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Characterization of Gourd Fruits (*Cucurbitaceae*) For Dietary Values and Anti-Nutrient Constituents.

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ABSTRACT

Four species of gourd fruits were characterized for dietary values and anti-nutrient constituents. Proximate analysis revealed that the dry matter content ranged from 6.75 to 8.72 g/100g. Oriental guard has the highest value of dry and ash contents. The crude fibres was highest in ash gourd while cucumber has the least crude fat content. The crude protein (1.87 - 7.88 g/100g) was highest in ash gourd and a maximum of 76.12 g/100g carbohydrate was obtained in cucumber. Sodium contents (1046 mg/kg) was highest in cucumber, iron and manganese (6.5 and 1.7 mg/kg respectively) in oriental gourd, calcium (99.4 mg/kg) in ash gourd and zinc (2.2 mg/kg) in marrow gourd. The level of vitamin C varied from 21.82 mg/100g in cucumber to 60.00 mg/100g in ash gourd while the least energy value (977.69 kJ/100g) was obtained in ash gourd. Absorption, gelation, emulsion and foaming capacities of the oil from the fruits were reported. Low levels of anti-nutrients (oxalate, phytate and tannins) were obtained among the gourd fruits studied The rich energy, dietary fibre, vitamin C, mineral contents and low levels of anti- nutrients in the gourd fruits are indices of their potentials as food sources with health benefits.

Keywords: Phytonutrients; Anti-nutrient; Oil absorption; Proximate analysis; Gourds;

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INTRODUCTION

Fruit species represented an enormous wealth of agricultural biodiversity with potential to contribute to improved incomes, food security and nutrition as well as to combat micronutrient (vitamin and mineral) deficiencies. High dietary intake of fruits and vegetables is strongly associated with a reduced risk of developing chronic pathologies, such as cardiovascular diseases, diabetes, various types of cancer, among others as established by a number of epidemiological studies and clinical trials [1-4]. This may be partly due to the presence of antioxidant (such as Vitamin C) and many other bioactive phytochemicals. A daily intake of a minimum of 400 g of fruits and vegetables, excluding tubers like potatoes and cassava has been recommended for the prevention of these chronic diseases [5]. However, limiting forces behind the low consumption of fruits and vegetables in developing countries include the reliance on only few crops to meet dietary requirements, lack of access to most wild fruits and high cost of commonly consumed food. While only few crops are commercialized on a significant global scale [6], most other species are neglected and thus underutilized. Among such species are the Cucurbits, the gourd fruits of the *Cucurbitaceae* family with about 120 genera and 825 species [7].

Gourds are grown as food and for ornaments while some (such as melons and pumpkins) are cultivated for their oil rich seeds [8]. Some other gourd species exploited ethno-medicinally include water melon, colocynthis, bottle gourd, sponge gourd and bitter gourd [9]. Others remain uncultivated and neglected. These include ash gourd (also known as wax and white gourd), an annual hispid climbing herbaceous plant several meters in length. The leaves are broad with five to eleven angular lobes. The mature fruit is somewhat spherical to oblong in shape measuring 30 - 40 cm in diameter and 15 - 23 cm in width, and weigh as much as 45 g, the immature fruit is use as summer squash [10]. Whereas another Gourd specie is marrow gourd (*Cucurbita pepo L.*) with fruits of variable size, elongated, peduncle hard, white flesh or yellow coarse texture. The seed is brown with clearly define rim. The matured fruit could be eaten boiled, roasted or cooked. Cucumber is another gourd fruit (*Cucumis sativus L.*) with variable shape and size. The flesh is pale green and the seeds are flat and white. While the mature fruit could be eaten raw in salads, the immature fruit are used as pickles. Oriental melon **(***Cucumis melo L*), also known as white cucumber, is a similar fruit like cucumber. Its fruits are berries, spherical to ovoid in shape, 3-7 cm in diameter and 3-10 cm in length. Their mean fresh weight reaches 41 g and they contain a mean of 180 seeds [11]. This study, therefore, investigated these four gourd fruits for their dietary values in order to encourage their cultivation and consumption of those with several nutraceutical values.

