ASSESSING THE PROXIMATE AND MINERAL COMPOSITIONS OF SOME INDIGENOUS DEFATTED AND UNDEFATTED LEAFY VEGETABLE IN GHANA

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Abstract

Indigenous Leafy Vegetables are the cheapest and most readily available sources of macro and micronutrients that play major role in maintaining healthy living. The mineral composition of undefatted and defatted vegetables; Amaranthus hybridus, Curcubita pepo and Gnetum africana was analyzed using the methods of Association of Analytical Chemist (AOAC) 1990. The moisture content of undefatted A.hybridus, C.pepo and G. africana was 8.35% ± 0.05, 8.55%± 0.01 and 7.60% ± 0.01 respectively while defatted samples had 17.60% ± 0.01, 18.70%± 0.02 and 15.00% ± 0.01 respectively. Undefatted A.hybridus, C.pepo and G. africana had 1.60% ± 0.02, 4.15% ± 0.02 and 7.10% ± 0.02 of crude lipids respectively. The crude protein content of defatted A.hybridus, C.pepo and G. africana was 12.04% ±0.00, 21.60% ± 0.01 and 4.86% ± 0.01 respectively while undefatted A.hybridus, C.pepo and G. africana had crude protein of 32.95% ± 0.01, 20.80% ± 0.02 and 19.67% ± 0.01 respectively. The crude fibre content of undefatted A.hybridus, C.pepo and G. africana was 19.60% ± 0.01, 16.35% ±0.00 and 27.25% ± 0.00 respectively while defatted A.hybridus, C.pepo and G. africana had crude fibre content of 12.40% ± 0.01, 3.16% ± 0.01 and 13.70% ± 0.00 respectively. The ash content of undefatted A.hybridus, C.pepo and G. africana was 17.70% ± 0.01, 15.20% ±0.02 and 8.00% ± 0.02 respectively while the ash content of defatted A.hybridus, C.pepo and G. africana was 43.60% ± 0.02, 43.60% ± 0.02 and 47.90% ± 0.02 respectively. The total carbohydrate content of undefatted A.hybridus, C.pepo and G. africana was 15.40% ± 0.02, 30.40% ± 0.01 and 30.38% ± 0.01 respectively while the total carbohydrate content of defatted A.hybridus, C.pepo and G. africana , was 14.36% ± 0.01, 12.94% ± 0.01 C.pepo and G. africana, was 14.36% ± 0.01, 12.94% ± 0.01 and 18.54% ± 0.01 respectively. The mineral composition of udefatted A.hybridus, C.pepo and G. africana showed 64.60mg/g, 38.60mg/g and 10.50mg/g of sodium; 11.05mg/g, 9.08mg/g and 3.40mg/g of potassium; 13.68mg/g, 11.52mg/g and 3.60mg/g of

magnesium; 28.80mg/g, 32.00mg/g and 13.60mg/g of calcuim; 87.50mg/g, 65.25 mg/g and 78.75mg/g of iron; 0.99mg/g 1.15mg/g and 0.35mg/g of phosphorus respectively. Defatted A.hybridus, C.pepo and G. africana showed mineral composition of 24.80mg/g, 17.50mg/g and 6.14mg/g of sodium; 8.65mg/g, 4.64mg/g and 4.10mg/g of potassium;12.48mg/g,2.18mg/g and 3.36mg/g of magnesium, 26.40mg/g, 28.40mg/g and 12.80mg/g of calcium; 0.81mg/g, 45.00mg/g and 37.50mg/g of iron; 8.57mg/g, 1.12mg/g and 0.18mg/g of phosphorus respectively. The cyanogenic glycoside was higher in the undefatted than the defatted vegetables. Based on the results obtained it is more rewarding nutritionally to consume leafy vegetables in their undefatted form.
Keywords: *proximate, mineral composition, defatted, undefatted, leafy, vegetables*

Introduction

Vegetables are the edible parts of plant that are consumed wholly or in parts, raw or cooked as part of main dish or salad. A vegetable includes leaves, stems, roots, flowers, seed, fruits, bulbs, tubers and fungi (Uzo, 1989; Uwaegbute, 1989). Vegetables are good sources of oil, carbohydrates, minerals and vitamins depending on the vegetable consumed (Ihekoronye & Ngoddy, 1985). Ononugbu (2002) reported that vegetable fats and oil lower blood lipids thereby reducing the occurrence of disease associated with damage of coronary artery. Leafy vegetables are important items of diet in many Nigerian homes. Apart from the variety which they add to the menu (Mepha & Eboh, 2007; Subukola et al., 2007), they are valuable sources of nutrients especially in rural areas where they contributes substantially to protein, minerals, vitamins, fibers and other nutrients which are usually in short supply in daily diets (Mohammed & Sharif, 2011). It is worthwhile to note that consumption of numerous types of edible plants as sources of food could be beneficial to nutritionally marginal population especially in developing countries where poverty and climate is causing havoc to the rural populace. In many developing countries the supply of minerals is inadequate to meet the mineral requirements of farm animals and rapidly growing population. Minerals cannot be synthesized by animals and must be provided from plants or mineral-rich water (Anjorin et al., 2010)

