*African Scientist Vol. 25, No. 4 December 31, 2024*
Printed in Nigeria

https://africansciientistjournal.org

afs2024038/25401

# Proximate Composition, Percentage Daily Value and Anti-Nutritional Levels of Raw and Processed Leaves of *Heinsia crinata* and *Vernonia amygdalina* from South East, Nigeria

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(Received July 20, 2024; Accepted in revised form November 21, 2024)

**ABSTRACT:** Proximate composition, percentage daily value and anti- nutritional levels of raw and boiled leaves of *Heinsia crinata* (HC) and *Vernonia amygdalina* (VA) were investigated using standard methods. There was no significant difference ($p > 0.05$) between the crude protein values of VA (3.80%) and HC (3.76%). Boiling decreased the protein content of the vegetables (HC: 3.65±0.02%; VA: 3.70±0.02%). The ash content of HC (2.36±0.02%) was significantly higher ($p < 0.05$) than the ash content of VA (1.64±0.02%) but boiling decreased their ash content. HC and VA had very low crude fat content (HC: 0.25±0.02%; VA: 0.20±0.01%). The fiber content of VA (7.58 ± 0.01%) was significantly ($p < 0.05$ higher than that of HC (7.03±0.01%), but boiling decreased their values. The carbohydrate content of VA (9.68±0.24%) was significantly ($p < 0.05$) lower than that of HC (17.3±0.02%), but boiling reduced their values. All the vegetables had low calorific values (VA: 46.5±1.99%; HC: 45.4±0.16%). Both vegetables had good crude protein potential and crude fiber potential but their crude fat potential and energy potential were low. Tannin (4.43±0.21%) and phytate (4.66±0.46%) concentrations of VA were significantly ($p < 0.05$) higher than those of HC (3.02±0.20%; 1.92±0.47%). There were no significant difference ($p > 0.05$) between the alkaloid (VA: 2.18±0.03%; HC: 2.15±0.03%) and cyanogenic glycosides (VA: 0.02±0.01%; HC: 0.07±0.01%) in the raw vegetables. Anti-nutrient concentrations of both vegetables significantly ($p < 0.05$) decreased by boiling. The findings in this study suggest that HC and VA are good sources of protein and fiber. Consuming enough amount of these vegetables in diet may contribute to meeting human requirements for these nutrients for normal growth and development. Boiling reduces the anti-nutrients in them and may thus enhance the bioavailability of the nutrients.

**Keywords**: Proximate composition, Percentage Daily Value, Anti-Nutritional levels, *Heinsia crinata, Vernonia amygdalina*.

## Introduction

Industrialization and urbanization unquestionably contribute significantly to human and economic development, For many decades, leafy green vegetables are known to be vital component of human healthy diet due to the fact that they are providers of dietary fibers, vitamins, minerals, plant proteins etc. Promoting better human nutrition therefore requires that there should be increase in the cultivation of this protective food as well as its consumption by the global society (Shukla *et al*., 2016).Daily, leafy green vegetables are becoming popular food for the masses because people are now made to know that there is need for them to consume natural and organic foods to meet daily nutrient requirements. People use vegetables either fresh or processed depending on the choice of the consumer. They are highly placed in the food pyramid being essential component of a balanced diet. The need to manage body weight entails that vegetables should be incorporated in our diets because they have low caloric value (Mohammad and Mohammad, 2015). Green leafy vegetables are rich in secondary metabolites called phytochemicals and this makes them essential for promoting health. The presence of phytonutrients such as flavonoids, alkaloids, tannins etc. is responsible for their therapeutic potentials. In fact, health specialists give strong advise that people should make leafy green vegetables part of their diets due to their vital nutritional and nutraceutical values (Roberts and Moreau, 2016; Mohammed and Qoronfleh, 2020). Vegetables contain a lot of phytochemical which play the role of antioxidants in the cell (Da Silva and Imai, 2017), there by promoting health (Dias, 2019) also reported that vegetables are enriched in bioactive substances such a minerals, vitamins, dietary fiber and phytochemical hence, they may help in reducing the risk of some diseases. The World Health Organization (WHO, 2023) stated that to meet recommended daily allowance of nutrition, at least 400g of fruit and non-starchy vegetables are required. The recommended dietary guidelines globally is five servings of vegetables a day based on an intake of 2000 calories (HHS/USDA, 2015). People need optimal health in Nigeria today, hence, crop diversity and nutritional potential of vegetable crops are vital for the provision of food and nutrition security (Fresco and Baudoin, 2004). A clear understanding of the phytochemicals in leafy green vegetables, bioavailability and post-harvest processing will make the populace to have firsthand knowledge of their utility in to enhancing health (Sarma and Bhavya, 2024).

