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Minerals and Anti-Nutrients in Two Varieties of African Pear (*Dacryodes edulis*)

Ibanga O. Isaac and Okon D. Ekpa
Department of Pure and Applied Chemistry, University of Calabar, P.M.B 1115, Calabar, Nigeria

Abstract: The biochemical composition of two varieties of African Pear (*Dacryodes edulis*)-*D. e. var. edulis* and *D. e. var. parvicarpa* have been determined using standard methods. Proximate moisture content was higher *in D.e. var. parvicarpa* (61.40%) than in *D. e. var. edulis* (46.59%). This difference implies *D. e. var. edulis* with low moisture content is of quality and is more stable compared *D. e. var. parvicarpa*. The measured anti-nutrient concentrations in the two varieties of *Dacryodes edulis* were low and fall within the acceptable levels based on National Agency for Food and Drugs Administration and Control (NAFDAC) in Nigeria and WHO. The concentrations of essential elements in both varieties were high such that phosphorus was 4446.04 mg kg^{-1} in *D. e. var. edulis* and 3674.07 mg kg^{-1} in *D. e. var. parvicarp*a. Cu concentration of 4.08 mg kg^{-1} in *D. e. var. edulis* and 3.66 mg kg^{-1} in *D. e. var. parvicarpa* was the lowest among the mineral elements determined. On the other hand, Cd and Pb were completely below detection level and hence were not detected. The variations in the mineral concentrations were attributed to the different rates at which these elements are taken up from the soil by the plants and subsequent incorporation into the oil. The percentage of oil content (68.29%) in *D. e. var. edulis* was higher than that of *D. e. var. parvicarpa* of 54.68%. This implies vegetable oils can be extracted in commercial quantity from *D. e. var. edulis*.

Key words: African pear, mineral elements, anti-nutrients, oil, biochemical composition

INTRODUCTION

The contribution of fruits, seeds and vegetable of some plants in Nigeria to minerals, vitamins and amino acids in human nutrition is limited due to the presence of anti-nutrients which render some of the essential nutrients and protein unavailable for human nutrition. There is a geometric increase in demand for vegetable oils in Nigeria for both domestic and industrial purposes. Ikhuoria *et al.* (2008) attributed increasing demand for vegetable oils and fats in Nigeria, for both domestic and industrial purposes, in recent times, to the nutritional needs of the teaming population and the increasing number of industries that require oils and fats as their primary raw material. It is therefore vital to determine the nutritive values of some of these products from tropical plants in Nigeria, since some of these products have been widely accepted as a dietary constituent among peasants in Nigeria and other African countries and as a source of vegetable oils. Oyolu (1980) stated that vegetables will continue to remain the primary source of proteins, minerals and vitamins in African countries.

African pear (*Dacryodes edulis*) is classified by most agriculturists as underutilized tree crop because the mineral composition of this plant has not been fully investigated. As a traditional food plant in Nigeria, it has a potential to improve nutrition, boost food security and support sustainable land care. Ikuhoria *et al.* (2008) stated that Nigeria being tropical country, has wide variations in climatic conditions and therefore has a wide variety of domestic plants that produces oil, but lack information on the composition and utilization of the many and varied oil seeds. Oil composition depends on fruit origin and ripening conditions (Gadet *et al.*, 2005) as well as the variety. *D. edulis* is consumed traditionally in Nigeria raw, roasted or boiled in hot water and is eaten alone, or used in garnishing fresh maize (Arisa and Lazarus, 2008). It is sometimes used as butter to eat bread. The leaves, bark, stem and roots of African pear are used as local medicine against diseases (Jirovetz *et al.*, 2003; Annabelle *et al.*, 2004; Ikhuoria and Maliki, 2007).

Previous studies have shown that oil of fruits of *D. edulis* is a rich source of amino acids and triglycericides (triacylglycerols) with saturated fatty acid content of 50.85% and an unsaturated fatty and content of 49.14% (Lam *et al.*, 2006). Lam (1985) and Omoti and Okiy (1987) have long proposed African pear (*D. edulis*) oil as a source of vegetable oil. The seeds of African pear have been found to contain reasonable amount of oil. The composition of this oil shows that it has both domestic and industrial potentials (Gunstone and Norris, 1982; Arisa and Lazarus, 2008).

