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Comparative Study of the Mineral Element and Fatty Acid Composition of *Dacryodes edulis* Pulp and Seed

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Abstract: A comparative study was carried out on the mineral element composition and fatty acid content of *Dacryodes edulis* pulp and seed using Atomic Absorption Spectroscopy and Gas Chromatographic methods respectively. The mineral element composition of the pulp ranged from 3.88 ppm for manganese to 298.07 ppm for sodium while that of the seed is 0.18 ppm for zinc to 85.15 ppm for potassium. The result revealed that *D. edulis* pulp is by far richer in mineral element content than the seed with sodium being the most prevalent followed by magnesium and then potassium. Potassium was the most abundant in the seed followed by magnesium and then sodium. Fatty acid composition varied greatly between the pulp and the seeds. The pulp contains more of unsaturated fatty acid (69.88%) than the seeds (39.13%) which makes it more nutritionally interesting. The two oils however are rich in oleic and linoleic acid and they both contain two of the essential fatty acids; this is of nutritional importance. The seed oil contains $C_{24:0}$ and $C_{26:0}$ which are long chain fatty acids. It also contains erucic acid; this is not found in the pulp oil. The saturated/unsaturated fatty acid ratio of the pulp and the seed oils are 0.52% and 1.53% respectively.

Key words: *Dacroydes edulis* · Pulp · Seed · Fatty acid

INTRODUCTION

The fatty acid composition of oil is its most useful chemical feature. Many of the chemical tests for oil identity or purity can be related to the fatty acid content of the oil [1]. Poly unsaturated fatty acids such as linoleic acid play an important role in modulating human metabolism and consumers consider fatty acid composition to be one of the important parameters of nutritional quality. Particularly, consumers are concerned with saturated/unsaturated fatty acid ratio and special attention is on the essential fatty acid with emphasis on the health potential of polyunsaturated fatty acid. Such fatty acids are known to be essential for human health [2]. It is now known that diet plays an important role in preventing certain diseases. The relationship between dietary fat and certain chronic illness including cardiovascular, neoplastic, endocrine disease and so on is also recognized. Consumption of saturated dietary fats has been associated with increased plasma cholesterol concentration potentially increasing the risk of cardiovascular disease [3]. Because of the importance placed on dietary monounsaturated fatty acid (MUFA), it has been recommended that MUFA intake be as high as half of the total recommended dietary intake of calories from fat as a means for increasing the risk of cardiovascular disease [4]. Recent studies have demonstrated that MUFA are better contributors to plasma cholesterol lowering effects [5]. Mineral elements are of great physiological importance particularly body metabolism [6]. Their importance ranged from role as biological essential components to imbalance created when excess of one interferes with the function of another to pharmacological activity.

D. edulis, a Buseraceae, known as African pear or plum is a native tree of tropical West Africa. It bears edible fruits and its oily seeds are used as food and fodder. It is used medicinally for earache, fever and headache and yields timber for furniture making. Currently despite the relatively high oil and seed-meal production in the U.S, the USDA (US Department of Agriculture) continues to investigate non-conventional oilseeds. The example set forth by the USDA is worth emulating by the developing countries that are more in need of alternate oil sources [7]. The research and development program of the USDA over the past 40 years on new, non-conventional

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oilseeds that could compete with and supplement the conventional ones has yielded some positive results. Some of the potential crops could be produced now, whereas others require additional input [8]. This study was carried out to compare the mineral element content and fatty acid composition of the pulp and seed of *D. edulis*. The results are used to determine the suitability of the oils from the pulp and the seed as substitutes for the more conventional oil types like soybean, olive, corn, coconut, peanut, cotton seed, palm, sunflower and rapeseed oils. Several workers have carried out some work on *D. edulis* [9-15] but there exist no literature on the comparative study of the metal and fatty acid composition of the pulp and seed of *D. edulis* from Nigeria.

MATERIALS AND METHODS

Collection of Materials: *D. edulis* fruits were purchased from local markets in Ibadan, Oyo state of Nigeria. The pulp was separated from the seed and then pulverized. Pulp and seed oils were extracted separately using the continuous soxhlet extraction technique with hexane (40-60°C) for 8h. The solvent was removed completely and the oils obtained were used for fatty acid determination.