Recently, people are aware of the relationship between the pattern of eating with nutrition and prevention of human diseases. This has made the scientists, dieticians and nutritionists to agree that the more the people consume leafy green vegetables, the more their nutrition is improved and the resultant effect is all round health (Dias, 2012).

According to Mosha and Gaga (1999), green leafy vegetables are essential components of diet in numerous Nigerian homes and serve as valuable sources of nutrients particularly in rural areas where they contribute substantially to protein, mineral, fiber and other nutrients which are usually in short supply in daily diets. They provide the cheapest and most abundant sources of protein (Fasuyi, 2006).They also add flavor, taste, color and aesthetic appeal to diet (Mepba *et al*., 2007). According to Whitney *et al*. (2002), there is a correlation between increasing colon and stomach cancer with low vegetable suggesting that vegetables may help to resist these types of cancers .Green leafy vegetables aid to maintain the alkaline reserve in the body (Ball, 2013).Dark green vegetables provide carotene, ascorbic acid and essential trace minerals that play vital role in nutrient metabolism and also help to slow down degenerative diseases (Yi-Fang *et al*., 2002). Anti-nutrients are natural or synthetic compounds that interfere with the absorption of nutrients (Cammack *et al*., 2006). Fayemi (1999) reported that the presence of phytates and oxalates which tend to bind calcium and iron in vegetables impair the bioavailability of these minerals. Many local vegetables are rich in anti-nutrients such as flavonoids, tannins, phenols, proanthocyanidins but low in saponins, phytates and alkaloids (Jimoh *et al*., 2010). The effects of anti-nutritional factors can be direct or indirect and ranges from minor reactions to death. Nitrates, phytates, oxalates, tannins and cyanogenic glycosides are major anti nutritional factors that have been implicated in various health-related issues. The content of these anti nutrional factors could be reduced by different processing methods such as cooking and blanching (Natesh *et al*., 2017).The amount of calorie compared to the amount of nutrients consumed by diabetics is therefore vital. The percentage daily value of food is expressed as the amount of food in a 100g sample divided by the RDA and expressed in percentage. Ranking by nutrient potential and nutrient density is one of the nutrient profiling strategy employed to promote health and prevent disease (WHO/IASO, 2014). Nutrient density means a measure of the nutrients provided per calorie of food (Hunter & Cason, 2005). Ordering foods by nutrient density is a method used in comparing foods by the proportion of nutrients in them. Nutrient dense foods are seen to be the opposite of energy dense foods. The Nutrient Rich Index (NRI) uses validated nutrient profiles against accepted measures of a healthy diet (Jeane and Susan, 2013).

The plant *Vernonia amygdalina* belongs to the order Asterales. It is usually called bitter leaf in English, (Farombi, 2011). In Nigeria, It is called *onugbo* (Igbo), *ewuro* (Yoruba), *etidot* (Efik) and *shuwake* (Hausa) (Kokwaro, 2009; Appiah, 2018). In South East Nigeria, *V. amygdalina* is used in making soup (*ofe onugbu*). The local people wash it to reduce the bitter content and dry it to be used in preparing fish and meat dishes, yam pourage. The leaves are used in place of hops in beer production. The natives also drink the liquid from the washed leaves believing that it prevents worms, as blood tonic and anti-diabetic (Pieroni, 2005) Some people also use the stick as chewing stick to maintain oral and dental hygiene (Asante *et al*., 2016).

