Available online at http://ajol.info/index.php/ijbcs

Int. J. Biol. Chem. Sci. 4(4): 1225-1233, August 2010

International Journal of Biological and Chemical Sciences

ISSN 1991-8631

Original Paper

http://indexmedicus.afro.who.int

Evaluation of the chemical composition of *Dacryodes edulis* (G. Don) seeds

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ABSTRACT

The Chemical composition and the effect of heat treatment on seeds of *Dacryodes edulis* (G.Don) were studied. In the proximate analysis, the moisture (42.63 - 48.05%) and carbohydrate (35.94 - 38.35%) values were the highest. The values of the tannins (21.80 - 25.77%), alkaloids (10.40 - 10.60%) and saponins (5.92 - 6.72%) were higher than the other phytochemicals measured. Potassium (9.0 ± 0.005 - 11.00 ± 0.10 mg/100g), calcium (2.23 ± 0.006 - 5.88 ± 0.005 mg/100g) and phosphorus, (1.09 ±0.05 - 2.01 ± 0.5 mg/100g) were the predominant elements present in the seeds. Sodium, magnesium, selenium, zinc and iron were present in appreciable amounts but manganese was not detected. The ascorbic acid and vitamin A contents were (18.79 ± 0.81 - 25.76 ± 1.51 mg/100 g) and (1.12 ±0.04 - 1.64 ± 0.01 mg/100g) respectively. The results of this study showed that *D. edulis* seeds are potential source of essential nutrients to man and animal when properly processed.

Keywords: Food, phytochemical, chemoprotective, antioxidant, cofactor, deficiency, radical.

INTRODUCTION

Dacryodes edulis (G.Don) (African pear) belongs to the family Burseracea and has many medicinal and nutritional uses (Burkill, 1985). *D. edulis* is consumed traditionally in Nigeria either raw, roasted or boiled in hot water. It is eaten alone, or used in garnishing fresh maize (Arisa and Lazarus, 2008). It is widely found in many sub-Saharan countries such as Nigeria, Liberia, Cameroon and Zaire (Boungou, et al., 1991), and it may be available for up to 6 months of the year (Eka, 1977; Lam, 1985; Omoti and Okiy, 1987). The nutritional value of the fruit lies in its edible mesocarp which is rich in fatty acids, amino acids and ascorbic acid (Omoti and Okiy, 1987; Kapseu and Tchiegang, 1996; Leakey, 1999). The fruits could also provide vegetable oils for the food, pharmaceutical and cosmetic industries (Fonteh, 1998; Kapseu, et al., 2002; Mbofung, et al., 2002; Kalenda, et al., 2002). According to Gunstone and Norris (1982), the seeds of the fruit contain up to 18 - 70% oil. This makes the seed to compare favorably with other oil bearing seeds such as palm kernel (40%), peanuts (49%), cotton seed (36%), and soybean (20%) (Abraham and Hron, 1992; Arisa and Lazarus, 2008). The consumption pattern usually involves discarding the seeds after the consumption of the mesocarp or pulp (Ajayi and Oderinde, 2002). Obasi and Okolie (1993) in their study showed that the seeds can be used as food supplement. Traditionally, *D. edulis* are gathered for household use or for sale in local markets, but increasingly, some enter national and international trade in significant quantities (Awono, et al., 2002). As a result of this, the fruits may provide means to reduce poverty and enhance food security. Research on the use and commercialization of indigenous fruits shows that they can effectively raise the income of the poor within sustainable land use systems (Schreckenberg, et al., 2002). A major problem faced by *D. edulis* is that of possible extinction due to large-scale deforestation of the tropical forests. This is because the species has not been widely cultivated in plantations. The existing stands are mainly from traditional agroforestry systems (Leakey, 2001; Akachuku, 2006).

This study will evaluate the nutritional composition of *D. edulis* seeds and the effect of heat treatment. The results are expected to expose the nutritional potentials and thereby increase the usage in human and animal food supplementation in the future.

MATERIALS AND METHODS

Plant sample collection and preparation

The ripe fruits of *D. edulis* used for the study were obtained from Ihiagwa market in Owerri-West LGA, Imo-State Nigeria. They were identified by Dr. A.C. Ibe, a plant taxonomist in the Department of Crop Science, Federal University of Technology Owerri, Nigeria. The ripe fruits were washed thoroughly and then divided into two groups. The pulp of one group was removed raw and the other group was boiled before removing the pulp. The seeds were allowed to dry at room temperature. The dried seeds were ground to fine powder with an electric grinder, packaged in air-tight glass jar and stored at room temperature until analysis was carried out.

