ASUU JOURNAL OF SCIENCE
A Journal of Research and Development
Vol 3, No. 2, December, 2016; pp. 29-46

Proximate and Antinutrient Profile of Selected Nigerian Soup Thickeners

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Abstract

Freshly dried seeds of Brachystegia eurycoma, Mucuna flagellipe, Detarium microcarpum and Sclerotium of Pleurotustuberregium commonly used as soup thickeners and medicine in the South - Eastern Nigeria were analyzed for their proximate and antinutrient composition. Proximate investigations (%) revealed levels up to 8.05, 1.00, 37.00, 4.50, 9.00 and 40.45 for M. flagellipe; 6.30, 5.50, 20.00, 1.50, 13.00 and 53.70 for B.eurycoma; 7.35, 4.00, 37.00, 14.50, 14.50 and 22.65 for D. microcarpum; 10.85, 5.50, 45.00, 0.50, 2.20 and 35.95 for Sclerotium of P. tuberregium,for crude protein, crude fiber, moisture content, ash, crude fat and carbohydrate respectively. Among the antinutrients studied, sparteine, ribalinidine, saponin, lunamarine and phenols were detected in all samples. Their respective mean concentrations (μg ml-1) were 9.068, 0.475, 0.143, 0.013, and 0.014 for M. flagellipe; 5.385, 0.951, 0.289, 0.018 and 0.020 for B. eurycoma; 3.139, 0.264, 0.233, 0.038, and 0.018 for D. microcarpum and 8.985, 0.818, 0.196, 0.014 and 0.023 for Sclerotium of P. tuberregium. Flavonoids (anthocyanin) were not detected in D. microcarpumbut gave0.002, 0.003 and 0.007 μg ml-1 for M. flagellipe, B. eurycoma, and Sclerotium of P. tuberregium respectively. Similarly, oxalates were found in low concentration (0.006 μg ml-1) in B. eurycoma. Tannins

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on the other hand, were detected in M. flagellipe(0.001 μg ml-1) and D. microcarpum (0.057 μg ml-1). This study therefore recommends consumption of these Nigerian soup thickeners giving observed high nutritional and low antinutritional composition and implications to health are discussed.

Keywords: *Soup thickeners; Proximate profile; Antinutrients; South - Eastern Nigeria.*

Introduction

In Nigeria, various indigenous plant parts/products are used as food; such plants include *Brachystegia eurycoma*, *Mucuna flagellipe*, *Detarium microcapum* and Sclerotium of *Pleurotus tuber-regium* respectively called Achi, Ukpor, Ofor and Usu in Nigerian Igbo language (language of the South-Eastern part of Nigeria). In West Africa, dietary pattern vary and is influenced by the vegetation belt. For example in the northern part of Nigeria, cereals dominate their diet, while in the south; legumes, nuts, seeds and starchy roots or tubers constitute the main food (Ene-Obong and Carnovalue, 1982). However, processing of these cereals and starch roots into puddings and eventual consumption with soup(s) is the general practice in Nigeria, irrespective of region (Nnamani *et al.,* 2009). Among the legumes used in soups (mainly for emulsification and stabilization) are *B. eurycoma, D. microcapum, M. flagellipe* and Sclerotium of *P. tuber-regium*. Each of the soup thickeners differs in specie from the others and so have their individual characteristic flavours, which they impart to soups (Ezeoke, 2010; Nwosu, 2012). B. eurycoma, *M. flagellipe, D. Microcarpum* and Sclerotium of *P. tuber-regium* are naturally found in tropical and sub-tropical areas of the world.

In a bid to find the 'mysterious' whole and nutritious foods, to combat hunger and rampaging diseases, it may be apposite to x-ray existing food to identify impact and opportunity. Nutrient-dense, whole, good tasting, familiar and available, but also affordable foods are most hunted by experts (The George Mateljan Foundation, 2015) to effectively make prescription towards excellent health. Although unified definition has been difficult (Drewnowski, 2005), the fact still remains that data gathering on familiar, available and affordable

foods to determine how healthful they are, is a step in the right direction. Ajayi *et al.* (2006) canvassed for detailed knowledge of food materials for appropriate choice of nutrition and combination.