*Heinsia crinata* which has the common name as bush apple is a perennial shrub that belongs to the family - Rubiaceae. In Nigeria, the Efik tribe call it *Atama* while in Yoruba, it is known as *tonoposho*. Igala cultures know the plant as *fumbwa*. *Heinsia crinata* is a small tree of height between 8-13m found in tropical rain forest (Ajibesin *et al*., 2008). Traditional medicine dealers us the plant for the treatment of various ailments like high blood pressure, sore throat, cough, catarrh , hence, it could be called medicinal plant (Mahesh and Satish, 2008). The plant also form a major composition of various herbal portions in ethnomedicine in the South West of Nigeria for treatment of acute bacterial infections and infertility (Enyi-Idoh *et al*., 2012)

In South East Nigeria, numerous domesticated leafy green vegetables as well as wild edible leaves are under-utilized because of inadequate scientific knowledge to justify their edibility through the nutrient and anti-

nutrient composition. This study focused on the investigation of the proximate composition, percentage daily value and anti-nutritional levels of raw and processed leaves of *Vernonia amygdalina* and *Heinsia crinata* from South East, Nigeria.
The scientific information obtained from the data provided in this study will educate the masses on the nutritional potential as well as the anti-nutritional factors in these leafy green vegetables and the effect of heat processing by boiling on their bioavailability. This may help to enlarge the food basket of the nation as well as plant biodiversity for bioprospection.

## Materials and methods

*Sample collection*: The vegetable crops under study were *Vernonia amygdalina* and *Heinsia crinata*. The later was purchased from bush marketers at Obio-Akpor in Port Harcourt, Rivers State while the former was obtained from a farmland at Umuekene in Abia State, South East geopolitical zone of Nigeria. The plants (*Vernonia amygdalina* and *Heinsia crinata*) were duly identified at the Herbarium in the Department of Plant Science and Biotechnology, University of Port Harcourt, Choba, Rivers State and given the voucher numbers UPH/24/02 and UPH/24/03 respectively. The plants were rinsed with distilled water and kept in cool condition until all the water droplets have evaporated.
*Sample processing*: Each sample was divided into two lots. Three hundred grams (300 g) of wet vegetable was placed in a pot and one half of clean water was used to boil the leaves for 10min and then drained off. Both the boiled and unboiled vegetables were powdered in a blender for material sample preparation for analysis.
*Proximate composition determination*: The methods of the Association of Official Chemists (AOAC, 2016) were used to determine the moisture content, crude fiber, ash and crude fat. Moisture content was obtained by heating three 2.0 g portions of sample (accurately weighed using a chemical balance) in an oven (plus II Sanyo, Gallenkamp Plc., England) at 105 ºC for 3hr in a crucible with lid, until a constant weight was obtained. Ash was obtained by incinerating three 2.0 g samples in a Gallenkamp furnace at 550 °C for 7.0 h. Nitrogen and crude protein content were determined using the Kjedahl method based on Association of Official Analytical Chemists (2016). Percentage nitrogen was converted to crude protein by multiplying using the protein conversion factor of 6.25 (i.e. crude protein = %Nitrogen x 6.25). Crude fat was determined by exhaustively extracting three triplicates of 9.0 g samples in the Soxhlet extractor using 300ml of anhydrous diethyl ether (B.P.) range 40-60 °C ) for 6 h. Total carbohydrate was estimated by differential calculation as described by Onyeike and Acheru (2002) (i.e. -(fat+protein +ash+ fiber + MC). Energy value was obtained by physical scoring by multiplying the mean values of total carbohydrate, crude fat and crude protein by the Atwater factors of 4, 9, 4 respectively, taking the sum of the products and expressing the results in K/cal per 100 g samples as described by Onyeike and Acheru (2002).
*Estimation of the proximate nutrient potential and energy potential (%DV):* Percentage daily values (%DV) were estimated by comparing the current samples with a 2,000 calorie reference diet, for adults and children aged 4 and above (USDA, 2011). It was calculated as follows:

