the leaves of *Pterocarpus soyansii* and *Pterocarpus santalinoides* which is (0.27 ± 0.01) and (0.380 ± 0.10) respectively is very much lower than those reported by (Oke, 1996). Thus, it is unlikely to pose toxicity problems to man since they are much below the toxic levels of 2-5g stated by Edeoga *et al* (2005). Excess consumption of oxalic acid can cause corrosive gastro enteritis (Eastwood, 1986). Hydrogen cyanide (HCN) controls cardiac and neuronal rhythm city. It also controls epilepsy and neuropathic pain (Akpanyung *et al.*, 1995). Alkaloids are mainly blended from amino acids and also protect the plant from herbivorous animals and may also be useful pharamacologically.

The result obtained from proximate analysis of the leaves of *Pterocarpus soyansii* and *Pterocarpus santalinoides* shows that they can be ranked as carbohydrate rich leaves due to their relatively high carbohydrate content when compared with the other components of the leaves. The low moisture content of the leaves would hinder the growth of microorganism and storage life would be high (Adeyeye and Ayejugo, 1994). The crude protein content of the leaves of *Pterocarpus soyansii* and *Pterocarpus santalinoides* are (19.74%) and (16.32%) respectively but they are relatively low when compared with cassava leaves (24.88%) *piper guinensis* (29.78%) and *Talinum triangulare* (31.00%) as reported by Akindahunsi and Salawu (2005). The values for ash content of the leaves *Pterocarpus soyansii* (9.46%) and *Pterocarpus santalinoides* (7.83%). The ash content of the leaves is lower than that of some leafy vegetables commonly consumed in Nigeria such as *Talinum triangulare*. The value of the ether extracts (crude fat) for the leaves of the two *Pterocarpus* species studied were moderate when compared to those of *Talinum triangulare* 5.90, *Amaranthus hybridus* (4.80%) (Akindahunsi and Salawu, 2005). Dietary fat functions in the increase of palatability of food by absorbing and retaining flavours. A diet providing 1- 2% of its caloric of energy as fat is said to be sufficient to human beings as excess fat consumption is implicated in certain cardiovascular disorders such as cancer and aging (Antia *et al.*,2006). The fat content of 3.27 and 4.25 in the dried leaves of *P. soyansii* and *P. santalinoides* is very low compared to those of calabash seed (43%) (Ekuagbere, 2007) and groundnut (43%) (Apata and Ologhobo, 1994). The leaves of *P. soyansii* could still be grouped under oil rich plant food and therefore could be used as source of oil for industrial and domestic purposes. *Pterocarpus soyansii* and *P. santalinoides* have 11.5% and 9.46% crude fibre which is higher compared to the 2.8% in gourd seed (Ogungbenle, 2006), 4.28% soybean (Akintayo *et al.*, 2002) and 2.53% calabash seed (Ekuagbere, 2007). It suggests that *P. soyansii*

leaves would provide high dietary fibre in the diet. *Pterocarpus soyansii* and *P. santalinoides* are good sources of vegetable protein having a protein content of 19.4% and 16.32% respectively. This value was higher than that (3.3%) recorded by the USDA Nutrient Database for Standard Reference (Hall, 1998). Their protein content makes their leaves suitable for consumption, as a necessity for body development. The protein value of *P. soyansii* and *P. santalinoides* as observed in this study confers on them the advantage as a rich source of vegetable protein over some vegetables such as raw cocoyam leaf (3.4%), cooked cocoyam leaf (2.1%), Amaranthus (6.1%) and *Moringa oleifera* (4.2%) as reported by Adepoju *et al.* (2006). However the study contradicts the report Chima and Igyor (2007) recorded who recorded lower protein values for "Oha" (2.0%) The carbohydrate content of *P. soyansii* and *P. santalinoides* (44.66% and 51.37%) are high and compares well with of *Amaranthus hybridus* (52.18%) (Akubugwo *et al.*, 2007). Carbohydrates are essential nutrients required for adequate diet. The result also revealed that *P. soyansii* and *P. santalinoides* have a low moisture content of 11.35% and 10.74

