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PROXIMATE AND MINERAL CONTENT OF SELECTED CONDIMENTS USED AS THICKENERS IN SOUP PREPARATION

Lawal, H. Z.,[1] Madu, P. C.,[2] Opaluwa, O, D.,[2] Mohammed, Y.,[2] Shuaibu B. S.[2]
[1]Department of Medicinal Chemistry and Quality Control, National Institute for Pharmaceutical Research and Development, Abuja. Nigeria
[2]Department of Chemistry, Nassarawa State University, Keffi, Nassarawa State
*Corresponding author: yarlawal@gmail.com 08036928415

ABSTRACT
This study determined the proximate and mineral content of Detarium microcarpum, Cissus populnea, Grewia mollis and Parkia biglobosa. The proximate content (moisture, ash, fat, fibre, protein and carbohydrate) were analyzed using methods of Association of Official Analytical Chemists (AOAC), while the mineral contents (Na, Ca, Fe, K, Mg, Zn, Se, Pb and Cr) were analyzed using Atomic Absorption Spectrometric Method. The results revealed the range of proximate and mineral content of Detarium microcarpum, Cissus populnea, Grewia mollis and Parkia biglobosa as 10.30 – 14.33% (Moisture), 2.67 – 18.87% (Ash), 1.53 - 4.70% (Fat), 8.74 – 13.15% (Protein), 18.11 – 48.20% (Fibre) and 12.48 – 53.13% (Carbohydrate). Analysis of variance (ANOVA) of the moisture, crude fibre and carbohydrate content reveals that there is significant difference observed among the samples. The mineral content was in the range of 84.00 – 932.00 µg/g (Na), 1346.00 – 18636 µg/g (Ca), 11.50 – 784.00 µg/g (Fe), 148.00 – 3659.00 µg/g (K), 148.00 -1306.00 µg/g (Mg), 7.00 – 57.00 µg/g (Zn), 8.00 – 17.00 µg/g (Se), ND – 1.00 µg/g (Pb) and 1.00 – 2.00 µg/g (Cr). The analysis of variance (ANOVA) of Na, Ca, Fe, Mg and Zn shows that there is significant difference observed among the samples. (Energy value: 3.067kcal/100g (DM), 1.118kcal/100g (CP), 1.200kcal/100g and 2.048kcal/100g (PB). The outcome of this study indicated that the condiments are rich source of many important nutrients that appear to have a very positive effect on human health.
Keywords: AAS, AOAC, Condiments, Minerals and Proximate.

INTRODUCTION

Developing countries including Nigeria are facing malnutrition and health problems. The major nutritional problems in these countries have been identified as insufficient food intake, consequent high prices of food and unbalanced food dieting. Conventional legumes and some dicotyledonous seeds, which have been proved to be a better and economically favorable alternative source of proteins and energy have played a major role in the management of these problems (Muhammad *et al*., 2016). Food condiments used as thickeners are globally used for centuries to provide certain textures to our meals. Thickening agents, often known as thickeners, are compounds that when added to a mixture, increase its viscosity while leaving other attributes, such as flavor and scent untouched. Popular thickeners are corn flour, corn starch, cream, yogurt and white flour. However, there are a good number of traditional soup thickeners like the (*Mucuna sloanei, Brachystera nigerica*, *Afzelia africana* etc,) that are lesser- known and offer much more than just providing texture to our foods (Ene-Obong and Carnovale, 1992). Soup is a tasty, popular food. It is nutritious, wholesome, and stimulates the appetite. Thickening, usually improves the taste, but most important is the nutritional value of foods. Every time the soup is thickened, its nutritive value is determined by the ingredients added to it. In the South-Eastern part of Nigeria, soup is the center of the people's daily food and culture. Almost all the carbohydrate diet is accompanied with one form of soup or another. Thus, pounded yam, boiled yam, processed cassava (garri and fufu), rice potato, cocoyam and water yam are taken with soup daily. These soups are prepared with different plant parts (such as seeds, leaves and fruits which are used as thickeners because of their thickening properties in soups. They are also known to be good sources of protein and vitamins (Oben *et al*., 2008).

