EFFECTS OF SOME PROCESSING METHODS ON ANTINUTRITIONAL, FUNCTIONAL AND PASTING CHARACTERISTICS OF *Detarium microcarpum* SEED FLOURS

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Abstract
This work studied the effects of soaking, roasting and boiling on antinutritional factors, proximate and functional properties of D. microcarpum flour. Three samples of flour were produced by soaking, roasting and cooking. The flours were evaluated for proximate, energy, anti-nutritional, functional and pasting. The proximate composition showed moisture content of 9.01 to 9.81%, protein (13.94 to 14.94%), ash (5.66 to 5.86%), crude fibre (3.61 to 4.27%), fat (1.01 to 4.67%) and carbohydrate (61.33 to 66.13%). The energy value ranged from 329.37-446.39 Kcal/100g. Antinutritional composition showed flavonoid of 0.66 to 0.82 mg/100g, saponin (0.02 to 0.03 mg/100g), phytic acid (0.23 to 0.87 mg/100g), tannin (0.34 to 0.67 mg/100g), oxalate (0.46 to 0.86 mg/100g. The functional properties showed water absorption capacity of 10.28 to 11.73 ml/g, oil absorption capacity (2.20 to 3.13 ml/g), loose and packed bulk densities (0.51 to 0.62 and 0.67 to 0.72 cm^3,respectively,) foam capacity (8.11 to 9.30 cm^3), solubility (2.02 to 3.01%), swelling power (3.42 to 4.72 cm^3). Soaked samples showed highest values (13298.50, 6989.00, 16026.50 and 9717 RVA) for peak, breakdown, final and setback viscosities, respectively. The pasting temperature and pasting time were not significantly ($p>0.05$) affected by treatments. The results showed that the seed displayed functional characteristics, which could enhance its applications in food formulations.

Keywords*:* *Detarium microcarpum*, proximate composition, soaking, boiling, roasting.

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1. INTRODUCTION

Legumes are the plants of the family *Fabaceace* or *Leguminosae*, which serve as food for a large number of people of tropical origin and constitute a very important source of dietary protein in many West African countries, including Nigeria (Akinjayeju and Francis, 2008). In many developing countries, malnutrition has been traced to a low level of protein in the diets. There has been a focus on the importance of legumes because they are excellent and cheap source of protein. This is due to the fact that milk, meat and fish prices are often high for the majority of the population (Yusuf *et al*., 2008). Considering the rising price of animal foods, there is a strong need for natural and economic protein foods from plant sources which an average family can afford as part of the daily meal. Several reports have shown that a number of plant products exist in the tropics which are still under-utilized but are potential sources of nutrients; among such crops is *Detarium microcarpum*.

Detarium microcarpum is an important legume found in West and Central Africa. It belongs to the family *Caesalpiniceae*, *Phylum spermatophyte* and the order *Fabaceae* (Uhegbu *et al.,* 2009). It is known by various tribal names as ‘Ofor’ (Igbo), ‘Taura’ (Hausa) and ‘Ogbogbo’ (Yoruba) (Akpata and Miachi, 2001). It is one of the least exploited legumes in Nigeria despite its high level of protein and minerals such as phosphorus sodium, potassium, calcium and magnesium. The seed flour is mainly used in the South-eastern part of Nigeria as a soup thickener. Although the seeds of *D. microcarpum* are in abundance during fruiting season, yet its utilization as food ingredient is limited due to the presence of

antinutritional factors and lack of concise nutritional information (Obun *et al*., 2008).
However, the significant approach to making proteins more widely available is to increase utilization of leguminous and other protein-rich plants. The use of protein in food system is determined by their functional properties. As protein is gaining increased interests as ingredients in food systems throughout many parts of the world, there is need to study its functional properties such as water and oil binding capacity, solubility index, bulk density (loose and Packed), foaming capacity and swelling power. This is because the success of utilizing plant protein as additives depends on the favourable characteristics (functional properties) that it impart to the food, and the replacement of animal foods with legumes has shown to improve nutritional status due to lower cholesterol level in plant foods (Sirtori and Lovati, 2001). Proteins are made by linking individual amino acids together in long chains and amino acids are made up principally of carbon, hydrogen, oxygen and nitrogen. Proteins are generally affected by heat processing methods. The *D. microcarpum* seeds have been implicated with anti-nutritional factors (ANFs) such as hydrogen cyanide, phytate, tannins, oxalate and saponins (Umar *et al*., 2007). Akpapunam and Sefa-Dedeh (1997) reported that processing operations like soaking, roasting, cooking, dehulling, germination etc reduces those anti-nutrients found in legumes, improves palatability and digestibility of legume protein. Therefore, this study aimed to investigate the effects of soaking, roasting and boiling on antinutritional factors, proximate and functional properties of *D. microcarpum* flour with the view to enhancing the utilization in food industry.