Brachystegia eurycoma is locally known as 'Achi' by the Ibos, 'Akolodo' by Yorubas; 'Okweri' by the Binis; 'Eku' by the Isharis; 'Ukung' by the Efiks; 'Akpakpo' by Ijaws and 'Oyam' by the Kwales. Similarly, *Detarium microcarpum* is locally called 'Ofo' by the Ibos; 'Ogbogbo' by the Yorubas and 'Taura' by the Hausas. *Mucuna flagellipe* has its local names as 'Ukpo' by the Ibos, 'Yerepe' by the Yorubas and 'Karasau' by the Hausas (Ayozie, 2010). The sclerotium of *Pleurotus tuber-regium* is called 'Katala' by the Hausas, 'Umoho' by the Igedes, 'Usu, Ike usu or Erousu' by the Ibos and 'Awu' by the Igalas, all in Nigeria (Ikewuchi and Ikewuchi, 2009). In forms in which they are eaten in the South-Eastern Nigeria, they have not been highly processed nor do they contain synthetic, artificial or irradiated additives and/or ingredients. The voracious use of these plant parts/ products in the South-Eastern Nigeria as soup thickeners and condiments necessitated a probe into their proximate profile and anti-nutrient composition. This study is therefore aimed at evaluating the chemical and anti-nutritional composition of *M. flagellipe* seeds, *B. eurycoma* seeds, *D. microcapum* seeds and Sclerotium of P. *tuber-regium* used as soup thickeners in most parts of Nigeria and the objective is to highlight the implication of their frequent consumption given global concern for nutritional hunger.

MATERIALS AND METHODS

The mature freshly dried seeds of *Mucuna flagellipe, Brachystegia eurycoma, Detarium microcarpum* and the sclerotium of *Pleurotus tuber-regium* were bought as sold in Eke-oyigbo market. The seeds were sorted to remove debris and unviable ones and stored in cellophane bags to avoid contamination.

PRE-DEHULLING TREATMENTS

The traditional method of processing was adopted in the treatment of seeds of *Brachystegia eurycoma*. The seeds after sorting were oiled with palm oil and kept for 12 hours, then roasted for 10-15 minutes; after which it was soaked for 4 hours in cold distilled water and

dehulled after which the cotyledons were soaked overnight in distilled water. The water was drained off and the cotyledons sun-dried and finally ground into fine powder.

The seeds of *Detarium microcarpum*, were oiled with vegetable oil and kept for 12 hours, then roasted for 10-15 minutes; after which it was soaked for 4 hours in cold water and dehulled. The seeds were washed for 3 or 4 times with distilled water and soaked overnight in distilled water. The water was drained off and the seeds sun dried and then milled.

Seeds of *Mucuna flagellipe*, were cracked, boiled for 20mins and dehulled. The seeds were washed for 3 or 4 times with distilled water and soaked overnight in distilled water. The water was drained off and the seeds sun dried and then milled.

Sclerotium of *Pleurotus tuber-regium* was peeled, sun dried and then milled.

Proximate Composition Analysis

Standard conventional methods were employed in all the analyses.

Crude fat

Crude fat was extracted by the soxhlet extraction method with petroleum ether at 40°C for 8 hours.Two grams of the sample was loosely wrapped with a filter paper and put into the thimble which was fitted to a clean round bottom flask, which has been cleaned, dried and weighed. The flask contained 120 ml of petroleum ether. The sample was heated with a heating mantle and allowed to reflux for 5 hours. The heating was then stopped and the thimbles with the spent samples kept and later weighed. The difference in weight was received as mass of fat and is expressed in percentage of the sample. The percentage oil content is percentage fat = ((W2 - W1) x 100)/ W3

Where W1 = weight of the empty extraction flask, W2 = weight of the flask and oil extracted, W3 = weight of the sample.