MATERIALS AND METHODS

Collection and Preparation of sample

The four gourd fruits were obtained from Oja Oba market in Akure, Ondo state, Nigeria, and washed with distilled water. They were separately diced into smaller pieces and dried in an

oven at 50^{0}C. The samples were ground to powder, stored in plastic bottles and then kept in refrigerator prior to analyses. Fresh samples were used for Ascorbic acid assay.

Proximate constituents

Proximate analysis was carried out using the standard procedures of the Association of Official Analytical Chemists [12]. Moisture content was obtained by heating the fresh samples to a constant weight in a thermostatically controlled oven at 105 ^{0}C. The ash content was determined by igniting a 0.5 g test sample in a muffle furnace at 550 ^{0}C, the percentage residue weight was expressed as ash content, nitrogen was determined using the Kjedhal method and crude protein was calculated by multiplying the percentage nitrogen by the conversion factor of 6.25. The dried pulverized sample was extracted with petroleum ether (boiling point 40-60 ^{0}C) using a soxhlet apparatus to obtain the crude lipid content while crude fibre content was estimated by consecutive acid and alkali digestion of sample followed by washing, drying, ashing at 600 ^{0}C and calculating the weight of ash free fibre and carbohydrate was calculated by difference. The energy value was calculated from proximate constituent as described by Kanu *et al*., (2009) [13], using the formula:

$$\text{Metabolisable energy (kJ/100g)} = \text{protein} \times 17 + \text{fat} \times 37 + \text{carbohydrate} \times 17$$

Quantification of Ascorbic acid

Ascorbic acid (Vitamin C) was quantified by titrating against phenol indo-2,6-dichlorophenol, DPIP [14]. The fruit samples (0.2 g) were separately homogenized with 40 ml of a buffer solution made up of 1 g/L oxalic acid and 4 g/L sodium acetate anhydrous. This was titrated against a solution containing 295 mg/L DPIP and 100 mg/L sodium bicarbonate. The results were expressed as mg/100 g dry weight.

Quantification of mineral elements

Each of the samples (0.5 g) was accurately weighed separately into crucibles and placed inside a muffle furnace at 550 ^{0}C for 5 hours for ashing. The ash was dissolve with 20 ml of 0.1M HNO_3 solution and made to a final volume of 100 ml with deionized water in volumetric standard flask. The mineral elements were determined by atomic absorption spectrophotometry. The Sodium and Potassium contents were determined using a flame photometer (Jenway PFP7).

Functional properties

The functional properties which include oil absorption capacity, water absorption capacity, least gelation and emulsion capacities were carried out using standard methods [15].

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RESULTS AND DISCUSSION

Table 1 shows the proximate composition of the fruits investigated, moisture content varied between 91.28 % and 93.25 %. The highest moisture content was obtained in cucumber and the lowest in oriental gourd. The moisture content of all four gourd fruits were higher than the reported values for two pumpkin species *C. moschata* and *C. maxima* [16]. All the fruits studied have higher moisture content which is typical for fresh fruits at maturity [39]. Moisture levels have direct bearing on the dry matter content, the higher the moisture, the lower the dry matter yield on drying.

Table 1: Proximate constituents of the gourd fruits (g/100g) on dry weight basis

Parameters (g/100g)	Cucumber	Marrow	Ash gourd	Oriental gourd
Dry matter	6.75 ± 0.02	7.15 ± 0.02	7.85 ± 0.02	8.72 ± 0.02
Moisture cont.	93.25 ± 0.02	92.85 ± 0.02	92.15 ± 0.02	91.28 ± 0.02
Ash content	1.60 ± 0.1	1.20 ± 0.02	1.60 ± 0.04	1.68 ± 0.05
Crude fibre	12.64 ± 0.10	33.56 ± 0.10	33.98 ± 0.02	22.58 ± 010
Crude fat	0.43 ± 0.05	0.60 ± 0.02	0.80 ± 0.05	0.94 ± 0.05
Crude protein	2.46 ± 0.01	2.26 ± 0.02	7.88 ± 0.02	1.87 ± 0.02
Carbohydrate	76.13 ± 0.02	74.20 ± 0.01	47.89 ± 0.01	64.31 ± 0.01
Energy value (kJ/100g)	1351.94	1322.02	977.69	1159.84

The ash content value is lowest in marrow (1.20 g/ 100g) and highest in oriental gourd (1.68 g/100g). The values obtained in this work are higher than what was reported for carrot (1.027 %) and tomatoes (0.508 %) [17]. The ash contents gave an idea of the inorganic (mineral) content of the samples. Samples with high percentages of ash content are expected to have high concentrations of various elements, which are expected to speed up metabolic processes and improve growth and development [18].