Fatty Acid Analysis: The determination of the fatty acids content of the oils was carried out following the method of Ajayi *et al*. [16]. To 0.10g of the oil was added 5 ml of CH_3OH and 1 ml of CH_2Cl_2. The mixture was cooled in ice and 0.6 ml of CH_3COCL was added. 1 ml of the solution was withdrawn into the hydrolysis tube and heated for 1 hour at 110°C. The solution was cooled and discharged into 10 ml of 100% NaCl solution in a separating funnel. The organics were extracted with 3 x 4 ml of hexane and the volume was reduced to 0.5 ml using a rotatory evaporator. This was eluted on silica gel column successively with 5 ml hexane and 4 ml CH_2Cl_2. The CH_2Cl_2 fraction was separated on a DB5 30m x 0.25mm capillary installed on a GC Chrompack 9001 equipped with computer software and Mosaic Integration. Flame ionization detector was used. The temperature was programmed as follows: 35°C for 3 minutes; temperature was then increased at 20°C per minute up to 230°C for 5 minutes. Heptadecanoic acid was used as an internal standard.

Minerals Composition: The method of Ajayi *et al*. [17] was followed in the determination of the metal composition of the pulp and seeds of *D. edulis*. 1g each of the seed and pulp was dried-ashed in a muffle furnace at 550°C for 5h until a white ash was obtained. The minerals were extracted from ash by adding 3 ml of concentrated HNO_3 (63%). The digest was carefully filtered into 100 ml standard bottle and made up to mark with distilled water. Minerals were estimated with the use of an Atomic Absorption Spectrophotometer (Perkin Elmer model 703, USA). The instrument was calibrated with standard solutions containing known amounts of the minerals being determined, using analytical reagents; results are expressed in parts per million of dry matter.

RESULTS AND DISCUSSION

The mineral element composition of the pulp ranged from 3.88 ppm for manganese to 298.07 ppm for sodium while that of the seed is 0.18 ppm for copper to 85.15 ppm for potassium (Table 1). The pulp is richer in mineral element content than the seeds as can be seen in the values for magnesium (240.3 ppm and 4.85 ppm); sodium (298.07 ppm and 1.36 ppm) potassium (195.21 ppm and 85.15 ppm) and calcium (4.97 ppm and 0.74 ppm) for the pulp and seeds respectively. The quantity of the trace elements found in the pulp is also greater than that of the seed. Sodium 290.07 ppm is the most prevalent in the pulp followed by magnesium 240.3 ppm followed by potassium 195.21 ppm and then phosphorus 35.43 ppm; while potassium is the most prevalent in the seed followed by iron 6.20 ppm and then magnesium 4.85 ppm. The pulp being richer in mineral element appears to have greater

Table 1: Mineral element composition[a] and proximate[b] and of *D. edulis* pulp and seed

Mineral composition[a]	Pulp	Seed
Phosphorus	35.43	N.D[c]
Calcium	4.97	0.74
Magnesium	240.30	4.85
Potassium	195.21	85.15
Sodium	298.07	1.36
Manganese	3.88	1.03
Copper	6.24	0.18
Zinc	8.08	0.55
Iron	N.D[c]	6.20
Proximate composition[b]	Pulp	Seed
Oil yield	11.94	10.44
Crude protein	1.93	1.40
Crude fibre	47.50	48.50
Moisture content	18.60	20.60
Ash content	3.00	2.60
Carbohydrate content	17.03	16.46

[a]Present work, [b]Ajayi and Oderinde, 2002

Table 2: Fatty acid composition[a] and Physicochemical properties[b] of *D. edulis* pulp and seed

Fatty acid composition[c]	Pulp	Seed
$C_{16:0}$	17.18	43.16
$C_{18:0}$	14.84	4.59
$C_{18:1}$	40.45	21.97
$C_{18:2}$	23.17	12.63
$C_{20:0}$	2.10	11.56
$C_{20:1}$	0.91	0.21
$C_{20:2}$	0.84	3.21
$C_{20:3}$	0.51	1.72
$C_{22:0}$	-	0.32
$C_{22:1}$	-	0.27
$C_{22:2}$	-	0.12
$C_{24:0}$	-	0.06
$C_{26:0}$	-	0.18
Saturated	34.12	59.87
Unsaturated	65.88	40.13
Physicochemical properties		
Acid value	5.61	5.61
Free fatty acid (as oleic acid)	2.82	2.81
Saponification value	179.52	179.52
Ester value	173.91	173.91
Iodine number	19.87	31.50
Peroxide value	30.00	20.00