Crude protein

The micro kjeldahl method described by AOAC (2006) was used. One gram of each of the triplicate samples was mixed with 10 ml of

concentrated H_2SO_4 in a heating tube. One gram of selenium catalyst was added to the tube and the mixture heated inside a fume cupboard. The digest was transferred into distilled water. Ten milliliters portion of the digest mixed with equal volume of 45% NaOH solution and poured into a kjeldahl distillation apparatus. The mixture was distilled and the distillate collected into 4% boric acid and indicator mixture containing 5 drops of Bromocresol blue and a drop of methylene blue. A total of 60 drops of distillate was collected and titrated to pink color using 0.01 M Hydrochloric acid. The Nitrogen content was calculated and multiplied with 6.25 to obtain the crude protein content.

This is given as percentage Nitrogen = Titre value x 0.01 x 14 x 4

Percentage crude Protein = % Nitrogen × 6.25

Available carbohydrate

The nitrogen free method described by AOAC (2006) was used. The carbohydrate is calculated as weight by difference between 100 and the summation of other proximate parameters as Nitrogen free Extract (NFE) percentage carbohydrate (NFE). = 100 - (M + P + F1+ A + F2)

Where M = Moisture, P = Protein, F1 = Fat, A = Ash, F2 = Crude fibre

Crude fibre

Two grams (2g) sample and 1g asbestos were put into 200 ml of 1.25% of H_2SO_4 and boiled for 30 minutes. The solution and content were then poured into Buchner funnel equipped with muslin cloth and secured with elastic band. This was allowed to filter and residue was then collected into 200 ml of 1.25% hot NaOH and boiling continued for 30 minutes, then transferred to the buchner funnel and filtered. It was then washed 3 times with hot water; the material obtained was washed thrice with acetone. The residue obtained was put in a clean dry crucible and dried at 130°C and ashed at 550°C in the moisture extraction oven to a constant weight. The dried crucible was removed, cooled and weighed. Then, difference of weight (i.e. loss in ignition) is recorded as crucible fibre and expressed in

Percentagecrude fibre = ((W1 - W2) x 100)/W3

Where W1 = weight of sample before incineration, W2 = weight of sample after incineration, W3 = weight of original sample.

Ash

Two grams of each of the triplicate samples was weighed into crucibles, heated in a moisture extraction oven for 3 hours at 100°C before being transferred into a muffle furnace at 550°C until it turned white and free of carbon. The sample was then removed from the furnace, cooled in a desiccator to a room temperature and reweighed. The weight of the residual ash was then calculated as Ash Content

Percentage Ash = (Weight of Ash x 100)/ Weight of original of sample

Moisture contents

Two grams of each of the triplicate sample was weighed into dried weighed crucibles. The samples were put into a moisture extraction oven at 105°C and heated for 3 hours. The dried samples was put into desiccators, allowed to cool and reweighed. The process was reported until constant weight was obtained. The difference in weight was calculated as a percentage of the original sample.

Percentage moisture = [((W2 - W1) x 100)/(W2 - W3)]

WhereW1 = Initial weight of empty dish, W2 = Weight of dish + no-dried sample, W3 = Weight of dish + dried sample

DETERMINATION OF ANTINUTRIENTS IN THE SELECTED NIGERIAN SOUP THICKENERS

Twenty grams (20g) of the samples were mixed with 60g of anhydrous sodium sulphate in agate mortar to absorb moisture. The mixture was placed in the extraction cellulose thimble, covered with Whatman filter paper and inserted into a soxhlet extraction chamber of the soxhlet unit. Extraction was done with 200 ml of n-hexane using EPA 354°C method for 8 hours. Crude extract obtained was evaporated using a rotary vacuum evaporator at 40°C and residue transferred with n-hexane onto a 5ml florisil column.

Florisil Clean Up and Separation

Florisil was heated in an oven at 130^{0}C overnight and was transferred to a 250 ml size beaker and placed in a dessicator. Moderately packed glass wool of 1cm thick was placed at the bottom of an 8 ml separating funnel. Anhydrous sodium sulphate (0.5 g) was added to 1.0 g of activated florisil (magnesium silicate) and poured into the separating funnel plugged with glass wool. Five millilitres of n-hexane was added to the separating funnel for conditioning. The stopcock was opened to allow the n-hexane run out until it is slightly above the sodium sulphate in a receiving vessel while tapping the top of the separating funnel gently till the florisil settles well in the flask. The extract was transferred to the separating funnel with disposable Pasteur pipette from the evaporating flask and each evaporating flask was rinsed twice with 1ml portions of n-hexane and added to the funnel. The eluate collected was transferred into an evaporating flask and placed in a rotary evaporator and evaporated to dryness. The dry eluate was dissolve in 1ml n-hexane and labelled GC sample.