2. MATERIALS AND METHODS

Materials

The dry seeds of *D. microcarpum* were purchased from Eke-Aba market in Abakaliki, Ebonyi state, South-Eastern Nigeria. *Detarium microcarpum* seeds were sorted and cleaned to remove spoilt seeds, sand, dirt and other contaminants. The chemicals were of analytical grades and obtained from Sigma Chemicals (St. Louis, MO, USA).

Preparation of Flours

The cleaned seeds of *D. microcarpum* were divided into three portions. The first portion was soaked in water for 12 h to ease dehulling. The soaked seeds were drained, dehulled, dried in an oven (Genlab oven, Cheshire, UK) at 60°C for 3 h and milled into flour. The flour was sieved using 300 µm sieve and labelled SDF. The second portion was cooked at 100 °C for 45-60 min, dehulled, washed, drained and dried in an oven (Genlab oven, Cheshire, UK) at 60°C. The dried seeds were milled into flour, sieved and labelled BDF. The third portion was roasted traditionally in a sand bath at a temperature 120°C with continuous stirring for 45 min, dehulled, milled, sieved and labelled RDF. The samples were packaged in airtight containers.

Proximate and Energy analyses of Fours

The flours were subjected to moisture, protein, fibre, ash, fat, carbohydrate analyses using AOAC (2005) methods and energy was estimated using the physiological fuel values of Atwater's conversion factors.

Functional Properties of Flours

The Bulk densities (packed and loose) of the flours were determined using the method described by Narayana and Narasinga. Water absorption capacity (WAC) and oil absorption capacity (OAC) were determined using the method of Sosulki *et al.* (1996). Swelling power was determined using the method described by Akpata and Miachi (2001). Solubility was determined with the cold water extraction method as described by Udensi and Onuorah (1992). Foaming capacity and stability were studied according to the methods described by Desphande *et al*. (1982).

Pasting Properties

These properties were determined using a Rapid Visco Analyzer (RVA) (Model RVA 3D+, Newport Scientific Australia).

Determination of Anti-nutritional Factors

Phytic acid content was determined using the method of Park *et al.*, (2006). Tannin content was determined by the modified vanillin- HCl method of Price *et al.* (1978). Oxalate was determined by AOAC (2005) method. Saponin content was determined by the method of Ready *et al.,* (1982). Total flavonoid contents were measured according to a colorimetric assay (Harbone, 1973).

3. RESULTS AND DISCUSSION

Proximate and Energy Compositions

The results of the proximate and energy compositions of different *D. microcarpum* flours are presented in Table 1. The moisture content of the flours ranged from 9.01 to 9.81%. There were significant differences (P < 0.05) among the samples. Boiled *D. microcarpum* flour had the highest value (9.81%) for moisture content while soaked flour had the lowest value (9.01%). The values were lower than moisture content of *D. microcarpum* reported by Akpata and Miachi (2001). This low moisture content of the flours is an indication of stable shelf-life when properly packaged and stored. Moisture in foods is actively involved in various metabolic reactions which determine the shelf-life and microbial susceptibility of food items (Onimawo and Egbekun, 1998). The protein contents were 13.94%, 14.76% and 14.93% for roasted, boiled and soaked samples, respectively. There was significant difference (P < 0.05) among samples. The values were higher than the result of Igwenyi and Azoro (2014) but lower than that of Uhegbu *et al*., (2009). The functions of protein which include supply of amino acids, body building and replacement of worn-out tissues can be achieved with these flours. The decrease in protein content could be as a result of denaturation of protein matrix, which also makes it more palatable for human consumption (Nwosu *et al*., 2011). The high ash content reflects high mineral in the samples. The values showed significant difference (P < 0.05). Measure of ash content could be a measure of the food quality. The level of ash is an indication of adulteration. Adulteration is the contamination of food product due to inorganic substances present in the food being analyzed (Pearson, 1976; Schroeder, 1986). The crude fibre content of samples was 3.95%, 4.27% and 3.61% for soaked (control), roasted and cooked samples. There was significant difference (P < 0.05) among samples. Fibre in diet play very significant role. The roasted sample with the highest fibre content than the other two samples implies higher lowering of nutrient bioavailability. Fiber regulates bowel actions and may help to guard against colon and rectal cancer as well as in diabetes. It is that portion of food that is not used up by the body. Fibre shortens the transit time of food through the gastrointestinal tracts, reduces low density lipoprotein and hence keeps the gut healthy. Fiber supplements or fiber-rich foods may function as normal dietary agents by modulating the digestive and absorptive process (Okaka *et al.,* 2006). They are very important in promoting a range of physiological effects, including increased fecal bulk, water-holding capacity, absorption of organic molecules such as bile acids, cholesterol and toxic components (reduced bile acid and plasma-cholesterol levels), reduction of minerals and electrolytes (Igwenyi, 2008). The fat content ranged from 1.01 to 4.67%. The boiled sample had the highest fat content (4.67%) while the roasted sample had the lowest. The lower value of the roasted sample may be due to the fact that during roasting more oil was evolved. There were significant differences (P < 0.05) among the samples. Hence, in terms of fat content, boiled samples may be preferred. The significance of fat in food may not be over-emphasized as it contributes greatly to the energy value of foods. It could slow down the rate of utilization of carbohydrates. During starvation, fat could be metabolized by the process of beta oxidation to provide energy for the body and provides more energy when compared with carbohydrates. Fat is an important “vehicle” for