Phytochemical test

Phytochemical test for the quantitative determination of alkaloids, flavonoids, tannins, saponnis, cyanogenic glycosides were done by methods described by Harborne (1973) and Trease and Evans (1989).

Proximate analysis

The proximate composition of the seeds for carbohydrate, ash, and moisture were determined by methods described by AOAC (1995). Crude protein, fibre and fat content were determined by methods described by Pearson (1976). Total ash content was determined by furnace incarnation using the method of James (1995). All determinations were done in triplicates.

Vitamin and mineral analysis

Vitamins A and C were determined by High Performance Liquid Chromatography (HPLC, model CO30). Sodium and potassium were determined by digital flame photometer (model 2655-00). The other minerals; calcium (Ca), phosphorous (P), magnesium (Mg), manganese (Mn), iron (Fe), zinc (Zn) and selenium (Se) were determined using the atomic absorption spectrophotometer (AAS-model-Alpha 4) as described by AOAC (1995).

Statistical analysis

The results obtained are presented as mean ± standard deviation and some as simple percentages. Microsoft Excel package was used for the analysis of variance (ANOVA) and for the test of significance between means ($p<0.05$).

RESULTS

The results of the proximate composition of the raw and heat treated *D.*

edulis seeds are shown in Table 1. Relative to the raw seeds, the heat treatment decreased ($p < 0.05$) the moisture content from 48.05% to 42.63%. Similarly the ash, ether extract and carbohydrate decreased ($p<0.05$) after the heat treatment. However, the crude protein and crude fibre contents increased ($p<0.05$) after heat treatment.

The results of the phytochemical analysis are shown in Table 2. The phytochemical content showed that alkaloids (10.40 - 10.60%) had the highest value and cyanogenic glycosides (0.42 - 1.71%) had the lowest. The alkaloids, flavonoids, saponins, cyanogenic glycosides and tannins decreased ($p<0.05$) after the heat treatment.

The results of the mineral contents of the raw and heat treated seeds are shown in Table 3. From the result, potassium (9.0 ± 0.005 - 11.00 ± 0.10 mg/100g) had the highest value followed by calcium (2.23 ± 0.006 - 5.88 ± 0.005mg/100g) and phosphorus (1.09 ± 0.05 - 2.01 ± 0.5 mg/100g). Zinc (0.011± 0.04 – 0.022 ± 0.05mg/100g) and iron (0.003 ± 0.01- 0.012 ± 0.03mg/100g) had the lowest values. Minerals such as sodium, magnesium, selenium were present in appreciable amounts but manganese was not detected. The concentration of the minerals decreased ($p<0.05$) after the heat treatment.

The results of the vitamin contents are shown in Table 4. The ascorbic acid (18.79 ± 0.81 - 25.76 ± 1.51 mg/100 g) and the vitamin A (1.12 ± 0.04 - 1.64 ± 0.01mg/100g) values of the seeds decreased ($p<0.05$) after the heat treatment.

Table 1: Proximate composition (%) of seeds of *Dacryodes edulis.*

Nutrients	Raw	Treated
Moisture	48.05 ± 0.50^{a}	42.63 ± 0.60^{b}
Ash	1.65 ± 0.05^{a}	1.35 ± 0.05^{b}
Crude protein	4.94 ± 0.04^{a}	5.71 ± 0.51^{b}
Ether extract	9.74 ± 0.09^{a}	4.63 ± 0.06^{b}
Crude fibre	2.69 ± 0.42^{a}	4.33 ± 0.06^{b}
Carbohydrate	38.35 ± 1.01^{a}	35.94 ± 0.33^{b}

Values are means ± standard deviation of triplicate determinations. Means having different superscript in the same row are significantly different ($p<0.05$).

Table 2: Phytochemical composition (%) of seeds of *Dacryodes edulis.*

Phytochemical	Raw	Treated
Alkaloids	10.60 ± 0.01^{a}	10.40 ± 0.05^{b}
Flavonoids	4.00 ± 0.10^{a}	3.00 ± 0.05^{b}
Saponins	6.72 ± 0.24^{a}	5.92 ± 0.05^{b}
Cyanogenic glycosides	1.71 ± 0.04^{a}	0.42 ± 0.01^{b}
Tannins	25.77 ± 0.32^{a}	21.80 ± 0.12^{b}

Values are means ± standard deviation of triplicate determinations. Means having different superscript in the same row are significantly different ($p<0.05$).