$$\%DV = (\text{Amount of nutrient/RDA}) \times 100.$$

*Determination of anti-nutritional factors:* Saponin content of the samples was determined by the method of Obadoni and Ochuko(2001), while alkaloid was determined as reported by Harbone (1973). Phytate, tannin and cyanogenic glycosides were determined as described by the Association of Official Analytical Chemists (2016).
*Statistical analysis*: Data were statistically analyzed by a one-way analysis of variance (ANOVA) using SPSS/PC$^{+}$ package. Tests of significance were carried out using Duncan's (1955) Multiple Range Text (DMRT) on SPPSS/PC$^{+}$. In all, significance was accepted at p-value of 0.05.

## Results and Discussion

*Proximate composition*: Proximate composition of the vegetables are shown in Tables 1a and 1b respectively. The moisture content of *Heinsia crinata* (HC) was significantly ($p < 0.05$) higher than that of *Vernonia amygdalina*. All the vegetables had high moisture content although the values were less than those of *C. chyyamansa, S. nodiflorum* and *S. biafrae* (Olaposi and Aduni, 2010) but comparable to the moisture contents of *S. aethiopicum, C. pepo* and *A. spinosis* (Olaiya and Adebisi, 2010). When these vegetables are consumed, they will help in food digestion because they have high level of moisture. However, their shelf life will be low due to the fact that moisture aids the action of microorganisms. The moisture content of any food is a reflection of its water activity (Olutiola *et al.*, 1991). Moisture level in food and drugs can be used to measure stability and susceptibility to microbial contamination (Uraih and Izuagbe, 1990).Boiling increased the moisture content of the vegetable samples. The moisture content of *S. nigrum* and *S. biafrae* increased by 6.51% and 5.85% respectively when cooked and this is due to the absorption of water by the fibre and other natural components of the vegetables (Lola, 2009).

The two vegetables had appreciable crude protein content. There was no significant difference ($p > 0.05$) between the crude protein values of VA and HC. The crude protein values of processed seeds of *Arachis hypogea* and *Anarcardium occidentale* (Okoroh and Onuoha, 2019), processed seeds of *Citrullus lanatus* (Okoroh *et al*., 2021) were much higher than the values for the vegetables investigated in this study. The values were comparable to the values of crude protein in *C. chayamansa*, *S. nodiflorum* and *S. biafrae* (Olaposi and Aduni, 2010), but lower than the values of *M. balsamina, M. oleifera, L. africana* and *L. hastate* (Plessi *et al*., 1999). The protein content of the two vegetables was higher than those of *T. triangulare, C. argentea* and *B. alba* (Olaiya and Adebisi, 2010). Proteins are building blocks in the cells and tissues for growth and repair. Consumption of appreciable amount of the leaves of these vegetables in diets may serve as good sources of plant protein. Boiling decreased the protein content of the vegetables. Lola (2009) reported that the protein contents of *S. nigrum* and *S. biafrae* decreased from 4.63-3.68%) and 4.30-2.98 % respectively due to boiling.

The ash contents of HC and VA were low and significantly ($p<0.05$) different. HC had higher ash content than VA. Fasuyi (2006) and Okoroh *et al*. (2019) reported higher ash content for *T. triangulare, A. cruentus* and *T. occidentalis* respectively and for processed seeds of *A. hypogea* and *A. occidentale* (AHUFS, AOUFS and AOPFS) respectively while Olaposi and Aduni (2010) and Okoroh and Onuoha (2019); Okoroh *et al*. (2021) reported comparable values of ash for *C. chayamansa, S. nodiflorum* and *S. biafrae* respectively and for processed seed of *A. hypogea* and *Citrullus lanatus* seeds respectively. Boiling decreased the ash content in VA and HC. Lola (2009) reported a loss in the ash content of *S. nigrum* and *S. biafrae* ranging from 59.79% to 58.20% probably due to leakage of minerals into the water used in boiling the vegetables.