fat soluble vitamins and also acts as lubricants in the intestine (Uhegbu *et al*., 2009).
The available carbohydrate (which excludes non-starch polysaccharides which are not digested by the endogenous enzymes of the human upper digestive system) of the samples was 61.33%, 62.35% and 66.13 for boiled, soaked and roasted samples, respectively. There was significant difference ($p < 0.05$) among the samples. This result is comparable to value of 57% reported for *D. microcarpum* (Uhegbu *et al*., 2009).The decrease in the carbohydrate may be as a result of hydrolysis of macromolecules like starch and other polysaccharides (Coffman and Gracia, 1997). The very high carbohydrate content of *D. microcarpum* as well as ability to form viscous gums at such low concentrations as 0.1-1% in sauce shows they belong to the class of food ingredients known as hydrocolloids (Ihekoronye and Ngoddy, 1985). Apart from the supply of energy, studies have shown that viscous polysaccharides can slow the rate of gastric emptying (Schwartz *et al.,* 1982). Within the small intestine, viscous polysaccharides which can form gel matrix may slow absorption by trapping nutrients, digestive enzymes, or bile acids in the gel matrix and by slowing mixing and diffusion in the intestine. Leeds *et al*. (1999) have shown through animal experiments, that viscosity is necessary for gum to blunt the rise in plasma glucose load. Thus the high carbohydrate content of these flours is quite significant to health. The energy values of the flours were 342.10, 329.37 and 346.39 Kcal/100 g) for soaked, roasted and boiled, respectively.

Table 1: Proximate and Energy Compositions of D. *microcarpum* Seed Flours

Sample	Moisture (%)	Protein (%)	Ash (%)	Crude fibre (%)	Fat (%)	Carbohydrate (%)	Energy (Kcal/100g)
SDF	9.26±0.18[b]	14.94±0.15[a]	5.86±0.05[a]	3.95±0.01[b]	3.66±0.09[b]	62.35±1.18[b]	342.10±2.03
RDF	9.01±0.20[c]	13.94±0.21[c]	5.66±0.03[c]	4.27±0.04[a]	1.01±0.01[c]	66.13±1.01[a]	329.37±1.89
BDF	9.81±0.19[a]	14.76±0.22[b]	5.82±0.06[b]	3.61±0.07[c]	4.67±0.03[a]	61.33±1.09[c]	346.39±1.96

Values are mean of duplicate samples. Values with the same superscript along the same column are not significantly ($P > 0.05$) different. SDF – Soaked Flour (Control), RDF – Roasted Flour, BDF – Boiled or Boiled Flour

Functional Properties

The functional properties of soaked, roasted and cooked flour samples are presented in Table 2. The roasted flour had the highest WAC value (11.73 ml/g), followed by 10.53 ml/g and 10.28 ml/g for soaked and cooked samples, respectively. The samples exhibited significant differences ($P < 0.05$). The ability to absorb water is an important property in food preparation (Onwuka, 2005). The highest value of WAC for roasted sample indicates loss of water in the samples during the roasting process. The increased absorption capacities could be attributed to the heat dissociation of proteins, gelatinization of carbohydrate in the flour (Narayana and Rao, 1982). The Oil Absorption Capacity (OAC) of soaked sample (2.20 ml/g) was lowest while that of roasted sample was highest (3.13 ml/g). These results showed that *D. microcarpum* flour contain hydrophobic protein which showed superior binding of lipids. There was significant difference ($P<0.05$) between soaked, roasted and cooked samples. Since oil acts to retain flavour and increase mouth feel of foods, oil absorption is an important property in such food formulations (Nwosu *et al*., 2011).