Corresponding Author: Ibanga O. Isaac, Department of Pure and Applied Chemistry, University of Calabar, P.M.B 1115, Calabar, Nigeria

The preferential habitat of *D. edulis* is shady, humid tropical forest like Nigeria. It is also found in other African countries like Cameroon, Sierra Leone, Uganda, Malaysia, Liberia and Zaire. There are two varieties of *Dacryodes edulis* in Nigeria-*D. e. var.* edulis and *D. e. var. parvicarpa*. The fruit of *D. e. var. edulis* is larger and the three has stout, ascending branches. *D. e. var. parvicarpa* has smaller fruit and slender, dropping branches.

Although, the consumption of *D. edulis* fruit has been widespread in Nigeria, particularly in the south eastern states of the country, the mineral and anti-nutrient composition of different varieties of this fruit has not been thoroughly investigated. It has also been proposed by some authors that the fruit can serve as a source of vegetable oil, but the variety in which oil can be extracted in commercial quantity has not been investigated. This study is therefore aimed at determining the oil content, anti-nutrients and minerals composition of the two varieties of *Dacryodes edulis* grown in Nigeria. This will help boost food security and improve nutrition, as well as providing information on food chemistry of the two varieties of *D. edulis* oil.

MATERIALS AND METHODS

The method of acquisition and handling of materials is very significant in any research, as this to a greater extent including other factors determines the accuracy of the result obtained thereof (Ekpa and Isaac, 2008). The two varieties of African pear-*D. e. var. edulis* and *D. e. var. parvicarpa* were purchased at Uyo Main Market, along Etuk Street, Uyo, Akwa Ibom State-Nigeria. All the reagents and other materials were of analytical grade. Distilled water was used throughout the whole analytical procedure.

Preparation of the samples for oil extraction, proximate analysis, minerals and anti-nutrients composition: The ripe fruits of *D. e. var edulis* and *D. e. var. parvicarpa* were washed thoroughly with distilled water and split open with a sharp knife to remove the seed from the pulp. The prepared pulp samples were divided into two each, one part for proximate analysis and the other for anti-nutrients, elemental composition and oil content evaluation. For the determination of the latter, the pulp samples were dried in a Gallenkamp hot air oven model OV 160 for 48 h. The dried samples were milled with corona traditional grain mill REF 121 (100 μm mesh size). One hundred gram each of the milled sample were measured and extracted separately using petroleum ether (60-80°C) in a soxhlet extractor. The oil was concentrated by heating in the oven at 60-80°C to ensure complete evaporation of the solvent and latter cooled in desiccator. The percentage oil content for each variety was estimated using the expression:

$$\text{Oil content}(\%) = \frac{\text{Weight of oil extracted}}{\text{Weight of sample}} \times \frac{100}{1} \quad (1)$$

Proximate composition analysis: Proximate compositions for nutrients were determined using the Onwuka (2005) method. The moisture content of the pulp samples were determined using indirect distillation method employing drying ovens. This was done by drying the samples to a constant weight at 60°C in a vacuum oven and moisture content evaluated following the relationship in Onwuka (2005). Protein was determined using Kjeldahl method and a conversion factor of 6.25. Ash content was determined by ignition in a muffle furnace for 4 h at 525°C. Fibre content for each variety was estimated from the loss in weight of the crucible and its content on ignition. Carbohydrate on the other hand was determined when the sum of the percentages of moisture, ash, crude protein, ether extracts and crude fibre were subtracted from 100. While the calorific values of the samples were calculated by multiplying the value of the crude protein, lipid and carbohydrate by 4, 9, 4 Kcal, respectively and taking the sum of their product.

Anti-nutrient analysis: Anti-nutrients in *D. e. var. edulis* and *D. e. var. parvicarpa*-hydrogen cyanide, oxalate, phytate and tannins were determined using standard methods. Hydrogen cyanide, phytate, oxalate and tannins were determined using Onwuka (2005) method.

Elemental composition analysis: The mineral elements-Ca, Na, K, P, Cu, Zn, Cd, Pb and Fe from the two samples were determined based on Onwuka (2005) method using a unicam atomic absorption spectrophotometer.

RESULTS AND DISCUSSION

Proximate analysis: Moisture content of food is of great importance to every food processor as a number of biochemical reactions and physiological changes in food depend very much on the moisture content (Onwuka, 2005). The moisture content of the two varieties of African pear was significantly high and this could imply short shelf life. The highest moisture content of 61.40% was observed in *D. e. var. parvicarpa* (Table 1). The moisture content of *D. e. var. edulis* of 46.59% compares well with other oil crops like fluted pumpkin seed harvested 32 weeks after anthethesis

Table 1: Proximate composition (%) of *D. e. var. edulis* and *D. e. var. parvicarpa*