With high content of protein, leguminous condiments serve as a tasty complement to sauces and soups and can substitute for fish or meat. In addition, they are also employed in dietary strategies to control obesity due to their high fibre, low carbohydrate and fat contents rather than physical exercise (Chukwu *et al*., 2018). They are healthy diets which boosts the brain power, protect the heart and prevents cancer (Green *et al*., 2012). Food condiments are helpful in food garnishing as appetizers as well as adding more value to foods. Most chemicals responsible for those distinctive taste and smell are compounds known as essential oils or volatile oils.

Despite the huge nutritional values and the availability of local condiments such as *Detarium microcarpum, Cissus populnea, Grewia mollis* and *Parkia biglobosa* for food preparations, these products still suffer from the problem of underutilization. The food use and consumption of these food thickeners calls for more research to provide information on their actual nutritional values, health and other medicinal importance. This study was aimed at determining the proximate and mineral contents of these condiments used as soup thickeners in order to ascertain their nutritional value.

MATERIALS AND METHODS

Materials and Reagents Used

All the equipments used were calibrated: Moisture balance (Model: MB200, England OHAUS), Analytical weighing balance (OHAUS Analytical plus, England), Atomic Absorption Spectroscopy (GBC AvantaGF300, Switzerland), Micro-kjedahl apparatus (S. W. Germany), Muffle furnance (Korl- kolb, Germany). All the reagents used in this study were of analytical grades purity; glass-wares of appropriate sizes were properly washed using appropriate solvents and rinsed with deionized water.

Sample Collection and Preparation

The samples: *Detarium microcarpum*, *Cissus populnea*, *Grewia mollis* and *Parkia biglobosa* each were purchased from Gwagwa market FCT, Abuja, Nigeria. The samples were identified and authenticated by a taxonomist at the Herbarium Unit, National Institute for Pharmaceutical Research and Development, Idu- Abuja, Nigeria. A voucher specimen was deposited at the herbarium of the institute with voucher specimen numbers NIPRD/H/7241, NIPRD/7242, NIPRD/7243, NIPRD/7244 for *Detarium microcarpum*, *Cissus populnea*, *Grewia mollis* and *Parkia biglobosa* respectively. They were cleaned by picking out stones and other impurities. The cleaned samples were pounded into powder form using mortar and pestle. Then powdered samples were stored in an air tight container, properly labelled and kept at room temperature for subsequent analysis.

Proximate Analysis

The recommended methods of the Association of Official Analytical Chemists (AOAC, 2006) were used for the determination of moisture, ash, crude protein, and crude lipid and crude fibre content. Moisture content determination: One (1.0g) gram of each sample was weighed, dried in an oven (Gallenkamp, UK) at 105^0C and allowed to cool in a desiccator and weighed until constant weight was obtained. The percentage loss in weight was expressed as percentage moisture content. Ash content was determined by the incineration of one (1.0g) gram of each sample in a muffle furnace thermostat at 550^0C for 3 hours. The percentage residue weighed was expressed as ash content. The Nitrogen content was estimated by micro- kjeldahl method based on the assumption that plant proteins contain 16% nitrogen, the protein content of each sample was calculated using the formula, $Protein = percentage\ nitrogen \times 6.25$. Crude lipid was assayed by exhaustively extracting one grams of each sample for 3 hours with petroleum ether in a soxhlet apparatus. Crude fibre was estimated by acid and alkaline digestion

methods with 1.25% H_2S0_4 (W/V) and 1.25% NaOH (W/V) solutions. Available carbohydrates were calculated by subtracting the total of the percentages of moisture, ash, crude protein, crude lipid and crude fibre from 100% moisture free samples, AOAC (2006). Calorific value (CV) was determined using the following equations: $CV\ \left(\frac{kcal}{100g}\right) = (CHO\ \times 4)\ \times (CL\ \times 9) \times (\mathrm{CP}\ \times 4)$ (Hassan *et al.,* 2008).

Sample Preparation and Analysis for Elemental Content

The samples were ash and digested with a mixture of concentrated nitric acid and hydrochloric acid (1:10), filtered into $50cm^3$ volumetric flask through Whatman filter paper, made-up to mark with deionized water and transferred into caped plastic bottle. The sample digestion process was used for blank sample preparation. The solution of the digested condiments samples were analyzed for Calcium (Ca), Copper (Cu), Iron (Fe), Magnesium (Mg), Selenium (Se), Lead (Pb), Chromium (Cr), Potassium (K), Sodium (Na) and Zinc (Zn) using Atomic Absorption Spectrometer (AAS) after optimization and calibration followed by blank. The readings of the standards, blank and the analyte concentrations and absorbance were rounded off from measurements in triplicate.