Table 2: Functional Properties of *D. microcarpum* Flours

Sample	WAC (ml/g)	OAC (ml/g)	Bulk density(g/ml)		Foam capacity (cm^3)	Solubility (%)	Swelling Power (cm^3)
			Loose	Packed			
SDF	10.53±0.79^b	2.20±0.01^c	0.51±0.00^c	0.67±0.01^b	9.30±0.11^a	3.01±0.11^a	4.05±0.08^b
RDF	11.73±0.45^a	3.13±0.03^a	0.62±0.01^a	0.72±0.01^a	8.11±0.14^b	2.52±0.09^b	4.72±0.07a
BDF	10.28±0.16^c	2.45±0.01^b	0.53±0.00^b	0.70±0.00^a	8.56±0.21^b	2.02±0.08^c	3.42±0.09c

Values are mean of duplicate samples. Values with the same superscript along the same column are not significantly different (P>0.05). SDF – Soaked Flour (Control), RDF – Roasted Flour, BDF – Boiled or Cooked Flour

The loose and packed bulk densities were highest for roasted sample (0.62 g/ml and 0.72 g/ml) and lowest for soaked sample (0.51 g/ml and 0.67 g/ml). All the samples showed significant difference (P < 0.05) in loose bulk density while roasted and cooked samples showed no significant difference (P > 0.05) in packed bulk density. Bulk density is dependent on factors such as method of measurement, geometry, size, solid density and surface properties of the food materials. It can be improved when the particles are small, compatible, properly tapped or vibrated and with a suitable packaging material (Machuka *et al*., 2006). The bulk density ratios help to reduce transportation and storage costs. The soaked sample had the highest value (9.30 cm^3) while the roasted sample had the lowest value (8.11 cm^3) for foam capacity. The results were lower than the report of Nwosu *et al*., (2011) for soaked, roasted and boiled samples of African yam bean. There was no significant difference (P > 0.05) between roasted and cooked samples. Foam capacity is useful in food system. Poor foam capacity indicates denaturation of protein molecules which are responsible for the foam formation. The solubility ranged from 2.02% to 3.01%. Lower values of solubility might be due to high protein and fat content, which can form inclusion complexes with amylase. Pormeranz (1991) reported that the formation of protein amylase complexes in starch or flours may be the cause of decrease in swelling or solubility index. The swelling power of the roasted sample was highest (4.27 cm^3) while boiled sample had the lowest (3.42 cm^3). The lower value for the boiled sample may be as a result of cooking in liquid. The extent of swelling in the presence of water depends on the temperature, availability of water, species of starch, and extent of starch damage due to thermal and mechanical processes and other carbohydrates and proteins (Ezema, 1989). Sanni *et al*., (2005) reported that the higher the swelling power index, the lower the associative forces.

Pasting Properties

The pasting properties of *D. microcarpum* seed flours presented in Table 3. Pasting property of a food material is important in predicting the behaviour of the food material in industrial applications (Adebowale *et al*., 2008). Peak viscosity is the ability of starch to swell freely before their breakdown and it ranged from 13298.50 to 12005.50 RVU for all the samples.

Table 3: Pasting Characteristics of *D. microcarpum* Seed Flour

Sample	Peak Viscosity (RVU)	Trough Viscosity (RVU)	Breakdown Viscosity (RVU)	Final Viscosity (RVU)	Setback Viscosity (RVU)	Pasting Time (Min)	Pasting Temp. (°C)
SDF	13298.50±1.15^a	6309.50±1.04^{ab}	6989.00±1.78^a	16026.5±0.48^a	9717.00±0.74^a	3.54±0.01^a	50.15±0.11^a
RDF	12005.50±1.13^a	5287.50±1.09^b	6718.00±1.46^a	13643.00±0.85^a	8355.50±0.81^a	3.74±0.00^a	50.20±0.10^a
BDF	12729.00±1.10^a	6411.00±1.19^a	6318.00±0.89^a	15577.00±0.74^a	9166.00±0.65^a	2.80±0.00^a	50.18±0.09^a