[a]Present work, [b]Ajayi and Oderinde, [c]Mean of triplicate result
[d]Room temperature, [e]Percent by weight of total fatty acids

nutritional significance than the seed and if eaten; can supply the body with these vital mineral elements. Potassium is the principal cation of intracellular fluid; it is involved in protein synthesis. Sodium is largely associated with 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 [6]. The fact that the pulp of *D. edulis* is rich in sodium and potassium is in accordance to the report in literature that most foods that are rich in potassium particularly proteinaceous food and fruit juices are equally rich in sodium [18]. Copper is essential for haemoglobin synthesis, normal bone formation and the maintenance of myelin within the nervous system [19]. In animals the manifestations of the deficiency of copper include anaemia hypo pigmentation, defective wool keritinization, abnormal bone formation with spontaneous reproductive and heart failure [20]. In human, it has been established that occurrence of Cu absorption disorder in after partial gastetomycin leads to severe malnutrition just as when protein is severely deficient in the diet; as in kwashiorkor [21]. The human body needs these elements in small quantities therefore the small quantities of these elements found in the pulp is of great nutritional importance. Calcium is an indispensable component of the structure of the body; the bones and teeth owe their hardness and strength to the presence of this mineral element [22].

The principal fatty acids in the pulp and the seed are oleic (18:1) 40.45% and palmitic (16:0) 43.16% acids, respectively. The seed also contains oleic acid 21.97%. Both pulp and seed of *D. edulis* contain linoleic (18:2) and arachidonic (20:0) acids which are two of the essential fatty acids with the percentage of the linoleic acid found in the pulp being greater 23.17% and 12.63% for the pulp and the seed respectively. Linoleic acid derivatives serve as structural components of the plasma membrane and are precursors of some metabolic regulatory compounds [16]. The fatty acid composition of the pulp and the seed oils investigated in the study revealed the predominant fatty acid in the pulp and the seed to be oleic acid 40.45% and palmitic acid 43.16%, respectively (Table 2). The seed however also contains large quantity of oleic acid (21.97%). Both the pulp and the seed contain linoleic acid with that of the pulp being greater (pulp 23.17%; seed 12.63%). This is of significant importance nutritionally. It has been reported by Vles and Guttenbos [23] that dietary fat rich in linoleic acid prevents disorders such as coronary heart diseases and atherosclerosis. Lionoleic acid is an 18-carbon molecule that contains double bonds in the cis-9 and cis-12 configurations. Conjugated linoleic acid (LCA) has been reported to have diverse biological effects such as increasing atherosclerotic risk and increasing body fat [24]. It has been claimed that gamma LA is effective in reducing inflammation and treating diabetic neuropathy and atopic eczema [25]. The pulp and the seed oils of *D. edulis* contain arachidonic acid which is also an essential fatty acid. The presence of two of the essential fatty acids in the oil makes them to be nutritionally valuable. Essential fatty acids in the human diet prevent nutritionally-related illness. The human body is not able to synthesize linoleic (18:2) and linolenic (18:3) acids. These fatty acids must be provided in the diet hence they are classified as essential fatty acid [26]. It is considered that the essential fatty acids (linoleic, linolenic and arachidonic) play a natural preventive role in cardiovascular disease and in the elevation of some other health problem [27] basically because they promote the reduction of both total and HDL cholesterol [28,29]. Long chain fatty acids such as lignoceric(24:0) and cerotic (26:0) acids are found in the seed oil; these are absent in the pulp oil. The seed oil also contains erucic acid (22:1) of

0.27% which is within the allowable limit [30]. According to Mbofung *et al*. [2] oil of plant origin often has a fatty acid composition that is characteristic of the family to which the plant belongs. The oils from the pulp and seed of *D. edulis* have many fatty acids in common even though these are in various proportions. On the whole when compared with each other, the pulp oil has higher percentage of unsaturated fatty acids (65.88%) than the seed oil (40.93%). The lowest total saturated fatty acids 34.12% found in the pulp oil could be an advantage over the seed oil (59.86%) since a diet low in saturated fat can benefit patients with cardiovascular disease [31]. The ability of some unsaturated vegetable oils to reduce serum cholesterol level may focus attention on the oil from *D. edulis* pulp. Considering the high level of unsaturated fatty acid in the oil especially that of linoleic acid; *D. edulis* oil seems to be very promising as edible oil.

In conclusion *D. edulis* pulp is comparatively richer in mineral element than the seed counterpart; the pulp oil also has higher level of unsaturates than the seed oil hence the pulp of *D. edulis* appears to have greater nutritional significance than the seed. However further work needs to be carried out to determine the antinutritional factors in both the pulp and the seed.

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