The gourd fruits contain high levels of fibre ranging from the 12.64 g/100g in cucumber to 33.98 g/100g in oriental gourd. Fibres have been regarded as a bioactive compound with functional properties and named as nutraceuticals that enhances human physiological performance by preventing or treating diseases and disorders [19]. They undergo fermentation in the digestive tract and accelerate bowel movements, reduce cholesterol synthesis and absorption, increase mineral absorption, improve the anti-oxidative defense system and help to prevent some disorders such as constipation and colorectal cancer [20]. Therefore, the fruits pulps could be processed into food ingredients and incorporated into some other commonly consumed food, like bread, to enhance its dietary fibre and nutrients.

The crude fat contents of the gourds were typically low (less than 1g/100g). Fruits are generally low in fat content and were recommended as part of weight reducing diet. This is an advantage as consumption of high fat diet has been implicated in several health related complications. Thus, the gourd fruits might be suitable for those requiring low fat diet.

The crude protein content is highest in ash gourd (7.88 g/100g) and lowest (1.87 g/100g) in oriental gourd. The protein contents of these fruits is higher than 0.2 % protein reported in bottle gourd and compared favourably with that of fruit pulp of baobab [21]. Protein are essential component of diet needed for survival of animals and human beings. Its basic function is to supply adequate amounts of required amino acids for nutrition [22]. Protein deficiencies causes growth retardation, muscle wasting, edema, abnormal swelling of the belly and collection of fluids in the body [23]. Since an adult male of about 70 kg body weight requires 35 g of protein daily [24], approximately 15g of cucumber, 16g of marrow, 5g of ash gourd and 19g of oriental gourd would be required to provide this minimum daily protein requirement respectively.

The carbohydrate content of these fruits is highest in cucumber (76.13 g/100g) and lowest in ash gourd (47.89 g/100g). Samples with low carbohydrate content might be ideal for diabetic and hypertensive patients requiring low sugar diets. The energy values obtained were as shown in Table 1, cucumber having the highest energy value (1351.94 kJ/100g) while ash gourd has the lowest value (977.69 kJ/100g).

Level of mineral elements in the four gourd fruits were presented in Table 2. The trend of the mineral contents in the gourds follows the order Na > Ca > Fe > Zn > K > Mn, with sodium being the most abundant mineral found in the fruits. Sodium is highest in cucumber (1046.0 mg/kg) and low in oriental gourd (286.0 mg/kg), ash gourd (268.0 mg/kg) and marrow gourd (260.0±0.1). Low sodium diet has been reported to be beneficial in the prevention of high blood pressure [25]. Calcium was also in high amount in the fruits. The level was found to be 99.40 mg/kg in ash gourd, 72.1 mg/kg in marrow and oriental, with cucumber having the least level (11.22 mg/kg). Calcium is required for bone development [26, 27].

Table 2: Levels of some mineral elements in the gourd fruits.

Elements (mg/kg)	Cucumber	Marrow	Ash gourd	Oriental gourd
Na	1046.00 ± 0.01	260.00 ± 0.10	268.00 ± 0.02	286.00 ± 0.01
Ca	11.22 ± 0.10	72.10 ± 0.10	99.40±0.1	72.1±0.02
Fe	5.60 ± 0.02	3.20 ± 0.02	3.20 ± 0.02	6.50 ± 0.01
Zn	2.00 ± 0.01	2.20 ± 0.02	1.30 ± 0.01	1.80 ± 0.02
K	2.00 ± 0.01	0.30 ± 0.02	1.10 ± 0.05	1.40 ± 0.01
Mn	1.10 ± 0.01	1.00 ± 0.02	1.10 ± 0.01	1.70 ± 0.02

Mean ± Std. deviation of triplicate determinations.