Values are mean of duplicate samples. Values with the same superscript in the same column are not significantly different (P > 0.05). SDF – Soaked Flour (Control), RDF – Roasted Flour, BDF – Boiled or Cooked Flour

There was no significant difference (P > 0.05) among the samples. Soaked *D. microcarpum* seeds had the highest peak viscosity while roasted seeds had the lowest. The relative high peak viscosity of the samples is an indication of high starch content (Osungbaro, 2009). This also indicates that *D. microcarpum* starch is suitable for products which require high gel strength and elasticity. Peak viscosity usually indicates the water binding capacity of a mixture in a product and it is also an indication of viscous load likely to be encountered by a mixing cooker (Ingbian and Adegoke, 2007). The values are higher compared to the values obtained for dried fufu and tapioca (Adebowale *et al*., 2005; Adebowale *et al*., 2008). Soaked sample had the highest trough viscosity (6309.50 RVU) while roasted had the least (5287.50 RVU). There was significant difference (P < 0.05) among samples. Trough viscosity measures the ability of paste to withstand breakdown during cooling (Newport, Scientific, 1998). The breakdown viscosity value is an index of the stability of starch (Fernandez and Berry, 1989). The breakdown viscosity values were 6989, 6718, 6318 RVU for the soaked, roasted and cooked samples, respectively. There was no significant difference (P > 0.05) in their breakdown viscosities. The values were lower than results of Uzomah and Odusanya, (2011) for defatted and undeffatted *D. Microcarpum* flours. Breakdown viscosity is the difference between the peak and trough viscosity and is an indication of the rate of gelling stability, which is dependent on the nature of the product (Newport, 1998).

The final viscosity, which is the ability of starch to form a viscous paste and gel during cooking and after cooling, respectively (Maziya-Dixon *et al*., 2007) ranged from 16026.50 to 13643 RVU. The soaked sample exhibited the highest while roasted sample had least value. The samples showed no significant difference (p > 0.05) between them. The final viscosities (cool-paste viscosity) were very high for all samples and this indicated that retrogradation or precipitation of the linear molecule of *D. Microcarpum* seed is very high. The setback viscosity values were 9717, 8355.50 and 9166 RVU for the soaked, roasted and cooked samples, respectively. There was no significant difference (P > 0.05) in their setback viscosities. The values were much higher than setback viscosities (31.66 and 32.91 RVU) for deffated and undeffatted *D. Microcarpum* seeds as reported by Uzomah and Odusanya, (2011). Sanni *et al*., (2004) reported that lower setback viscosity during cooking of a paste indicates greater resistance to retrogradation. Peak time, which is a measure of the cooking time, had values (3.54, 3.74 and 2.80 min) for soaked, roasted and boiled samples, respectively. The samples showed no significant difference (P > 0.05) in their peak time. The boiled sample had the lowest peak time (2.80 min), which could be as a result of cooking in water during processing. The pasting temperature is a measure of the minimum temperature required to cook a given sample. The temperature at the onset of the rise in viscosity is the pasting temperature (Adebowale *et al*., 2008). The pasting temperature of the flours were 50.15 °C, 50.20 °C and 50.18 °C for soaked, roasted and boiled samples, respectively. There was no significant difference (P > 0.05) among samples. The roasted sample exhibited the highest pasting temperature (50.20 °C) and lower peak viscosity (12005.50 RVU), indicating that there was restricted swelling of the flour granules and also the presence of strong binding forces within the interior of the granules. Restriction to the swelling of starch granules has been associated with high amylose content (Gerald *et* al., 1999).