Statistical Data Analysis

All the data obtained were subjected to statistical analysis using PRISM Graphad Software version 5. One-way analysis of variance (ANOVA) was performed on the data where Mean, range. Standard deviation, standard error and p-value were obtained. The level of statistical significance was set at $p<0.05$.

RESULTS AND DISCUSSION

The results for the proximate and elemental composition of *Detarium microcarpum, Cissus populnea, Grewia mollis* and *Parkia biglobosa* are presented in Table 1 and 2.

Table 1: Proximate composition of the samples (% dry matter)

Parameter	GM	CP	DM	PB
Moisture	13.33± 0.57^{c}	12.00 ± 1.00^{b}	14.33 ± 0.57^{d}	10.30 ± 1.15^{a}
Ash	10.60 ± 0.10^{b}	18.87 ± 0.32^{c}	2.83 ± 0.05^{a}	2.67 ± 0.57^{a}
Crude lipid	1.93 ± 0.12^{a}	1.53 ± 0.07^{a}	4.70 ± 0.17^{b}	2.00 ± 0.30^{a}
Crude protein	13.15 ± 0.01^{c}	8.74 ± 0.01^{a}	12.99 ± 0.02^{c}	9.83 ± 0.02^{b}
Crude fibre	48.20 ± 0.27^{d}	42.37 ± 0.23^{c}	18.11 ± 0.11^{a}	30.50 ± 0.01^{b}
Carbohydrate	12.48 ± 0.01^{a}	15.79 ± 0.01^{b}	53.13 ± 0.01^{d}	40.90 ± 0.01^{c}
Energy value	1.200kcal/100g	1.118kcal/100g	3.06kcal/100g	2.048kcal/100g

All values were mean ± standard deviation of three triplicate determinations.
Values in the same row with different superscript differs significantly ($P < 0.05$)
ND= Not Detected
Key: GM = *Grewia mollis*
CP = *Cissus populnea*
DM = *Detarium microcarpum*
PB = *Parkia biglobosa*

Table 2: Mean Concentration of Mineral Content (µg/g) of the samples

Mineral	GM	CO	DM	PB
Sodium	84.00 ± 0.33^{a}	124.00 ± 0.33^{b}	136.00 ± 0.17^{c}	932.00 ±14.30^{d}
Calcium	16495.00 ± 3.26^{d}	18636.00 ± 3.35^{c}	1346.00± 0.15^{b}	173.00 ± 0.37^{a}
Iron	11.50 ± 0.01^{a}	784.00 ± 0.12^{d}	88.00 ± 0.01^{c}	55.00 ± 0.01^{b}
Potassium	3659.00 ± 0.53^{c}	4209.00 ± 0.45^{d}	1704.00± 0.15^{b}	148.00 ± 0.36^{a}
Magnesium	1306.00 ± 0.19^{c}	1801.00 ± 0.45^{d}	288.50 ± 0.10^{b}	148.00 ± 0.07^{a}
Zinc	7.00 ± 0.00^{a}	14.00 ± 0.00^{b}	18.00 ± 0.00^{c}	57.00 ± 0.01^{d}
Selenium	17.00 ± 0.00^{c}	11.00 ± 0.04^{b}	11.00 ± 0.04^{b}	8.00±0.04^{a}
Lead	1.00 ± 0.00^{a}	1.00 ± 0.00^{a}	ND	ND
Chromium	2.00 ± 0.00^{b}	2.00 ± 0.00^{b}	2.00 ± 0.00^{b}	1.00±0.00^{a}

All values were mean ± standard deviation of three triplicate determinations.
Values in the same row with different superscript differs significantly ($P < 0.05$)
ND= Not Detected

Proximate Composition

Table 1 shows the results of proximate content (moisture, ash, fibre, protein, lipids and carbohydrate) of *Grewia mollis, Cissus populnea, Detarium microcarpum* and *Parkia biglobosa* In this study, the results indicated higher percentage of moisture in *Detarium microcarpum* (14.33 ± 0.57%) as compared to *Grewia mollis* (13.33 ± 0.57%), *Cissus populnea* (12.00 ± 1.00%) and *Parkia biglobosa* (10.30 ± 1.15%). Analysis of variance (ANOVA) of the moisture content of the samples indicated p-value as $p = <0.0001<0.05$ which means there is significant difference observed among the samples. The moisture contents were also comparable to values reported by (Hassan and Umar, 2006) for *Afzelia Africana* 11.34%, *Citrullus colocynthis* 11.35% and *Detarium microcarpum* 10.96%. The percentage moisture in all the samples analyzed falls within the WHO maximum permissible limit of moisture for food which is <15%. This indicated that all the samples are less susceptible to deterioration which could result from bacterial or fungal growth and had better tendency for longer shelf life due to its lower moisture content. The moisture contents obtained in this study are however higher compared with that obtained by (Ekpo *et al*., 2007).