Iron was detected in all samples with highest concentration obtained in oriental gourd (6.5 mg/kg), and least concentrations in marrow and ash gourd (3.2 mg/kg). The iron contents of these gourd fruits are much higher than those obtained from carrot (1.841 mg/kg) and tomatoes (0.455 mg/kg) [17]. Iron deficiency causes anemia, reduced immune function and low resistance to infection, development delays, irreversible work performances and adverse frequency outcomes [28, 29]. The level of iron in these fruits could contribute to dietary needs

of human. Zinc is required for the proper functioning of the reproductive system [30], it was present in all the gourd fruits with marrow having the highest concentration of 2.2 mg/kg and ash gourd, the least (1.3 mg/kg). Zinc is important in diet for many proteins and enzymes [31].

The levels of potassium ranged from 2.0 mg/kg in cucumber to 0.3 mg/kg in marrow gourd. Potassium aids in fluid balance and nerve impulse transmission within the cells [32]. The highest concentration of manganese was found in oriental gourd (1.7 mg/kg) and the least concentration in marrow gourd (1.0 mg/kg). Manganese is essential for normal functioning of the nerve, heartbeat, central nervous system and a good anti-oxidant. It is a micronutrient for bone formation and aids enzymatic actions [33].

Figure 1 indicated the level of Vitamin C in the fruit samples. Vitamin C is a highly effective antioxidant and a very small daily intake of this vitamin for an adult is required to avoid scurvy. Even in small amounts it can protect indispensable molecules in the body, such as proteins, lipids (fats), carbohydrates, and nucleic acids (DNA and RNA) from damage by free radicals and reactive oxygen species that can be generated during normal metabolism as well as through exposure to toxins and pollutants [34]. In this work, ash gourd has the highest amount of Vitamin C (60.00 mg/100g) while cucumber has the lowest value (21.82 mg/100g) among the four gourd fruits analysed. These gourd fruits have higher amount of Vitamin C than mango (11.0 mg/100g), lemon (26.2 mg/100g), orange (27.7 mg/100g) and apple (21.5 mg/100g) [35].

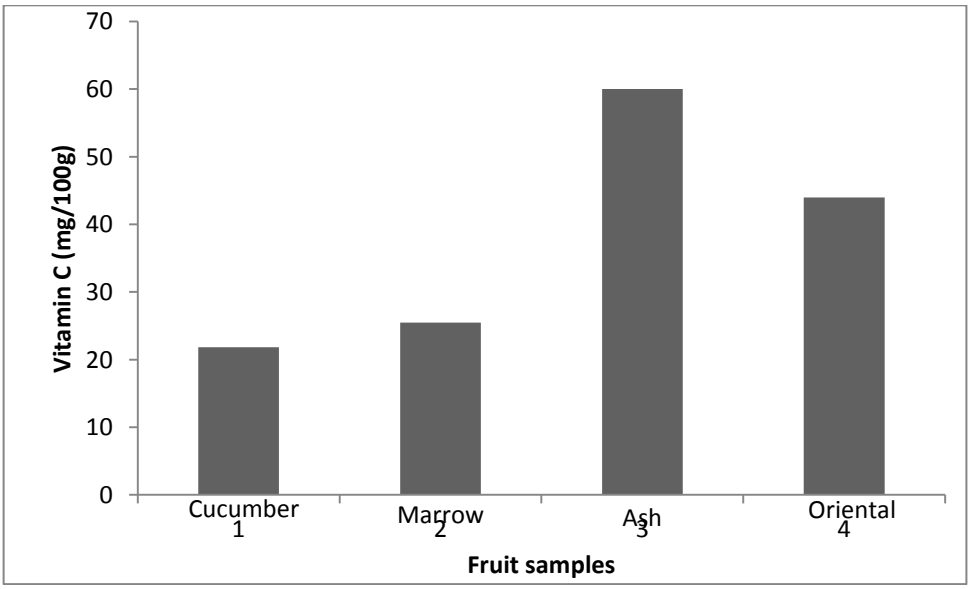

Figure 1: Level of vitamin C in the four Gourd fruits

The anti-nutrients analysis conducted on the four gourd fruits confirms the presence of oxalate, phytates and tannins over different concentrations.