HC and VA had very low crude fat content and the values were not significantly ($p>0.05$) different. The crude fat content of processed seeds of *A. hypogea* and *A. occidentale* (Okoroh and Onuoha, 2019) as well as *C. lanatus* (Okoroh *et al*., 2021) but comparable to those for *C. chayamansa, S. nodiflorum* and *S. biafrae* (Olaposi and Aduni, 2010); *C. pepo, T. occidentalis* (Olaiya and Adebisi, 2010), and lower than those of *A. officianalis* and *A. indica* (Aberoumand, 2006). The fat content of vegetables was decreased by boiling. Lola (2009) reported that the fat content of *S. biafrae* and *S. nigrum* decreased by 9.7% and 16% respectively.

The fibre content of VA was significantly ($p<0.05$) higher than that of HC. The values were higher than those of *T. triangulare, A. cruentus* and *T. occidentalis* (Fasuyi, 2006); *C. chayamansa, S. nodiflorum* and *S. biafrae* (Olaposi and Aduni, 2010), *A. hypogea* and *A. occidentale* (Okoroh and Onuoha, 2019) but less than the values reported by Isong and Idiong (1997) for some Nigerian vegetables; Okoroh *et al*. (2021) for *C. lanatus seeds.* Fibre consists of non-nutrient substances such as lignin and cellulose. It also has cell wall polymers. These materials cannot be digested by humans. Nutritionally, fiber is important because it helps to clean the intestinal tract. Fibre helps to lower the rate of absorption of glucose in the digestive tract. Fibre also removes cholesterol. Since, the findings in this study indicated that the vegetable samples are rich in fibre, they are therefore good in the diet of diabetic patents. Fibre is essential in the diet because it helps to maintain bulk and also the movement of the intestine by the process of peristalsis via surface extension of food in the digestive tract (Mathenge, 1997). This implies that the consumption of these vegetables will produce healthy condition, make food digestion easy and cure certain nutritional disorders. However, consumption of too much with high concentration of fibre may cause irritation of the intestine. It may also decrease the availability of nutrients. Boiling reduced the fibre content of the vegetables and the findings corroborates that of Lola (2009).

The carbohydrate content of the vegetables were significantly different ($p<0.05$) and the value of VA was higher than that of HC.The carbohydrate content of the two vegetables were comparable to the values reported for *C. chayamansa. S. nodiflorum* and *S. biafrae* (Olaposi and Adunni (2010); *A. spinosus, A. hybridus, A. caudatus, T. triangulare* and *C. pepo* (Olaiya and Adebisi, 2010); *C. lanatus* (Okoroh *et al*., 2021); *A. hypogea* peeled fried seeds (AHPFS) and *A. occidentale* unpeeled fried seeds (Okoroh and Onuoha, 2019); but lower than those of *A. officianalis* and *A. indica* (Aberoumand, 2010); *M. balsamina* (Pearson, 1999); *A. occidentale* peeled fried seeds (Okoroh and Onuoha , 2019). Boiling reduced the carbohydrate content of the vegetables.

All the vegetables had low calorific values which were further decreased by heat treatment. This could be due to the low values of crude protein, crude fat and carbohydrate coupled with their high moisture content. The calorific value of VA was significantly higher ($p<0.05$) than that of HC.

Proximate nutrient potential and energy potential of the raw and boiled leaves of HC and VA are shown in Tables 2a and 2b respectively. For the raw vegetables, the crude protein potential and crude fiber potential of VA was higher than that of HC and both vegetables had good crude protein potential and crude fiber potential. The crude fat potential of both vegetables was low. The carbohydrate potential of both vegetables were appreciable in the raw samples although the value of HC was higher than that of VA. Both vegetables recorded low energy potential. Okoroh *et al*. (2020 ) also reported high crude protein potential and crude fibre potential, low lipid potential and low energy potential for samples of organically cultivated *P. ostreatus* ( AVOS, WWS, and SAWCS). Heat processing had significant effect ($p < 0.05$) on the proximate potential and energy potential of the heat processed vegetables.