Gas Chromatographic Analysis

The concentrated GC sample fraction was transferred into labelled glass vials with Teflon rubber crimp caps for GC analysis. The concentrated GC sample (μg/ml) was injected by means of hypodermic syringe through a rubber septum into the column. Separation occurs as the vapour constituent partition between the gas and liquid phases. The sample was automatically detected as it emerges from the column (at a constant rate) by the FID detector whose response is dependent upon the composition of the vapour (Martinez *et al.*., 2004).

Statistical Analysis

All data was subjected to statistical analysis. Values are reported as Mean$\pm$standard error of mean (SEM). Significant differences between values are determined using the ANOVA (Analysis of Variance), differences existed at $p < 0.05$.

RESULTS

Obtained results show proximate and antinutrient profile of *Mucuna flagellipe, Brachystegia eurycoma, Detarium microcarpum* and Sclerotium of *Pleurotus tubber-regium.* Means were compared at p?0.05 using analysis of variance (ANOVA).

Table 1: Proximate profile of *Mucunaflagellipe, brachystegi aeurycoma Detarium microcarpum* and Sclerotium of *Pleurotus tubber-regium* (mg/100 g dry weight)

Parameters *(%)*	*M.flagellipe*	*B.eurycoma*	*D.microcarpum*	*Sclerotium of tubber-regium*
Crude protein	8.05±0.010ab	6.30±0.006a	7.35±0.007b	10.85±0.006c
Crude fibre	1.00±0.010c	5.50±0.010a	4.00±0.006b	5.50±0.010a
Moisture	37.00±0.035c	20.0±0.010a	37.00±0.006c	45.00±0.010ab
Ash	4.50±0.006ab	1.50±0.000b	14.50±0.010a	0.50±0.010c
Crude fat	9.00±0.010 b	13.00±0.006c	14.50±0.010ab	2.20±0.010a
Carbohydrate	40.45±0.025c	53.70±0.029b	22.65±0.029a	35.95±0.000a

Data are means ± standard error of triplicate determinations. Means in same row with same alphabets are not significantly different at p?0.05.

Table 2: *Antinutrient profile* of *Mucuna flagellipe, Brachystegia eurycoma, Detarium microcarpum* and Sclerotium of *Pleurotus tubber-regium* (μg/ml)

Parameter	*M.flagellipe*	*B.eurycoma*	*D.microcarpum*	Sclerotium of *P.tubber-regium*
Sparteine	9.068 ± 0.001^{a}	5.386 ± 0.001^{ab}	3.139 ± 0.001^{b}	8.985 ± 0.000^{c}
Oxalate	NIL	0.006±0.000	NIL	NIL
Anthocyanin	0.002 ± 0.000^{a}	0.003 ± 0.000^{b}	NIL	0.007 ± 0.000^{c}
Phenol	0.014 ± 0.000^{a}	0.020 ± 0.000^{ab}	0.018 ± 0.000^{b}	0.023 ± 0.000^{c}
Lunamarine	0.013 ± 0.000^{a}	0.018 ± 0.000^{ab}	0.038 ± 0.000^{b}	0.014 ± 0.000^{c}
Saponin	0.143 ± 0.000^{b}	0.289 ± 0.000^{c}	0.233 ± 0.000^{ab}	0.196 ± 0.000^{a}
Ribalinidine	0.475 ± 0.000^{a}	0.951 ± 0.000^{ab}	0.264 ± 0.000^{b}	0.818 ± 0.000^{c}
Tannin	0.009 ± 0.000^{b}	NIL	0.057 ± 0.000^{a}	NIL

Data are means ± standard error of triplicate determinations. Means in same row with same alphabets are not significantly different at p?0.05.