Table 3: Mineral composition (mg/100g) of seeds of *Dacryodes edulis.*

Minerals	Raw	Treated
Calcium (Ca)	5.879 ± 0.03[a]	2.225 ± 0.01[b]
Phosphorous (P)	2.012 ± 0.50[a]	1.088 ± 0.05[b]
Magnesium (Mg)	0.295 ± 0.03[a]	0.239 ± 0.01[b]
Manganese (Mn)	ND	ND
Iron (Fe)	0.012 ± 0.03[a]	0.003 ± 0.01[b]
Zinc (Zn)	0.022 ± 0.05[a]	0.011 ± 0.04[b]
Selenium (Se)	0.181 ± 0.05[a]	0.101 ± 0.04[b]
Potassium (K)	11.00 ± 0.10[a]	9.00 ± 0.05[b]
Sodium (Na)	0.800 ± 0.05[a]	0.500 ± 0.10[b]

Values are means ± standard deviation of triplicate determinations. Means having different superscript in the same row are significantly different ($p<0.05$). ND= not detected.

Table 4: The vitamin content (mg/100g) of seeds of *Dacryodes edulis.*

Vitamin	Raw	Treated
Vitamin A (mg/100g)	1.13 ± 0.04[a]	1.64 ± 0.01[b]
Ascorbate (mg/100g)	25.76 ± 1.51[a]	18.79 ± 0.81[b]

Values are means ± standard deviation of triplicate determinations. Means having different superscript in the same row are significantly different ($p<0.05$).

DISCUSSION

The high moisture content of *D. edulis* seeds suggests that it would have poor keeping quality. This also indicates that for the seeds to be stored, they have to be dried for longer time in order to reduce the moisture content. Low moisture content is a desirable quality in food processing and preservation because low moisture content reduces food spoilage (Omotoso and Adedire, 2007). The moisture value is higher than what was reported for seeds of *Irvingia gabonensis* (12.80%) and *Irvingia wombolu* (11.90%) (Joseph, 1995; Tchoundjeu et al., 2005), which are used as food condiments in Nigeria and other West African countries. The moisture content is also higher than the value (4.83 – 5.5%) reported by Obasi et al. (2007) for Almond nut (*Terminalia catappa*), another neglected nut which has been shown to be a good source of nutrient (Kochhar, 1986). The crude protein content of the raw and heat treated seeds are lower than the values reported by Obasi et al. (1993). The increase ($p<0.05$) in the value of protein in the heat treated seeds could be attributed to denaturation (Bankhead et al., 1978; Ubbaonu and Nwosu, 2002; Giami et al., 1999). Also heat processing, especially moist heat treatment has been reported to improve the digestibility of proteins by opening up of the protein structure through denaturation (Abbey and Berezi, 1988; Anwa et al., 2007). Proteins are for growth and repair of tissues and also as an alternative energy source in the absence of carbohydrate and fats.

Our results suggest that *D. edulis* seeds are good source of carbohydrate with content of 38.35% and 35.94% for the raw and treated seeds respectively. This result agrees with the work of Mbofung et al. (2002). When compared with the neglected seeds of some plants such as *Lablab purpureus* (24.48±0.32%) and *Mucuna utilis*

(26.89±0.39%) the carbohydrate content is higher but slightly lower than 40.56±1.20% for *Leucaena leucocephala* (Alabi and Alausa, 2006). The decrease in the ether extract from 9.74% in the raw seeds to 4.63% in the heat treated could be due to leaching occasioned by boiling (Bankhead et al., 1978). The ether extract content is within 4.3±0.2% and 7.5±0.3% obtained for *L. purpureus* and *M. utilis* (Alabi and Alausa, 2006). The decrease ($p<0.05$) in the ash content could also be attributed to the leaching effect resulting from boiling. Our result showed that the crude fibre increased ($p<0.05$) after the heat treatment. The increased temperature of boiling which may have resulted into the leaching and denaturing of other content resulted in the increased value of crude fibre. High crude fibre in diet is known to enhance the digestibility, decrease the blood cholesterol and reduce the risk of large bowel cancers (Anderson et al., 1995; Salvin et al., 1997). Carbohydrates and lipids are the major energy sources in human and animal diets.

The results of the phytochemical constituents are shown in Table 2. Our results showed that the heat treatment decreased ($p<0.05$) all the phytochemicals in *D. edulis*. Phytochemicals in freshly harvested plant foods may be destroyed or removed by processing techniques, such as cooking. For this reason, processed foods are likely to contain fewer phytochemicals and may thus be less beneficial than unprocessed foods. Absence or deficiency of phytochemicals in processed foods may contribute to increased risk of preventable diseases (Liu, 2004; Rao and Rao, 2007). Tannins have the highest content of 25.77% and 21.80% for raw and treated seeds respectively. Tannins are polyphenols and have been reported to hasten wound healing and inflamed mucous membranes (Okwu, 2004). The presence of high level of tannins could confer on the user's chemoprotective benefits (Enechi and Odonwodu, 2003). Tannins have also shown potential for antiviral, antibacterial and antiparasitic effects. Tannins have the potential for decreasing the digestibility and palatability of proteins because they can form insoluble complexes with them (Osagie, 1998).