% respectively. Moisture content is an index of water activity of many foods. The observed value implies that *P. soyansii* and *P. santalinoides* may have a long shelf life since microorganisms that cause spoilage do not thrive in foods having low moisture content. The low moisture content of Oha 11.35% and that of Nturu kpa 10.74% is not consistent with the report of Ekumankama (2008) who observed a high moisture value for vegetables like Oha (83.75%), Nturu kpa (80.75%). *P. soyansii* and *P. santalinoides* have also been recognized as an excellent source of fiber, which is an important consideration for people who suffer from elevated cholesterol levels and in helping to cleanse the colon (Zhao *et al.*, 2007). A number of studies have indicated that components of plants such as dietary fiber have beneficial effects in lowering blood cholesterol levels aside from the decreased intake of saturated fat and cholesterol that occurs with high intakes of plant foods (Ekumankama, 2008). Fibre cleanses the digestive tract, by removing potential carcinogens from the body and prevents the absorption of excess cholesterol (Smith, 1985). Finally fiber binds to cancer-causing chemicals, keeping them away from the cells lining the colon, providing yet another line of protection from colon cancer (Ensminger and Ensminger, 1996).

Conclusion

The results of the quantitative phytochemical study of the leaves of *P. soyansii* and *P. santalinoides* showed the presence of alkaloids, tannins, steroids, saponins, phenols and flavonoids. The extensive study of these phytochemicals and establishment of good correlation among the plant phytochemicals is essential for ensuring efficiency and quality of the herbal medicine. The result of the proximate analysis clearly shows that the leaves of both species of *Pterocarpus* have high nutritional value. Their leaves are used for soup making in the south eastern part of Nigeria. Some tribes in the Eastern and Southern Nigeria use the leaf extracts from *P. soyansii* and *P. santalinoides* in the treatment of headaches, pains, fever, convulsions, and respiratory disorders. However, adequate and proper care of these vegetables during processing and storage will ensure the conservation of their usefulness.

References

- Adepoju, O. T., Onasanya L. O., & Udoh, C. H. (2006). Comparative studies of nutrient composition of cocoyam (*Colocassia esculenta*) leaf with some green leafy vegetables. *Nig. J. Nutr. Sci.*, 27: 40-43

- Akindahunsi, A. A., & Salawu, S. O. (2005). Phytochemical screening of nutrient and antinutrient composition of selected tropical green leafy vegetables. *Afr. J. Biotech.*, 4: 497-501.
- Akintayo, E. T., Adebayo, E. A., & Arogundade, L. A. (2002), Chemical composition, physicochemical and functional properties of akee (*Bilphia sapida*) pulp and seed flours, *Food Chemistry*, 77, 333 – 336.
- Akpanyung, E. O., Udoh, A. P., & Akpan, E. I. (1995). Chemical Comp. of the edible leaves of *P. mildbraedii*. *Plants Foods and Human Nutri.* 48(3): 209 – 215.
- Akubugwo, I. E., Obasi, N. A., Chinyere, G. C., & Ugbogu, A. E. (2007). Nutritional and chemical value of *Amaranthus hybridus* L. Leaves from Afikpo, *Nigeria. Afr. J. Biotech.*, 6: 2833-2839.
- Antia, B. S., Akpan, E. J., Okon, P. A., & Umoren, I. U. (2006). Nutritive and antinutritive evaluation of sweet potatoes (*Ipomoea batatas*) leaves. *Pak. J. Nutr.*, 5:166-168.
- AOAC. (2004). Official Methods of Analysis. 15th Edn., Association of Official Analytical Chemists, Washington DC. USA., pp: 200-210.
- Apata, D. F., & Ologhoba, A. D. (1994). Biochemical evaluation of some Nigerian legume seeds. *Food Chemistry*, 49: 333 – 338.
- Chavan, U. D., Shinde, B. G., Kadam, S. S., & Amarowicz, A. (2010). Isolation and Characterization of Starch from Horse Gram. *African Journal of Food Science and Technology*, 1(3), 64-67.
- Chima, C. E., & Igyor, M. A. (2007). Micronutrient and antinutritional contents of selected tropical vegetables grown in South East, Nigeria. *Nig. Food J.*, 25: 111- 116.
- Ekuagbere, A. O. (2007). Chemical, mineral and amino acid composition and functional properties of calabash seed, pp. 24 – 36.
- Ekumankama, I. O. (2008). Nutrient composition of indigenous vegetables (*Pterocarpus soyanxii*, *Pterocarpus santalinoides* and *Gnetum africanum*). *Nig. J. Nutr. Sci.*, 29: 195-200.
- Ensminger, A. H., & Esminger, M. K. J. (1996). Food for Health: A Nutrition Encyclopedia. Pegus Press, Clovis, California.
- Enjuigha, U. M., and Ayodele, O. M. (2003). Nutritional status of lesser- known oil seeds. *Int. J. Food Sci. Tech.*, 38: 1-4.
- Ezeagu, I. E., Metges, C. C., Proll, J., Petzke, K. J., & Akinsoyinu, A. O. (2011). Chemical Composition and Nutritive Value of Some Wild-Gathered Tropical Plant Seeds. Retrieved on February 3 from: <http://www.chemcomandnutrient>.
- Gates, J. C. (1984). Basic Foods. Holts, Rinehart and Winston, Canada, 171:186-192
- Guarino, L. (1995). Traditional African vegetables: Proceedings of the ICGRI International Workshop on Genetic Resources of Traditional Vegetables in Africa, 29-31 August, 1995; ICRAF Headquarters Nairobi, Kenya, pp: 4.
- Hall, R. (1998). Kale, *Brassica oleraceae* (Acephala Group). USDA Database for Standard Reference, Release 12 (March, 1998). about.com. Nutrition guide. <http://www.nutrition.about.com>. Accessed
- Harbone, J. B., & Baxter, H. (1993). *Phytochemical dictionary*. A handbook of bioactivecompounds from plants. Taylor and Francis Ltd., London, Washington D.C. Pp. 324-689.
- James, C. S. (1995). Experimental method on analyticalchemistry of foods. Chapman and Hall, New York, 6:75-84.