Nutrient density is a measure of the amount of nutrients a food contains in comparison to the number of calories. A food is more nutrient dense when the level of nutrients is high in relationship to the number of calories the food contains. By eating the World's Healthiest Foods, one will get all the essential nutrients that you need for excellent health, including vitamins, minerals, phytonutrients, essential fatty acids, fiber and more for the least number of calories. And whenever possible, the healthier way of eating recommends purchasing "Organically Grown" foods, since they not only promote your health, but also the health of our planet. Requirements differ from individual to individual depending on calorie needs. Given the current dietary trends, the nutrient density approach can be a valuable tool for nutrition education and dietary guidance. The nutrient density standard, as defined by the FDA, is the ratio of the amount of beneficial nutrients relative to the food's energy content per reference amount customarily consumed. The advice to limit the consumption of energy-rich foods is grounded in the assumption that energy density and nutrient density are inversely linked.From table 1, crude protein, crude fibre, moisture, ash, crude fat and carbohydrates levels (%) ranged from 6.3 - 10.9, 1.0 - 5.5, 20 - 45, 1.5 - 14, 2.2 - 14.5 and 23.1 - 53.7 respectively. On the other hand, antinutrient profile (μg/ml) of *Mucuna flagellipe, Brachystegia eurycoma, Detarium microcarpum* and Sclerotium of *Pleurotus tubber-regium* ranged from 3.1 - 9.1, below detection limit - 0.01, below detection limit - 0.01, 0.01- 0.02, 0.01 - 0.04, 0.1 - 0.3, 0.3 - 1.0 and below detection limit - 0.06 for sparteine, oxalate, anthocyanin, phenol, lunamarine, saponin, ribalinidine and tannin respectively (Table 2).

Discussion

The studied soup thickeners are relatively rich in carbohydrate, with *Brachystegia eurycoma* having the highest value of 53.00, followed by *Mucuna flagellipe*, Sclerotium of *Pleurotus tuber-regium* and *Detaruim microcarpum* with observed values of 40.45, 35.95 and 22.65 all in percentages respectively, which are lower than that reported by Ali (2011) 65.84% for *Chlorophytum comosum* and Igwenyi and Azoro (2014) for *M. sloanei* 70.71%, *D. microcarpum*

70.38%, *B. nigerica* 65.97%, the decrease could be as a result of the processing method in the preparation of the seed samples and other environmental factors. Food thickeners frequently used are based on polysaccharides (starch) content, vegetable gums, proteins, corn-starch, potato, or tapioca (Morton, 2004).

Moisture content was in this order Sclerotium of *P. tuber-regium M. flagellipe D. microcarpum B. eurycoma.* The quality of vegetables and fruits are usually inspected visually based on colour. Moisture content is the main parameter influencing the colour of fruits and vegetables. Controlling the amount of moisture content is a major critical issue in monitoring the quality of foods and other products in industries (Norimi *et al.*, 2012). Microbial activity of the food materials is enhanced with the moisture availability in the food. Moisture rich foods are easily susceptible to the microbial attack and got rotted and damaged. Thus the shelf life of the food material is determined by the moisture content in the food.Low moisture foods usually slow down growth of microorganisms hence the need for analysis and control of food moisture. These slightly high moisture contents of 45.00, 37.00, 37.00 and 20.00 (%) for the earlier order, also implies that dehydration would increase the relative concentration of other food nutrient and therefore would improve the shelf-life or preservation of the seeds. There is also need to store the seeds in cool condition if they would be kept for a long period to avert spoilage. There is significant difference at $P \leq 0.05$ in moisture content between *B. eurycoma, M. flagellipe, D. microcarpum* and Sclerotium of *P. tuber-regium*. The implication is that *B. eurycoma* will have a longer shelf-life than *M. flagellipe, D. microcarpum* and Sclerotium of *P. tuber-regium.*

The protein contents of the seeds as shown in table 1 above were (%) Sclerotium of *P. tuber-regium* (10.85)having the highest amount, followed by *M. flagellipe* (8.05), *D. microcarpum* (7.35) and *B. eurycoma* (6.30) which are comparable to that earlier reported by Agomuo (2011) 7.88% for Sclerotium of P. tuberregium and Uhegbuet al. (2009) 8.20% and 7.20% for D. *microcarpum* and *B. eurycoma* respectively. The functions of protein which includes supply of amino acids, body building and replacement of worn-out tissues may be achieved with these selected soup thickeners. Since Sclerotium

of P. tuberegium has the highest crude protein content, it implies that this soup thickener can contribute significantly to the daily human protein requirements.