The alkaloids content of the seeds were relatively low, with 10.60% and 10.40% for alkaloid in raw and treated seeds respectively. Alkaloids are employed for prophylaxis of cardiac arrhythmias and for the treatment of arterial fibrillation (Adesegun and Cooker, 2001). Saponins possess a carbohydrate moiety attached to a triterpenoid or a steroidal aglycone (Sridhar and Bhat, 2007). Saponins are natural antibiotics which fight infections and microbial invasions (Okwu, 2004; Okwu and Emenike, 2006). Saponins have hypocholestrolemic properties which could give some chemoprotection against heart diseases to human consumers (Price et al., 1987). The flavonoids content were relatively low (4.00% and 3.00%). Flavonoids are associated with free radical scavenging activity (Parke and Ioanides, 1994). The presence of flavonoids in *D. edulis* may confer anti-carcinogenic potential to consumers. The cyanogenic glycosides content are very low and are significantly ($p<0.05$) affected by the heat treatment. The concentration is within the permissible level (Enechi and Odonwodu, 2003: Abu et al., 2005) and below the toxic levels given by World Health Organization (Munro and Bassir, 1969).

Our results also showed that the values of all the minerals decreased ($p< 0.05$) after the heat treatment. This decrease may be as a result of leaching (Bankhead et al., 1978) and bond breaking effects (Oliviera and Lamb, 1998; Giami et al., 1999). The most abundant minerals in the seeds of *D. edulis* are potassium (9.0 ± 0.005 - 11.00 ± 0.10 mg/100g), calcium (2.23 ± 0.006 - 5.88 ±

0.005 mg/100g) and phosphorus (1.09 ±0.05 - 2.01 ± 0.5 mg/100g) for raw and treated seed respectively. These values are very low when compared to that obtained from seeds of *L. purpureus, M. utilis* and *L. leucocephala* (Alabi and Alausa, 2006). Potassium is the principal cation of intracellular fluid and it is involved in protein synthesis. Phosphorus is required for the synthesis of nucleic acids, some proteins and a constituent of bones and enamel, and a lack of phosphorus in diet causes rickets (Fliedner and Teichman, 2000) and osteoporosis (Okwu and Emenike, 2007). Calcium is also an important constituent of bone and enamel. It activates ATPase during muscular contraction and it is important for blood coagulation (Okaka and Okaka 2001). Minerals such as sodium, magnesium, selenium, zinc, and iron were present in appreciable amount. Manganese was not detected. Potassium plays key role along with sodium in maintaining electrical potential across cell membranes and in the conduction of nerve impulses (Taylor, 2003). Sodium is associated with the regulation of acid-base equilibrium, protection against dehydration and maintenance of osmotic pressure in the body. It plays a role in the normal irritability of muscles and cell permeability (Schwart, 1975). Selenium and zinc are cofactors for glutathione peroxidase and alcohol dehydrogenase. Iron is a component of haemoglobin and ferrodoxin and also a cofactor in catalase and peroxidase enzymes (Taylor, 2003).

The results of the vitamin contents of the seeds showed that the seeds have high levels of ascorbic acid and appreciable amount of vitamin A. The ascorbic acid content of *D. edulis* seeds is higher than the seeds of *Adasonia digitata* (6.71 ± 0.04 mg/100 g), *P. africana* (0.92 ± 0.02 mg/100 g) and groundnut (9.8 mg/100 g) (Nkafamiya et al., 2007a). Vitamin A concentration is also higher in *D. edulis* seeds when compared with seeds *of P. africana* (0.89 ± 0.01 μg/100 g) but lower than that of *Adasonia digitata* (5.26 ± 0.03 μg/100 g) (Barminas et al., 1998; Nkafamiya et al., 2007). These seeds serve as foods and condiment in Nigerian diet. Ascorbic acid has antioxidant properties and can reduce the effect of tannin on iron which makes iron not available for absorption. It is also required in the hydroxylation of proline residues during collagen synthesis. The vitamin A content of the seeds, though low, can help to alleviate symptoms of vitamin A deficiency (Nkafamiya et al., 2007b). The concentrations of these vitamins can contribute to daily vitamin needs (Murray, 1998; Trumbo et al., 2004).

This study has shown that the seeds of *D. edulis* are good sources of phytochemicals, minerals and other essential nutrients. Therefore, proper seed processing could make it acceptable as a substitute for commonly used condiments and could be used in human and livestock feed formulations.

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