The anti- nutrient concentrations of the raw and boiled leaves of the vegetables are shown in Tables 3a and 3b respectively. The tannin, and phytate concentrations of VA were significantly ($p<0.05$) higher than those of HC. There were no significant difference ($p>0.05$) between the alkaloid and cyanogenic glycosides in the raw vegetables. The saponin level in HC was significantly higher ($p<0.05$) than the value in VA. Lola (2009) reported comparable concentrations of phtates and tannin for *S. nigrum* and *S. biafrae* in their work. The concentrations of the anti-nutrients in the vegetables were significantly ($p<0.05$) decreased by boiling. This may enhance the bioavailability of nutrients in these vegetables.

**Table 1a:** Proximate Composition (%) and Calorific Values of the raw leaves of *Heinsia crinata(*HC) and *Vernonia amygdalina* (VA)

| Constituent | HC | VA |
|---|---|---|
| Moisture | 79.3±0.03[a] | 77.1±0.21[b] |
| Dry matter | 30.7±0.03[a] | 22.7±0.21[b] |
| Ash | 2.36±0.02[a] | 1.64±0.02[b] |
| Crude protein | 3.76±0.01[a] | 3.80±0.55[a] |
| Crude fat | 0.25±0.02[a] | 0.20±0.01[a] |
| Crude fibre | 7.03±0.01[b] | 7.58±0.01[a] |
| Total carbohydrate | 17.3±0.02[a] | 9.68±0.24[b] |
| Caloric value (Kcal/100 g sample) | 45.4±0.16[b] | 46.5±1.99[a] |

Values are means ± standard deviations of triplicate determinations. Values in the same row having the same superscript letters are not significantly different (P<0.05). Where HC =*Heinsia crinata*; VA= *Vernonia amygdalina*

**Table 1b:** Proximate composition (%) and calorific values of the boiled leaves of *Heinsia crinata* (HC) and *Vernonia amygdalina* (VA)

| Constituent | HC | VA |
|---|---|---|
| Moisture | 79.20±0.01[b] | 82.8±0.05[a] |
| Dry matter | 20.8±0.0.01[a] | 17.2±0.05[b] |
| Ash | 1.25±0.02[a] | 0.97±0.01[b] |
| Crude protein | 3.65±0.02[a] | 3.70±0.02[a] |
| Crude fat | 0.23±0.02[a] | 0.17±0.01[b] |
| Crude fibre | 4.42±0.01[b] | 4.61±0.03[a] |
| Total carbohydrate | 11.25±0.02[a] | 7.75±0.02[b] |
| Caloric value (Kcal/100 g sample) | 34.10±0.18[b] | 34.90±1.23[a] |

Values are means ± standard deviations of triplicate determinations. Values in the same row having the same superscript letters are not significantly different (P<0.05), where HC = *Heinsia crinata*; *Vernonia amygdalina*

**Table 2a:** Proximate nutrient potential and energy potential of the raw leaves of *Heinsia crinata* (HC) and *Vernonia amygdalina* (VA)

| Constituent | [DRV(g)] | HC (%DV) | HC | VA (%DV) | VA |
|---|---|---|---|---|---|
| Crude protein | 50 | 7.52 | 3.76±0.01[a] | 7.60 | 3.80±0.55[a] |
| Crude fat | 20 | 1.25 | 0.25±0.02[a] | 1.00 | 0.20±0.01[a] |
| Total carbohydrate | 125 | 13.84 | 17.3±0.02[a] | 7.74 | 9.68±0.24[b] |
| Energy | 2000 | 2.27 | 45.4±0.16[b] | 2.32 | 46.5±1.99[a] |

Values are means ± standard deviations of triplicate determinations. Values in the same row having the same superscript letters are not significantly different (P<0.05). Where HC =*Heinsia crinata*; VA=*Vernonia amygdalina*; DRV= Daily reference value; %DV=Percentage daily value