The percentage composition of crude fat was also investigated in the samples (table 1). *D. microcarpum* (14.50), *B. eurycoma* (13.00), *M. flagellipe* (9.00) and Sclerotium of *P. tuber-regium* (2.20) which were comparable to that earlier reported by Igwenyi and Azoro (2014) and Uhegbu *et al.* (2009) 15.50%, 14.00% for *D. microcarpum* and *B. eurycoma* respectively. But the values are same compared to that earlier reported by Agomuo (2011) for Sclerotium of *P. tuber-regium*. The significance of fat in food may not be over-emphasized as it contributes greatly to the energy value of foods. It could also slow down the rate of utilization of carbohydrates. During starvation, fat can 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 lubricant in the intestine (Uhegbu *et al.,* 2009). When fats are digested, emulsified, and absorbed, they facilitate the intestinal absorption and transport of fat soluble vitamins A, D, E, and K. They are also used to cushion and protect the heart, kidneys and liver. In certain climates subcutaneous body fat helps to insulate the body from the cold and prevent heat loss through the skin.

Ash content was also investigated, which is high in *D. microcarpum* (14.00), *M. flagellipe* (4.50) and *B. eurycoma* (1.50) but low in Sclerotium of *P. tuber-regium* (0.50) compared to that earlier reported by Agomuo (2011) 1.20 for Sclerotium of *P. tuber-regium*. The proportion of ash content is a reflection of the mineral contents in the food materials (Nnamani *et al..,* 2009). With the ash reported in this study *B. eurycoma* has a high reflection of mineral contents but *D. microcarpum* and Sclerotium of *P. tuber-regium* may have a low mineral content.

Crude fiber content was high in Sclerotium of *P. tuber-regium* (5.50), *B. eurycoma* (5.50), *D. microcarpum* (4.00) and *M. flagellipe* (1.00) compared to that earlier reported by Uhegbu *et al.* (2009) 1.10% for *D. microcarpium*. Fiber regulates bowel actions and may help to guard against colon and rectal cancer as well as in diabetes.

Crude fiber is the inorganic residue left after the defatted food materials have been treated with boiling dilute hydrochloric acid, diluted sulphuric acid, boiling dilute sodium hydroxide, alcohol and ether. 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). According to Igwenyi (2008), fiber is 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. Excessive intake of fiber, however can reduce the transit time through the intestines to such a degree that other nutrients cannot be absorbed.

Among the antinutrients studied, sparteine (alkaloid), ribalinidine (alkaliod), saponin, lunamarine (alkaloid) and phenols were present in all samples. Their concentrations (μg/ml) were 9.068, 0.475, 0.143, 0.013, and 0.014 for *M. flagellipe*, 5.385, 0.951, 0.289, 0.018, 0.020 for *B. eurycoma*, 3.139, 0.264, 0.233, 0.038, and 0.018 for *D. microcarpum* and 8.985, 0.818, 0.196, 0.014 and 0.023 for Sclerotium of *P. tuber-regium* respectively. The presence of alkaloids in these soup thickeners is of interest. This is because alkaloids have dual functions. At high concentrations most alkaloids are toxic, while having pharmacological effects at low concentrations. Alkaloids often have pharmacological effects and are used as medications, as recreational drugs, or in entheogenic rituals. Alkaloids are also known to regulate plant growth. Some alkaloids can produce developmental defects in the offspring of animals that consume it but cannot detoxify the alkaloids (Andreas, 2009). The alkaloids values obtained was low compared to that earlier reported by Uhegbu *et al.* (2009) 1.25 mg/g for *B.eurycoma*. In plants, saponins may serve as anti-feedants and to protect the plant against microbes and fungi (Foerster, 2006). Some plant saponins may enhance nutrient absorption and aid in animal digestion. However, saponins are often bitter to taste and so can