- Lee, H. C., Htoon, A. K., & Paterson, J. L. (2007). Alkaline Extraction of Starch from Australian Lentil Cultivars: Matilda and Digger Optimised for Starch Yield and Starch and Protein Quality. *Food Chemistry*, 102, 551–559.
- Nwokolo, E. (1987). A nutritional assessment of Africa yam bean *Sphenostyles stenocarpa* and Bambara groundnut *Voandzeia subterranean* L. *J. Sci. Fd. Agric.* 41: 123 – 129.
- Obadoni, B. O., and Ochuko, P. O. (2001). Phytochemical Studies and Comparative Efficacy of the crude extracts of some homeostatic plants in EDO and Delta States of Nigeria. *Global J. Pure and Applied Sciences* 8:203 -208.
- Ogukwe, C. E., Oguzie, E. E., Unaegbu, C., and Okolue, B. N. (2004). Phytochemical Screening on the leaves of *Sansevieria trifasciata*. *J. Chem. Soc. Nigeria.* . 29(1): 8 – 9.
- Ogungbenle, H. N. (2006). Chemistry, functional properties of some edible oil seeds. *La. Rivista Italiana*. Vol. LXXX III, 81 – 86
- Okwu, D. E. (2004). Phytochemicals and vitamin content of indigenous spices of Southeastern Nigeria. *J. Sustain. Agric. Environ.* 6(1): 30-37.
- Okwu, D. E., and Okwu, M. E. (2004). Chemical composition of *Spondias mombin* linn plant parts. *J. Sustain Agric. Environ.* 6(2): 140-147.
- Onwuka, D. (2005). Elevation of the chemical composition of species and flavouring agents. *Global J. Pure Appl. Sci.*, 7(3 : 455-459
- Osuagwu, G. G. (2008) proximate and Vitamin content of for Nigerian Pterocarpus Species, *Nigerian Food Journal*, Volume 26 No 1 pp 21 – 26.
- Pearson, D. (1976). *Chemical Analysis of Foods*, 7th ed., London: Church Hill Livingstone
- Smith, I. F. (1985). Use of Nigerian leafy vegetables for diets modified in sodium and potassium. *Nig. J. Nutr. Sci.*, 4: 21-27nd
- Sofowora, A. (1993). *Medical Plants and Traditional Medicine in Africa*. 2 ed., Spectrum Books Ltd. Ibadan, Nigeria Pp. 71-73.
- Stary, F. (1998). *The Natural Guide to Medicinal Herbs and Plants*. Tiger Books International, London p. 12-16.
- Ukpabi, A., and Ejidoh, E. O. (1989). *Experimental Procedures or Food and Water Analysis*, San Press Publishers, Enugu, Nigeria, pp; 89.
- Zhao, H., J., Grossman, H. B., Hernandez, L. M., Dinney, C. P., and Wu, X. (2007). Dietary isothiocyanates, GSTM1, GSTT1, NAT2 polymorphisms and bladder cancer risk. *Int. J. Cancer*, 120: 2208-2213.