Determination of ash content is one of the components in the proximate analysis of biological materials, consisting mainly of salty, inorganic constituents and it is an important quality attribute for some food ingredients (Barminas *et al*., 2004).

The ash content obtained in this study showed that *Cissus populnea* has the higher percentage ash 18.87 ± 0.32% followed by *Grewia mollis, Detarium microcarpum, Parkia biglobosa* as 10.60 ± 0.01%, 2.83 ± 0.05% and 2.67 ± 0.57% respectively. The ash content was also comparable to values reported by (Umedun *et al.*,2013) for *Xylopia aethiopica* 3.15%, *Mucuna sloanei* 2.66% and *Irvigna gabonesis* 2.47%. High ash content is an indication of high inorganic mineral content and vitamins (Vadivel and Janardhanan, 2005). The ash contents of *Grewia mollis, Detarium microcarpum* and *Parkia biglobosa* were below the specified limit of ash for edible plants which is 5.00 – 8.70% (Dosumu *et al.*, 2015). Analysis of variance (ANOVA) of the ash content of *Detarium microcarpum* and *Parkia biglobosa* reveals that there is no significant difference observed among the samples.

Crude fibre has a range of health benefits, it lowers risk of heart diseases, reduce risk of type 2 diabetes, improved weight control, improved digestive health, reduce inflammation, and help to boost immune system (Dosumu *et al.*, 2015). High fibre content of food can inhibit the intestinal absorption of nutrient especially the trace element. In this study, the percentage fibre content obtained showed that *Grewia mollis* has the highest percentage fibre 48.20 ± 0.26%, *Cissus populnea* 42.37 ± 0.23%, *Parkia biglobosa* with 30.50 ± 0.01% and *Detarium microcarpum* with the least 18.11 ± 0.11%. These values are higher than the values reported by (Azokpata *et al.*, 2008). The analysis of variance reveals that there is significant difference observed among the samples.

Proteins are a class of macromolecules that performs a diverse range of functions for the cell which helps in metabolism by providing structural support and by acting as enzymes, carriers or hormones. Proteins are needed in the diet to provide the essential amino acids that cannot be synthesized by the body (Omafuvbe *et al.*, 2004). The percentage protein obtained were (13.15 ± 0.01%) *Grewia mollis*, (8.74 ± 0.01%) *Cissus populnea*, (12.99 ± 0.02%) *Detarium microcarpum* and (9.83 ± 0.02%) *Parkia biglobosa*. The protein contents were lower than that produced from melon and locust beans (Njoku and Frank, 1999). The results of the analysis of variance reveals that there is no significant difference observed for *Grewia mollis* and *Detarium microcarpum.*

Lipids are fatty acids and natural occurring derivatives compounds that are related biosynthetically (Pamela *et al.*, 2005). The result obtained in this study indicated the percentage lipid of *Grewia mollis* as (1.93 ± 0.11%), *Cissus populnea* (1.53 ± 0.07%), *Detarium microcarpum* (4.70 ± 0.17%) and *Parkia biglobosa* (2.00 ± 0.30%). These values are lower than results of similar study of "*Kimba*" (*Xylopia aethiopica)* (99.58%) as reported by (Ganiyu, 2006). Analysis of variance (ANOVA) of the lipid content of *Grewia mollis, Cissus populnea* and *Parkia biglobosa* shows that is no significant difference observed among the samples.