reduce plant palatability (e.g in livestock feeds), or even imbue them with life-threatening animal toxicity (Jonathan *et al.*, 2004). Saponin values obtained were low compared to that earlier reported by Igwenyi and Azoro (2014) 0.56 mg/100 g for *Mucunasloanei.* Phenol and its vapors are corrosive to the eyes, the skin, and the respiratory tract (Budavari, 1996). Its corrosive effect on skin and mucous membranes is due to a protein-degenerating effect. The values for phenol were lower than 0.146% for *M. flagellipe* earlier reported by Onuegbu *et al.* (2011).

Flavonoids (anthocyanin) were not detected in *D. microcarpum*, 0.002, 0.003 and 0.007(μg/ml) for *M. flagellipes*, *B. eurycoma*, and Sclerotium of *P. tuber-regium* respectively which was low compared to that reported by Igwenyi and Azoro (2014) 6.55 mg/100 g for *Afzelia africana*. Anthocyanin is a class of flavonoids that have beneficial effects on human health and have been reported to have antiviral, anti-allergic, anti-platelet, anti-inflammatory, anti-tumor and anti-oxidant activities (Tripoli *et al.*, 2007). Epidemiological studies have shown that flavonoid intake is inversely related to mortality from coronary heart disease and to the incidence of heart attacks (Narayama *et al.*, 2001).

Similarly, oxalates were found in low concentration (0.0055 μg/ml) in *B. eurycoma* which is lower than 1.08 mg/100 g reported for *Afzelia Africana* (Igwenyi *et al.*, 2013). Oxalates bind to calcium and prevent its absorption in the human body.

There was no oxalate and in the other hand, there was tannins detected in *M. flagellipe* (0.0009 μg/ml) and *D. microcarpum* (0.0567 μg/ml) these values are lower than 0.38-0.77 mg/100 g reported for *Glycine max* and *Vigna unguiculata* (Okwu and Orji, 2007). According to Emijiugha and Agebede (2000) and Mada *et al.* (2012), tannin usually forms insoluble complex with proteins, thereby interfering with their bioavailability. Poor palatability is generally attributed to high tannin diets. 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 are capable of leaving available protein by antagonistic competition and can therefore elicit protein deficiency syndrome, 'Kwashiorkor' (Bolanle *et al.*, 2014).

Conclusion

From the results obtained from this work, an insight of the proximate profile of the four selected Nigerian soup thickeners Ukpor (*Mucuna flagellipe*), Achi (*Brachystegia eurycoma*), Ofor (*Detarium microcarpum*) and Usu (Sclerotium of *Pleurotus tuber-regium*) is given. The nutritional profile of all the selected Nigerian soup thickeners showed a high level of moisture, carbohydrate, fat and protein which are essential for man and livestock which are macro-nutrients needed in large quantities for growth and maintenance of the body. These four selected Nigerian soup thickeners have great nutritional values which could be used to meet the nutritional needs of the teeming population. Use of Usu as seen from the study has low calorie implications and may be explored by 'weight-watchers'. Antinutrient composition of four selected Nigerian soup thickeners were well below the permissible level of 0.00054 mg/g for saponin, 0.01-0.02 ppm for oxalate, 0.015 mg/g for tannins, 30 mg/100 g for phenol in food crop.Values exceeding these would adversely affect their nutritional values or cause any of the toxic effects associated with the anti-nutrients. This could mean that the four selected soup thickeners may not pose adverse conditions in human nutrition.

Given high carbohydrate composition, fat and protein contents of the seeds, it is therefore suggested that Achi, Ofor, Usu and Ukpor could serve as supplementary source of essential nutrients to man and livestock.Low antinutritional content suggested that Ukpor, Achi, Ofor and Usu may serve as safe food additives, consumption and production is hence recommended. Also, following relatively high moisture content observed, packaging of these thickeners should be preceded by adequate drying to prevent recurring spoilage.

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