Phytochemical Composition

The phytochemical compositions of *D. microcarpum* seed flours are presented in Table 4. Phyto-chemistry in the strict sense of the word is the study of phyto-chemicals (Trease and Evans, 1989). In a narrow sense, the term is used to describe the large number of secondary metabolic compounds from plants (Adodo, 2002). Many of these are known to provide protection against insect attacks and plant diseases as seen in BT toxin (*Baccillus thurengensi*) that paralyze insects that feed on the plant. They also exhibit a number of protective functions in human existence (Iwu, 1993). The concentration of flavonoid was higher in the soaked sample (0.82 mg/100 g) while roasted samples had the lowest value (0.66 mg/g). There was significant difference (p<0.05) among soaked, roasted and boiled samples. The results were lower than the report of Igwenyi and Azoro, (2014) for 165.93 mg/100g, 6.17 mg/100 g, 9.75 mg/100 g, 41.89 mg/100 g in *Mucuna sloanei, Brachystegia nigerica, Afzelia Africana* and *D. microcarpum,* respectively and lower than values of 1.56±0.20, 1.45±0.30, and 1.82±0.06, 1.58±0.05 reported by Uhegbu *et al*. (2009) for undehulled and dehulled seeds of *B. eurycoma and D. microcarpum*, respectively. Flavonoids are potent water soluble antioxidants and free radical scavengers, which prevent oxidative cell damage, strong anticancer activity. In the intestinal tract, flavoniods lower the risk of heart disease and provide anti-inflammatory activity (Okwu, 2004). The samples contained saponin in similar concentrations. The values showed no significant difference (P > 0.05) amongst them. However, there seems to be little danger with the concentrations of saponin present, as the saponin ingested are destroyed in the gastro intestinal tract, hence very little is absorbed into the system if any (Uhegbu *et al.*, 2009). The boiled sample had the highest value for tannin (0.67 mg/100 g) while soaked samples had the lowest value (0.34 mg/100 g). There were significant differences (P < 0.05) among the samples. The presence of tannin in *D.microcarpum* explains the darkening of soups within few days of preparation. Tannin being complex phenolic polymer is capable of enzymatic oxidation, hence the pigmentation or browning of foods that contain tannin as seen in some yam species which browns when cut. Tannins have stringent properties, hasten the healing of wounds and inflamed mucous membranes (Agoha, 1974). Tannins are bitter plant polyphenols that either bind and precipitate or shrink proteins.

Table 4: Phytochemical Composition of *D. microcarpum* Flour

Sample	Flavonoid (mg/100g)	Saponin (mg/100g)	Phytate (mg/100g)	Tannin (mg/100g)	Oxalate (mg/100g)
SDF	0.82±0.01^a	0.03±0.00^a	0.87±0.01^a	0.34±0.00^c	0.46±0.01^c
RDF	0.66±0.01^c	0.02±0.00^a	0.23±0.01^c	0.44±0.01^b	0.52±0.01^b
BDF	0.78±0.00^b	0.03±0.00^a	0.57±0.02^b	0.670.01^a	0.86±0.01^a

Values are mean of duplicate samples. Values with the same superscript in the same column are not significantly different (P > 0.05). SDF – Soaked Flour (Control), RDF – Roasted Flour, BDF – Boiled or Cooked Flour

The astringency from the tannin is what causes the dry and puckery feeling in the mouth following the consumption of red wine or an unripened fruit. It main function in nature seems to be one of protection; animals are deterred from eating plants high in tannins because of the bitter, astringent. Tannins have traditionally been considered anti-nutritional but it is now known that its beneficial or anti-nutritional properties depend upon the chemical structure and dosage (Muller-Harvey and McAllan, 1992). Recent studies have demonstrated that products containing chestnut tannins included at low dosages (0.15 - 0.2%) in the diet can improve wellbeing (Schiavone *et al*., 2007). The concentrations of phytate in the samples were 0.87 mg/100g, 0.23 mg/100g and 0.57 mg/100g for soaked, roasted and boiled samples, respectively. There were significant differences (p < 0.05) among the three samples. The boiled sample had the highest oxalate concentration (0.86 mg/g), then roasted sample (0.52 mg/g) while soaked sample had the least (0.46 mg/g). The samples showed significant differences (p < 0.05) among them.

Generally, anti-nutrients are growth inhibitors that bind to protein molecules, thereby hindering digestion, absorption and hence, impairing the growth of organisms. These results in wastage, as crude proteins are passed out along with faeces (Eyo, 2003). Therefore, the decrease in levels of anti-nutrients of the processed seeds is expected to enhance digestibility and absorption potential, and provide nutritional components of the seed to consumers.

4. CONCLUSION

The study showed that *D. microcarpum* flour contains appreciable quantities of nutrients like carbohydrates and protein. The high water absorption capacity of the flour justifies its use as a food thickening agent. The antinutritional factors were reduced by processing especially heat treatments. The *D. microcarpum* flour has a high percentage yield of carbohydrate which can also serve as fuel source for the generation of the energy currency of the cell. Traditional methods of food preparation such as soaking, cooking, and roasting increase the nutritive quality of plant foods through reducing certain anti-nutrients that are found in the food material. The functional properties showed that the seed displayed functional characteristics, which could enhance its applications in food formulations.

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