Levels of the anti-nutrients in the gourd fruits were as reported in Table 3. The amount of oxalates and phytates obtained for the samples are low, with highest value of oxalates obtained in ash gourd (3.303 mg/100g) and highest phytate content in cucumber (4.07

mg/100g). Oxalate is a concern due to its negative effect on mineral availability. High oxalate diet increase can increase the risk of calcium absorption and has been implicated as a source of kidney stones [18]. The phytate and oxalate of these gourd fruits pose no danger in diet, as Siddhuraju and Becker (2001) [36] reported a safe limit of 4 - 9 mg/100g for phytates and oxalate in diet and may not inhibit mineral inhibition in the body when consumed. As reported in the Table 3, for all gourds fruits, tannin is highest in ash gourd (10.40 mg/l) and lowest in marrow (6.90 mg/l). Although tannins are known to inhibit the activities of digestive enzymes and lower protein digestibility, it belongs to a class of polyphenols which has been reported to act as antioxidants, thus preventing oxidative stress that causes coronary heart diseases, cancers and inflammation [37]. The gourd fruits are therefore likely to have antioxidant properties.

Table 3: Level of some anti-nutrients in the gourd fruits

Properties	Cucumber	Marrow	Ash gourd	Oriental gourd
Oxalate (mg/l)	0.901±0.01	0.826±0.02	3.303±0.01	0.405±0.02
Phytate (mg/100g)	4.07±0.02	2.47±0.01	0.45±0.01	1.95±0.01
Tannin (mg/l)	8.01±0.04	6.90±0.02	10.4±0.02	8.42±0.01

Mean ± Std. deviation of triplicate determinations

The functional properties of the gourd fruits were reported in Table 4. Oil absorption capacity ranged between 4.56 (in cucumber) to 9.4 oil/g (in marrow). The values compared favourably with 5.28 oil/g reported for *Curcuma longa* (Rhizome plant) [38]. Least gelation value ranged between 0.60 (in oriental) to 0.80 g (in cucumber). Emulsion capacity (%) of cucumber, marrow, ash and oriental gourd are 2.68, 1.85, 1.44 and 1.28 % respectively. Foaming capacity (%) ranged between 0.030 (in marrow) and 0.085 % (in cucumber). Water absorption capacity, linked with the quality of protein content and polysaccharide, was highest in cucumber (4.40 %) and lowest in oriental gourd (1.20 %).

Table 4: Functional properties analysis of the four gourd fruit samples

Properties	Cucumber	Marrow	Ash gourd	Oriental gourd
Oil absorption (oil/g)	4.56 ± 0.02	9.40±0.02	6.96±0.1	7.63±0.1
Least gelation (g)	0.8±0.1	0.6±0.2	0.8±0.2	0.6±0.01
Emulsion Capacity (%)	2.68±0.01	1.85±0.1	1.44±0.1	1.28±0.2
Foaming Capacity (%)	0.085±0.1	0.03±0.1	0.08±0.1	0.07±0.1
Water absorption Capacity	4.40±0.2	2.10±0.01	3.10±0.01	1.20±0.1

Mean ± Std. deviation of triplicate determinations

CONCLUSION

The gourd fruits contained high amounts of dietary essentials and antioxidants with low levels of fat and anti-nutrients. They are recommended for regular consumption and the cultivation should be encouraged.