Carbohydrate are substances found in certain kinds of food that provide the body with glucose, which is converted to energy used to support bodily functions and physical activity. It promotes good health by delivering vitamins, minerals, fiber, and a host of important phytonutrients. The healthiest sources of carbohydrates are unprocessed or minimally processed whole grains, vegetables, fruits and beans (Ullah *et al.*, 2012). The result obtained in the analysis indicated higher percentage in *Detarium microcarpum* **(**53.13 ± 0.01%), *Parkia biglobosa* (40.90 ± 0.03%), *Cissus populnea* (15.79 ± 0.01%) and *Grewia mollis* (12.48 ± 0.01%). These results are comparable to the work of (Sambo *et al.*, 2015) who recorded 51.03% in *Detarium microcarpum,* 43.32% in *Brachystegia eurycoma* and 59.64% in *Mucuna sloanei* respectively. The ANOVA result for percentage carbohydrate for all the samples at $p<0.05$ were $p<0.0001$ which means there is significant difference observed among all the samples. Plant is a moderate source of carbohydrate when compared with the Recommended Dietary Allowance (RDA) of 130g (Kayode et al., 2010).

The energy value of *Detarium microcarpum* (3.067kcal/100g) appeared to be higher than *Parkia biglobosa* (2.048kcal/100g), *Grewia mollis* (1.200kcal/100g) and *Cissus populnea* (1.118kcal/100g). Food with higher energy value may contribute in giving energy; i.e. the energy value of food is a measure of the heat energy available by the complete combustion of a stated weight of the food.

Mineral Content

The results indicated Potassium, Magnesium, Sodium, Selenium, Chromium, Calcium, Iron and Zinc in all the samples. Lead was only present in *Grewia mollis* and *Cissus populnea* and not detected in *Detarium microcarpum* and *Parkia biglobosa.* The macro-elements (K, Ca, Na, and Mg) were generally high, while the micro-elements (Fe and Zn) were low.

Sodium allows for nerve cell function, without it the brain would not be able to send messages and the muscles would not move. The ranges of mean concentration of sodium in the samples were 84.00 - 932.00µg/g. This result was in line

with the findings of (WHO, 2007). The ANOVA result at $p<0.05$ were $p<0.0001$ which means there is significant difference observed among all the samples. Sodium is an essential element for all animals and some plants. Sodium regulates blood volume, blood pressure, osmotic equilibrium and pH. High content of sodium makes a condiment a strong seasoning agent (Dosumu, 1997), with the highest quantity of sodium in *Parkia biglobosa,* it is expected to be the most pungent of the four condiments.

Humans needs calcium to build and maintain strong bones. It is also necessary for maintaining healthy communication between the brain and other parts of the body. It plays a role in muscle movement and cardiovascular function (Ukachukwu *et al.,* 2000). The ranges of mean concentration of calcium in the samples were (16495.00 - 173.00µg/g) and this result is comparable with that reported by (Ndulaka *et al*., 2017). The ANOVA result at $p<0.05$ were $p<0.0001$ which means there is significant difference observed among all the samples. Very high levels of calcium can lead to kidney problems, calcification of soft tissues and blood vessels, kidney stones and constipation. Calcium deficiency may result in low calcium levels (known as hypokalemia), bulimia, anorexia and some other eating disorders (Mensah *et al*., 2008).

Iron as an essential element for human which play a vital role of facilitating oxidation of carbohydrate, protein and fat to control body weight which is an important factor in diabetic patient Rajurkar and Damame, 1997). Iron is required for production of optimum hemoglobin concentration needed for blood volume expansion during growth phase, menstrual loss and normal hemoglobin concentration for different age and gender groups. Iron overload typically damages cells in the heart, liver and elsewhere, which can cause significant adverse effects, including coma, metabolic acidosis, shock, liver failure, adult respiratory distress syndrome, long-term organ damage, and even death (Kohmeier, 2003). The daily requirements of iron by humans are 10 -15mg for children, 18mg for women and 12mg for men. The result obtained from the study showed that *Cissus populnea* (784.00 ± 0.12 µg/g) has the higher iron content followed by *Detarium microcarpum* (88.00 ± 0.01 µg/g), *Parkia biglobosa* (55.00±0.01 µg/g) and *Grewia mollis* (11.50 ± 0.01 µg/g). The values are considerably high when compared with those obtained by (Ibeanu *et al*., 2012). The ANOVA result at $p<0.05$ were $p<0.0001$ which means there is significant difference observed among all the samples.

