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Comparative evaluation of nutritional compositions of *Amaranthus cruentus* L. and *Amaranthus viridis* L.

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Abstract

*Leafy vegetables are renowned as rich sources of phyto compounds with healthful and nutritional properties. The culinary and therapeutic properties of leafy vegetables are believed to be influenced by factors such as genetic properties and species diversity. The current study evaluated the nutrient compositions of two different species of amaranth: Amaranthuscruentus*L. *and Amaranthus viridis L. The proximate compositions of the macro-nutrients was carried out using the standard AOAC methods while the mineral contents were estimated through atomic absorption spectrometry. The results showed that the different species of amaranth had similar proximate composition but the mineral components were significantly different (P<0.05). The study inferred that the species of amaranth could serve as good sources of nutrients for human consumption.*

Keywords: Amaranth, species, proximate analysis, nutritional compositions, mineral contents.

Introduction

Natural products including many herbs and fruits have been reported to have beneficial biological activities when consumed as they provide the body with essential nutrients and various free radical-scavenging antioxidants, such as, antioxidant vitamins, phenolics and flavonoids that help in contending the detrimental effects of oxidants[1].

Positive correlation exists between the consumption of fruits and vegetables and decreased risk of diseases through epidemiological data[2,3]. Thus, five or more servings of various vegetables and fruits per day had been recommended for prevention of cancer by the World Cancer Research Fund and the American Institute for Cancer Research[4]. The biological activities of some of these natural products has been attributed to the presence of phytochemicals found in the plants[5]. Variations in the nutritional contents and phytochemical properties of leafy vegetables have been reported to be influenced by variety, growing conditions and post-harvest handlings[1].

Amaranthus species belonging to the family of *Amaranthaceae* are examples of cosmopolitan leafy vegetables which are considered valuable sources of nutrients and phytochemicals with important medicinal properties[6,7]. Several species of amaranth are often considered weeds; examples include *A. spinosus* L. and *A.thunberch* Moq. However, some are nutritive and have been used for culinary purposes and sometimes as forage for herbivores animals and organic manure[8]. This study aimed at assessing the comparative nutritional qualities of *A. cruentus* L. and *A.viridis* L.

Materials and methods

A. cruentus L. (purple Amaranth) and *A. viridis* L. (dark green spinach) were purchased in a local market in Gbongan, Osun State and identified at the Biological Science Department, Federal University of Technology Akure, Ondo State. The leafy part of the plants were removed and air-dried for fourteen days. The air-dried leaves were screened to remove any foreign particles that may have being included during the cause of air-drying, both air-dried leaves were ground separately into powder in an electric blender. The powdered samples obtained from *A. cruentus* and *A. viridis* were stored in a clean, sterile and air tight container at room temperature (29±1°C) separately.

Chemicals: Sodium Hydroxide, n-hexane, Digestion catalyst (mixture 50g anhydrous $CuSO_4$ anhydrous K_2SO_4/$NaSO_4$-500g and selenium-0.5g), sulphuric acid, Boric acid, Hydrochloric acid, Indicator (methyl red and bromo-cresol green), ferric sulfate, MnO_2, zinc nitrate, Magnesium powder.

Proximate analysis: Proximate analyses were performed in triplicate in accordance with the AOAC[9] below are the procedures used for carrying out the proximate analysis.

Moisture content: Exactly 2.0g of sample was weighed into a crucible which is made up of ceramic, the sample was transferred into a hot air oven and dried at 70°C. The weight was taken repeatedly until constant weight was obtained.

$$\text{Moisture } (\%) = \frac{\text{Initial weight (g)} - \text{Final weight (g)} \times 100}{\text{Weight of sample taken (g)}}$$

Crude protein: The total nitrogen in the samples was determined through micro Kjeldahl method. A nitro-to-protein conversion of 6.25 was used for the proximate determination of the crude protein in the samples.