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REFERENCES

[1] Liu R. America J Clin Nutr 2003; 78: 517S–520S.
[2] Arts I and Hollman P. American J Clin Nutr 2005; 81: 317S–325S.
[3] Erdman J, Balentine D, Arab L, Beecher G, Dwyer JT, Folts J and Burrowes J. J Nutr 2007; 137: 718S–737S.
[4] Henrıquez M, Almonacid S, Lutz M, Simpson R and Valdenegro M. CyTA. J Food 2012; 24: 1-9.
[5] WHO 2003. Diet, nutrition and the prevention of chronic diseases. Report of a FAO/WHO Expert Consultation. Geneva, World Health Organization, 2003 (WHO Technical Report Series, No. 916).
[6] FAO 1997. First Report of the State of the World's Plant Genetic Resources for Food and Agriculture http://apps3.fao.org/wiews/docs/SWRFULL2.PDF.
[7] Tyagi N, Ganesh N, Sharma VH. Int Res J Pharm 2012; 3(3): 1-4.
[8] Bello MO, Akindele TL, Adeoye DO and Oladimeji AO. Int J Basic Appl Sci 2011; 11(6): 9-14.
[9] Shrivastava A and Roy S. J Med Pl Stud 2013; 1(4):16- 20.
[10] Tindal HD. Vegetable in the tropics. Pub. Macmillian Press London. 1963; pp 146-196.
[11] Kouonon LC, Anne-Laure J, Arsene IZ, Pierre B, Jean-Pierre B and Yao D. Annals Bot 2009; 104: 1129-1139.
[12] AOAC. Official Methods of Analysis 1990; 15th Edition, Washington, D.C., USA.
[13] Kanu PJ, Sandy EH, Kandeh J, Bahsoon JZ and Huiming Z. Pak J Nutr 2009; 8: 1335-1343.
[14] Papuc C, Pop A, Serban M, Metode Analitice in Biochimia Veterinara; Editura Printech, Bucharest, Romania, 2001; pp. 167-169.
[15] AOAC. Official methods of analysis of the Association of official Analytical Chemists 1995; 10th Edition VOL.II Washington, DC, U.S.A.
[16] Fedha MS, Mwasaru MA, Njoroge CK, Ojijo NO and Ouma GO. Agric Biol J North Am 2010; 16: 1299-1302.
[17] Motegaonkar MB and Salunke SD. Res J Rec Sci 2012; 1(4): 60-63.
[18] Bello MO, Falade OS, Adewusi SR, Olawore NO. Afr J Biotech 2008; 7: 3972-3979.
[19] Wildman REC. Nutraceuticals: A brief review of historical and teleological aspects. In: Wildman REC (ed), Handbook of nutraceuticals and functional foods. CRC Press, Florida 2001; pp 2 -12.
[20] Anderson JW, Baird P, Davis RH Jr, Ferreri S, Knudtson M, Koraym A, Waters V and Williams CL. Nutr Rev 2009; 67(4): 188-205.
[21] Osman MA. Plant Foods Hum Nutr 2004; 59: 29-33.
[22] Pugalenthal M, Vadivel V, Gurumoorthi P and Janardhanam K. Trop Subtrop Agroecosyst 2004; 4: 107-123.
[23] Perkins-veazie PM, Collins JK and Robert W. J Hort Sci 2005; 39: 830.
[24] Fagbemi TN and Oshodi AA. Nig Food J 1991; 9: 26-32.
[25] Lichtenstein AH, Appel LJ, Brands M, Carnethon M, Daniels S, Franch HA, etal. Arterioscl Thromb Vasc Biol 2006; 26: 2186-2191.
[26] Nelson DL and Cox MM. Lehninger Principle of Biochemistry 2005; 4th edition. WH Freeman.

[27] Helena E. J Health Fit 2008; 42: 48-102.
[28] Cooper MJ, Cockell KA and Labbe MR. Can J Diet Pract Res 2000; 67(3): 130-138.
[29] Naghii MR and Fouladi AL. Nutr Health 2006; 18(2): 133-139.
[30] Hambidge M. J Nutr 2006; 130: 1344S-1349S.
[31] Lippard SJ and Jeremy MB. Principles of Bioinorganic Chemistry. Mill Valley, CA University science Books 1994; pp 411.
[32] Whitney E. and Rolfe S.R. (2005). Understanding Nutrition. Thompson Learning Inc. New York, USA.
[33] Bakhru HK. Vitamins that heal natural immunity for better health. Orient paperbacks, New Delhi, India 2002.
[34] Caunii A, Rodica C, Andrea MZ, Elena T, Camelia G. Seria Ştiinţele Vieţiif 2010; 20(2): 45-48.
[35] Esch JR, Friend JR and Kariuki JK. J Electrochem Sci 2010; 5: 1464-1474.
[36] Siddhuraja and Beekers. 2001. http://www.unix.oit.umass.edu/mcclemen/581minerals.html
[37] Bello MO and Falade OS. Ife J Sci 2009; 10(1): 33-39.
[38] Olumayede EG. J Chem Soc Nigeria 2006; 31: 58-62.
[39] Umoh IB. Commonly used fruits in Nigeria. In: nutritional quality of plants foods. (Eds Osagie AU and Eka OU) Post harvest Research Unit, University of Benin, Nigeria 1998.