Proximate composition	*D. e. var. edulis*	*D. e. var. parvicarpa*
Moisture (%)	46.59±0.01	61.40±0.01
Crude protein (%)	3.15±0.06	10.50±0.01
Lipids (%)	68.29±0.01	54.68±0.01
Ash	2.84± 0.01	2.46±0.01
Crude fibre	1.39±0.01	1.81±0.04
Carbohydrate (%)	24.34±0.01	29.58±0.01
Caloric value (Kcal) energy	724.53±0.02	652.36±0.03

(Akwaowo *et al*., 2000), African oil bean seed (*Pentadethra macrophylla* Bent) (Ikhuoria *et al*., 2008). The differences in the moisture content of the two varieties of *D. edulis* suggest that *D. e. var. edulis* is of better quality and more stable than *D. e. var. parvicarpa*.

According to Onwuka (2005), moisture content determines the stability and quality of foods. There was no significant difference in crude fibre and ash content of *D. e. var. edulis* and *D. e. var. parvicarpa* (Table 1). Also, the crude fibre and ash content were generally low and this will enhance quality control of the extracted oil. The crude fibre and ash content values are important in terms of the suitability of the fruit cakes for the compounding of animal feeds. As a result of the low crude fibre content, the two varieties of *D. edulis* may be considered unsuitable for compounding animal feeds. However, on the grounds of fairly high carbohydrate content in *D. e. var. parvicarp* (29.58%) and low ash content of 2.46 (Table 1), it may be considered otherwise. Ikhuoria *et al.* (2008) also reported that African oil bean seed cake with low ash content and high percentage carbohydrate (38.99%) can be used for compounding animal feeds. Similar report was made by Abighor *et al.* (1997).

The percentage crude protein and carbohydrate in *D. e. var. parvicarpa* were higher than that of *D. e. var. edulis* (Table 1). On the other hand, the caloric value of *D. e. var. edulis* (724.53 Kcal) was significantly higher than that of *D. e. var. parvicarpa* of 652.36 Kcal (Table 1). This suggests that more energy is derived from consuming *D. e. var. edulis* variety of African pear than *D. e. var. parvicarpa*.

Oil content and mineral composition: African pear (*D. edulis*) extracts from the two varieties were liquid at room temperature. This implies they could be classified as oils. The percentage oil content in *D. e. var. edulis* and *D. e. var. parvicarpa* were evaluated using equation 1 to be 68.29 and 54.68%, (Table 1) respectively. The high oil content in *D. e. var. edulis* suggest that processing this variety for vegetable oil would be more economical. Ikhuoria and Maliki (2007), reported 23.2% oil content for African pear. The researchers did not specify the variety of African pear from which the oil was extracted. The low value in oil content reported by the authors could be attributed to the variety of African pear, the mount of sample from which the oil was extracted (in this case 50 g) and the method of extraction used. The oil content varies with varieties as observed in this study.

Table 2: Elemental nutrient composition (mg kg^{-1}) of *D. e. var. edulis* and *D. e. var. parvicarpa*

Elemental nutrient composition in mg kg^{-1}	*D. e. var. edulis*	*D. e. var. parvicarpa*
Iron (Fe)	42.78±0.05	64.11±0.14
Copper (Cu)	4.08±0.05	3.66±0.01
Sodium (Na)	255.20±0.08	354.37±0.09
Potassium (K)	433.36±0.01	266.65±0.04
Zinc (Zn)	39.68±0.04	32.37±0.03
Calcium (Ca)	3001.07±0.09	3205.49±0.03
Phosphorus (P)	4446.04±0.05	3674.07±0.09
Cadmium (Cd)	ND	ND
Lead (Pb)	ND	ND

ND: Not Detected

According to Onwuka (2005), mineral elements can be classified as major elements, trace elements and non-essential and or toxic elements. The concentration of major elements-Ca, Na, K and P, in the two varieties of *D. edulis* were very high (Table 2). Phosphorus was 4446.04 mg kg^{-1} in *D. e. var. edulis*, while concentration of 3674.07 mg kg^{-1} was obtained from *D. e. var parvicarpa*. Ca, K and Na concentration in *D. e. var. edulis* were 3001.07, 433.36, 255.20, 3205.49, 266.65 and 354.37 mg kg^{-1} were observed for *D. e. var. parvicarpa* (Table 2), respectively. The minerals (Ca, K, Na and P) are essential to health; their presence in the African pear makes the fruits and the oil from the two varieties viable source of these minerals in the body. Zn content in the two varieties was lower than Fe concentration (Table 2). Fe is needed for blood formation in the body. Cu and Zn, when present even in trace concentrations are important for the physiological functions of living tissues and regulate many biochemical processes. The present of Zn in both varieties of African pear implies the oil can be use to formulate cream that can be used to check skin infections in babies and consumption of these fruits will serve as a source of these nutrients in the body. Pb and Cd were not detected in the two varieties. This implies the two varieties are free from toxic elements. Generally, the varying levels of these minerals may be attributed to the different rates at which the elements are taken up from the soil by the plants and subsequent incorporation into the oil. It can also be due to geographical location of these plants and availability of these minerals in the soil.