$$\% \text{ Nitrogen} = \frac{\text{Titre value} \times \text{concentration of acid} \times 0.014 \times \text{Dilution factor} \times 100}{\text{Weight of sample taken}}$$

$$\% \text{ Crude protein} = 6.25 \times \% \text{ Nitrogen in sample}$$

Crude lipids: Proximate determination of the lipid contents in the vegetables was using a Soxhlet extractor. N-hexane was used as the extracting solvent. The percentage of the crude lipids was obtained using the following expression.

$$\text{Crude lipid } (\%) = \frac{((\text{Weight of flask} + \text{Oil}) - \text{Weight of empty flask})\ (\text{g}) \times 100}{\text{Weight of sample taken (g)}}$$

Crude fibre: Exactly 2.0g of sample was defatted using n-hexane, dried and poured into a 600ml beaker. Briefly, 200ml of 1.25% sulphuric acid was added and boiled under reflux for 30 minutes. The beaker was covered with a mini condenser containing some cold water to prevent evaporation. The mixture was filtered with a sieving cloth and rinsed with hot distilled water to remove excess acid. Precisely 200ml of 1.25% sodium hydroxide was added to the residue and the mixture was boiled for 30 minutes under reflux.

It was filtered with a sieving cloth and rinse with hot distilled water to remove excess sodium hydroxide. It was transferred into a hot air oven and dried overnight at 70^{o}C constant weight was obtained. The sample was transferred into a muffle furnace set at 600^{0}C until it was turned to ash. The final weight of the sample was taken.

$$\text{Crude fibre } (\%) = \frac{((\text{Weight of Crude fibre} + \text{Ash}) - \text{Weight of Ash})\ (\text{g}) \times 100}{\text{Weight of sample taken (g)}}$$

Ash content: The empty crucible was weighed, 2.0g of sample was weighed into the crucible which is made up of ceramic, and the sample was transferred into a muffle furnace and allowed to ash at 600^{0} C for 3hours. The weight of the ash and the crucible was taken.

$$\text{Ash } (\%) = \frac{((\text{Weight of empty crucible} + \text{Ash}) - \text{Weight of empty crucible})\ (\text{g}) \times 100}{\text{Weight of sample taken (g)}}$$

$$\text{Total carbohydrate } (\%) = 100 - (\text{Moisture content} + \text{Protein} + \text{Lipids} + \text{Ash} + \text{Crude fibre})$$

Mineral Analysis: Mineral analysis, which included nutritionally valuable minerals, such as calcium (Ca), copper (Cu), iron (Fe), Magnesium (Mg), Manganese (Mn), Nickel (Ni), Potassium (K), and sodium (Na), phosphorus (P), and zinc (Zn), were determined and quantified using Atomic Absorption spectrophotometer. The minerals were analysed from solutions obtained by first dry-ashing the samples at 55^{0}C and dissolving the ash in 10% (v/v) HCl, filtered and made up to 100ml in a volumetric flasks using distilled or deionized water.

The quantities of sodium and potassium were evaluated through flame photometry. Phosphorus was determined by the spectrophotometric technique according to the method described by Kirk and Sawyer[10].

Statistical analysis: The data were presented as mean ± standard deviation. Statistical analysis was carried out using student t-test (two sample t-test) at $P<0.05$.

Results and discussion

The result presented in Table-1 showed that there was no significant differences ($P<0.05$) between the proximate compositions of the two *Amanrathus* spp. This report is in agreement with the findings of Kariukiet al.[11] that the different species of amaranth had similar nutrient composition. It was however in disagreement with the report of Akin-Idowu[12] that there are significant differences in the proximate compositions among five species of amaranth.

The present study showed that the species of amaranth had satisfactory levels of proteins and fibres. Moreover, the ash content of the vegetal were considerably compared to those of tubers and cereals[13]. The leafy vegetables contain substantive amount of essential minerals (Table-2).

The levels of calcium, magnesium, phosphorus, sodium and potassium in the vegetables were significantly different ($P<0.05$).