Potassium is crucial to heart function and plays a key role in skeletal and smooth muscle contraction, making it important for normal digestive and muscular function but too much consumption of it can be harmful to those whose kidneys are not fully functional to remove its excess from the blood (Khan *et al.,* 2008). The result of this study which indicated potassium as the mineral with high concentration in the samples analyzed was in agreement with the findings reported by (Jacobs *et al.,* 2015), which indicated that, plant foods usually have a characteristic of high potassium content. The mean concentration of potassium obtained ranges as 148.00 - 3659.00 µg/g, which the ANOVA results at $p<0.05$ gave $p<0.0001$ which indicated significant difference observed among the samples.

The mean concentrations of zinc obtained in the samples were within the ranges of 7.00-57.00µg/g and the ANOVA results of p-value at $p<0.05$ gave $p<0.0001$ which means there is significant difference observed among the samples. These concentrations were below WHO permissible limit for zinc in herbals (Kawatra and Bakhetia, 2008). Zinc is an essential microelement needed for prevention of diseases. The concentration of zinc in blood plasma stays relatively constant regardless of zinc intake, cells in the salivary gland, prostate, immune system and intestine use zinc signaling as one way to communicate with other cells in the body. Its deficiency has been known to cause growth retardation in children, delay sexual maturation, infection susceptibility, and diarrhea and also affect bone metabolism (Hassan and Umar, 2004).

Magnesium plays an important role in glucose control and insulin metabolism. Magnesium deficiency may worsen insulin resistance, which is a condition that often develops before type 2 diabetes. On the other hand, insulin resistance may cause low magnesium levels (Nelson and Cox, 2008). The concentration ranges of magnesium obtained in the analyzed samples were 148.00 - 1306.00 µg/g. This result was higher than that reported by (Okwu, 2001) with 1.899% for *Grewia mollis*. 55.34% in *Brachystegia eurycoma* and 62,12% in *citrullus colocynthis*. The ANOVA results reveals that there is significant difference observed among all the samples.

Lead is a highly poisonous metal (whether inhaled or swallowed), it affects almost every organ and system in the body when exposed. The main target for lead toxicity is the nervous system, both in adults and children. Lead exposure can result in decreased performance in some tests that measure functions of the

nervous system. Exposure to high lead levels can cause severe damage to the brain, kidneys, thyroid gland impairment and anxiety, cardiovascular system and the immune system (Bergeson, 2008). The mean concentrations of lead were only detected in *Grewia mollis* and *Cissus populnea* (1.00 ± 00 µg/g) and is not detected in *Detarium microcarpum* and *Parkia biglobosa*. The results indicated that the samples contained lead below WHO specified limit for lead (10ppm) in edible plants. However, even at this low level, a prolonged intake can be hazardous to human. The traces of Pb found in food might be linked to the concentration in the polluted area and also the consequences of road traffic and lead emission from petrol in the area where theses samples were bought (Khan *et al*., 2008). The level of Pb reported in this study is comparable to those reported 0.89mg/kg in *Grewia mollis* by (Okwu, 2001). The ANOVA results of p-value indicated that there is no significant difference observed among the samples.

Chromium is an important element for the insulin activity and DNA transcription, a hormone critical to the metabolism and storage of carbohydrate, fat and protein. However, an intake below 0.02 mg per day could reduce cellular responses to insulin. But chronic exposure to it may result in liver, kidney, lung damage and others such as skin rash, nose irritations, nasal itch and lungs cancer (Kohlmeier, 2003). In this study, the mean concentration of chromium obtained in *Parkia biglobosa* is 1.00 ± 00µg/g, while 2.00 ± 00µg/g in the other samples. There is not enough data to establish a Recommended Dietary Allowance for chromium according to the Institute of Medicine, Food and Nutrition Board. There was no significant difference observed among the other samples.

Selenium is a trace element nutrient that functions as cofactor for reduction of antioxidant enzymes, such as glutathione peroxidases. Selenium may help prevent cardiovascular disease, thyroid problems, and cognitive decline, which means disorders related to thinking, cancer and asthma. Selenium is toxic if taken in excess. Exceeding the tolerable upper intake level of 400 micrograms per day can lead to selenosis (Yamashita *et al*., 2010). In this study, the mean concentration of selenium obtained in the samples were ranged from (8.00 – 17.00 µg/g). The ANOVA results of *Cissus populnea* and *Detarium microcarpum* reveals that there is no significant difference observed among the samples.

CONCLUSION

The outcome of the study revealed that the condiments were richer in proximate and mineral content, which if properly utilized can assist in combating the problem of malnutrition.

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