Anti-nutrient composition: The most common anti-nutritional factors in fruits and leafy vegetables are oxalic acid, tannins, phytic acid and hydrocyanic acid (Akwaowo *et al*., 2000). The distribution of anti-nutrients in some vegetable crops and their effects on other

nutrients has been reported (Broadhurst and Jones, 1978; Desphande and Cheryan, 1985; Marks *et al*., 1987; Udosen and Ukpana, 1993). A daily intake of 450 mg of oxalic acid has been reported to interfere with metabolism (Akwaowo *et al*., 2000). High oxalate levels in food may reduce the bioavailability of such metal as calcium. Phytic acid intake of 4.00-9.00 mg/100 g reduces iron (Fe) absorption by 4-5 fold in humans (Hurrel *et al*., 1992).

The anti-nutrients composition of the two varieties of African pear were generally low such that none of the anti-nutrient were above the lethal dosage approved by standard bodies like National Agency for Food and Drugs Administration and Control (NAFDAC) in Nigeria. The cyanide content (0.007 mg/100 g) for *D. e. var. edulis* and 0.176 mg/100 g for *D. e. var. parvicarpa* (Table 3), indicates that the two varieties of *D. edulis* will not affect human nutrition if consumed in a large quantity. But it should be noted that the concentration of cyanide is always reduced during processing and as such there might be a reasonable concentration of cyanide in a raw African pear fruit which could render the consumption of it in a raw form harmful to health. It is therefore, advisable to consume the fruit when cooked than raw. Some *D. e. var. parvicarpa* has bitter taste because of elevated cyanide content in this variety. As seen in this research. Total oxalate concentration was 13.20 mg/100 g for *D. e. var. edulis* and 17.60 mg/100 g for *D. e. var. parvicarpa* (Table 3). Munro and Bassir (1969) reported that the lethal level of oxalate in man is 2-5 g. Pingle and Ramastin (1978) have demonstrated the ability of soluble oxalates to inhibit calcium, potassium and sodium absorption due to their insolubility properties. Akwaowo *et al*. (2000) also reported that oxalates form insoluble complexes with Ca, Mg, Zn and Fe, thereby interfering with utilization of these mineral elements. From this study, the concentration of oxalate both total and soluble does not reach the level that could be injurious to health. The same was applicable to phytate and tannins with very low concentrations in both variety of African pears. Though tannins and phytates are also known to affect human nutrition and metabolism, for example, Akwaowo *et al*. (2000) reported that higher intake of tannic acid has been associated with carcinogenic effect in man, poor protein utilization, liver and kidney toxicity. The same authors also reported that tannic acid is associated with lower nutritive value of protein foods. Their concentrations in the two varieties of *D. edulis* did not exceed lethal levels; therefore the consumption of the fruits will not pose any harmful effect to health. Phytic acid intake of 4-9 mg/100 g is said to decrease Fe absorption by 4-5 fold in humans (Hurrel *et al*., 1992). None of these effects could be noticed when these fruits are consumed because the levels of antinutrient does not reach lethal dosages. It is however, documented by Dunu *et al*. (1986) that most of these toxicants are eliminated during processing and cooking; hence it is advisable to consume cooked African pear and not raw.

Table 3: Anti-nutrient composition (mg/100 g) of *D. e. var. edulis* and *D. e. var. parvicarpa*

Anti-nutrient composition in mg/100 g	*D. e. var. edulis*	*D. e. var .parvicarpa*
Cyanides	0.007±0.01	0.176±0.01
Total oxalates	13.200±0.01	17.600±0.08
Soluble oxalates	8.770±0.01	8.800±0.08
Phytates	1.592±0.02	1.056±0.01
Tannins	0.846±0.03	0.976±0.03

CONCLUSION

Evaluation of the chemical composition of the two varieties of African pear shows that *D. e. var. edulis* has a high percentage of oil than *D. e. var. parvicarpa* and the mineral element and anti-nutrient compositions of these fruits suggest that they can serve as a source of essential elements and vegetable oil of high quality and high nutritive value.

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