Table-1: Proximate composition of the leaves of *A. cruentus* and *A. viridis.*

Parameters (%)	*A. curentus*	*A. viridis*
Moisture	10.09±2.84^{a}	12.76±2.71^{a}
Crude Protein	41.70±2.29^{a}	38.50±4.02^{a}
Lipids	5.62±1.80^{a}	3.71±0.10^{b}
Crude Fibre	4.40±1.92^{a}	4.12±0.53^{a}
Total Ash	17.73±3.95^{a}	16.47±2.40^{a}
Carbohydrate	21.24±4.22^{a}	25.58±4.82^{a}

All values are expressed as mean ± SD. A different superscript letters within each row are significantly different ($P< 0.05$).

Table-2: Mineral content of the leaves of *A. cruentus* and *A. viridis*

Parameters (ppm)	*A. cruentus*	*A. viridis*
Calcium	370.00±8.54[a]	325.00±9.20[b]
Magnesium	336.00±9.82[a]	464.00±21.73[b]
Phosphorous	420.89±24.30[a]	119.12±9.12[b]
Sodium	226.12±23.75[a]	209.82±23.50[b]
Potassium	189.02±11.60[a]	200.01±10.36[b]
Iron	0.15±0.03[a]	0.30±0.04[b]
Copper	0.21±0.06[a]	0.40±0.12[b]
Zinc	0.17±0.03[a]	0.03±0.01[b]
Manganese	0.20±0.01[a]	0.28±0.01[a]
Nickel	0.16±0.05[a]	0.32±0.05[b]

All values are expressed as mean ± SD. A different superscript letters within each row are significantly different (P< 0.05).

Discussion: The present study validates the earlier reports that magnesium and potassium are calcium antagonists[14,15]. The vegetables may serve as good sources of minerals. It is noteworthy to mention that the excessive uptake of magnesium and potassium by *A. viridis* compared to *A. cruentus* could be responsible for the observed decreased in calcium uptake by *A. viridis*. This essential minerals function as co-factors to many enzymes, constituents of bones, components of functional proteins that are involved in vital activities in the body. For instance, calcium is involved in various biological functions serving as cofactors in many enzymes reactions and also as components of bones and teeth; magnesium plays vital roles in energy metabolism, release of neurotransmitters, nerve and muscle excitability[16,17]. Magnesium also plays essential role in the structural development of bone and synthesis of glutathione[18]. Sodium has been linked with maintenance of fluids[19] while potassium plays important role in impulse transmission and in contraction of cardiac muscle[19]. Phosphorus is involved greatly in energy metabolism as it is required in the synthesis of compounds such as ATP, GTP and creatinine phosphate which are used as sources of energy for metabolic processes[19]. The sample had slight amount of concentrations of iron (Fe), copper (Cu), zinc (Zn), manganese (Mn) and nickel (Ni). These are only required in trace amount; higher concentrations of these elements can be detrimental[20]. Iron plays vital role in the myoglobin and haemoglobin formation. Iron deficiency can result in hypochromic anaemia[16]. Copper and zincplay important role as a co-factor in the reactions catalysed by cytochrome C oxidase family of enzymes[21]. Zinc plays crucial roles in cell division and it is required for DNA and protein metabolism[22]. Zinc deficiency can result in impairment of DNA synthesis and in due course immune function. Manganese aids the formation of connective tissues sex hormones and blood-clotting factors[23]. It also plays significant role in carbohydrate metabolism[24]. The biological function of nickel in human is fairly uncertain, however, there are suppositions of its involvement in prolactin production[25].

Mineral contents of vegetal could vary dramatically depending the environmental factors such as drought, temperature and light intensity[26]. Moreover, the nature of the soil where the vegetable was planted could also contribute immensely to the variations in the mineral compositions. These soil factors include salinity, mineral composition and pH. Other factors may include genetic properties of the vegetables, maturity, fertilization practices and time of harvesting[26]. The two species of amaranth used in the present study were purchased in a local market which might imply the vegetables have been harvested from different locations.

Conclusion

The current findings demonstrated that the species of amaranth vegetables investigated are nutritionally dense and have similar nutrient profile. Thus, they could be important sources of nutrients. The observed differences in the mineral composition could be attributed to the variations in the planting conditions. Further studies are recommended to establish the phytochemical profile of the different species of amaranth.

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