**Table 2b:** Proximate nutrient potential and energy potential of the boiled leaves of *Heinsia crinata* (HC) and *Vernonia amygdalina* (VA)

| Constituent | [DRV(g)] | HC (%DV) | HC | VA (%DV) | VA |
|---|---|---|---|---|---|
| Crude protein | 50 | 7.30 | 3.65±0.02[a] | 7.40 | 3.70±0.02[a] |
| Crude fat | 20 | 1.15 | 0.23±0.02[a] | 0.85 | 0.17±0.01[b] |
| Crude fiber | 28 | 15.79 | 4.42±0.01[b] | 16.46 | 4.61±0.03[a] |
| Total carbohydrate | 125 | 9.00 | 11.25±0.02[a] | 6.20 | 7.75±0.02[b] |
| Energy | 2000 | 1.70 | 34.10±0.18[b] | 1.75 | 34.90±1.23[a] |

Values are means ± standard deviations of triplicate determinations. Values in the same row having the same superscript letters are not significantly different (P<0.05). Where *Heinsia crinata* =HC; *Vernonia amygdalina*=VA; DRV= Daily reference value; %DV=Peercentage daily value.

**Table 3a:** Anti-nutrient composition (%) of the raw leaves of *Heinsia crinata* (HC) and *Vernonia amygdalina* (VA)

| Anti-nutrients | HC (% Conc.) | VA (%Conc) |
|---|---|---|
| Tannins | $3.02 \pm 0.20^b$ | $4.43 \pm 0.21^a$ |
| Phytates | $1.92 \pm 0.47^b$ | $4.66 \pm 0.46^a$ |
| Alkaloids | $2.15 \pm 0.03^a$ | $2.18 \pm 0.03^a$ |
| Cynogenic glycosides | $0.07 \pm 0.01^a$ | $0.02 \pm 0.01^a$ |
| Saponins | $7.45 \pm 0.05^a$ | $3.63 \pm 0.03^a$ |

Values are means ± standard deviations of triplicate determinations. Values in the same row having the same superscript letters are not significantly different (P<0.05). Where HC = *Heinsia crinata;* VA=*Vernonia amygdalina*; %Conc. = percentage concentration.

**Table 3b:** Anti-nutrient composition (%) of the boiled leaves of *Heinsia crinata* (HC) and *Vernonia amygdalina* (VA)

| Anti-nutrients | LA (%Conc.) | TO (% Conc.) |
|---|---|---|
| Tannins | $1.20 \pm 0.01^b$ | $1.59 \pm 0.02^a$ |
| Phytates | $0.85 \pm 0.01^b$ | $2.03 \pm 0.03^a$ |
| Alkaloids | $1.10 \pm 0.02^a$ | $0.87 \pm 0.02^b$ |
| Cynogenic glycosides | $0.005 \pm 0.00^a$ | $0.003 \pm 0.00^a$ |
| Saponins | $1.87 \pm 0.01^a$ | $1.31 \pm 0.02^a$ |

Values are means ± standard deviations of triplicate determinations. Values in the same row having the same superscript letters are not significantly different (P<0.05). Where HC=*Heinsia crinata*; VA=*Vernonia amygdalina*; % Conc.= percentage concentration.

## Conclusion

The leaves of HC and VA were found to be rich in protein, fibre but had low amount of ash, fat, carbohydrate and energy. The findings in this study suggest that HC and VA are good sources of these nutrients as shown by their estimated proximate nutrient potential values. Consuming enough of these vegetables in diet may contribute in meeting human requirements of these nutrients for normal growth and development. Subjection of the leaves of both vegetables to boiling reduced the anti-nutrients in them and may thus enhance the bioavailability of the nutrients.

## Authors' contribution

PNO conceived the idea of this study and produced the experimental design, PNO, OCA and KLE ran the analyses. KLE conducted statistical analysis. The authors were involved in reviewing and editing the work.

## Conflict of Interest

We declare that there was no conflict of interest.

## Acknowledgement

We are grateful to the laboratory technologists at Biochemistry laboratory, Gregory University, Uturu, Abia State, Nigeria and Medical Biochemistry laboratory, David Umahi Federal University of Health Sciences, Uburu, Ebonyi State, Nigeria, for their technical assistance during this study.

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