In tropical Africa where the daily diet is dominated by starchy staples, indigenous leafy vegetables are the cheapest and most readily available sources of important proteins, vitamins, especially the pro vitamin A (Martin and Meitner, 1998) and essential amino acids. Vegetables are the most widely grown crops in Africa. They provide vital food security for many subsistence farmers in the country. Vegetables rank higher in production than all other crops. They are known to provide 80% of the vitamin A in diet (Bosland and Votava, 2000). Indigenous vegetables are reported to play a very important role in income generation and subsistence (Schippers, 2000). They are important commodities for poor households because their prices are relatively affordable when compared to other food items. Vegetables provide very important sources of employment for those outside the formal sector in peri-urban areas because of their generally short, labourintensive production systems, low levels of investment and high yield (Schippers, 2000). A large number of African indigenous leafy vegetables have long been known and reported to have health protecting properties and uses (Okeno et al., 2003). It is reported that the roots, leaves and twigs, as well as the bark of the tree of Moringa plant (Moringa oleifera) are used in traditional medicine (Dalziel, 1937 in Smith and Eyzaguirre 2007). Several of these indigenous leafy vegetables continue to be used for prophylactic and therapeutic purposes by rural communities (Dalziel, 1937). This indigenous knowledge of the health promoting and protecting attributes of indigenous leafy vegetable is clearly linked to their nutritional and non-nutrient bioactive properties. Indigenous leafy vegetables have long been, and continue to be reported to significantly contribute to the dietary vitamin and mineral intakes of local populations (Smith, 1982; Nordeide, et al., 1996).

The leafy vegetables investigated were Amaranthus hybridus commonly called African spinach, Curcubita pepo commonly called marrow and Gnetum africana which belong to the family of plants called Gnetaceae. The increasing population of many tropical countries led to awareness of the importance of vegetables as a source of essential nutrients which may not be available in other food sources. Vegetables are good sources of oil, carbohydrates, minerals and vitamins depending on the vegetable consumed (Ihekoronye and Ngoddy, 1985). Undefatted leafy vegetable is the vegetable that has its total crude lipid content not isolated while defatted leafy vegetable is the vegetable that has its total crude lipid content isolated. Undefatted leafy vegetables play the role of being a source of energy to man, lipids in the vegetable help in maintaining the integrity of the cell membrane, lipids in vegetables protects the body from mechanical injury when deposited in the adipose tissues and lipids in vegetables make it palatable for eating (Ononugbu,2002). Undefatted vegetable serves the function of transporting fat soluble vitamins (A,D,E and K) and in combination with certain proteins called apoproteins mediate a number of enzyme activities (Ononugbu, 2002). Ononugbu, 2002 reported that vegetable fats and oils lower blood lipids thereby reducing the occurrence of disease associated with the damage of the coronary artery. Vegetable fats and oils serve as precursors of prostagladins which are known to perform the role of vasoconstriction and vasodilation of the blood vessels. Vegetable fats and oils are known to serve as precursors of thromboxane which facilitate blood clotting in humans (Ononogbu, 2002). In defatted leafy vegetables off-flavours and odorous state are eliminated and these are as a result of lipid autoxidation which eventually leads to rancidity. Amaranthus hybridus belongs to the family Amaranthacae. Amaranthus hybridus tolerates varing soil and climatic conditions but altitudes of over 1500ft are unsuitable (Tyndall, 1968). Amaranthus hybridus is widely grown in West Africa, Indonesia and Malaysia (Hugue, 1989). Amaranthus hybridus is an annual plant, it is spineless and up to 80m high with grooves. The leaves are green and variable in shape and size. Curcubita pepo is commonly called marrow. It belongs to the family Curcubitacae. Curcubita pepo grows in Malaysia and tropics (Hugues, 1989). C.pepo is a dry season crop which is adversely affected by excessive humidity and high temperature (Tyndall, 1968). It is an annual plant. It has prickly stems and the leaves are large with rough surface. The male and female flowers are on the same plant. C. pepo fruits are variable in size, shape and colour (Tyndall, 1968). C. pepo plays important role as first-crop plants and functions as cover plants (Hugues et al, 1989). The major disease that affects C.pepo is the downy mildew and it is remedied by spraying or dusting with copper fungicide (Tyndall, 1968). Gnetum africana belongs to the family of plants called Gnetaceae.

The WHO recommended a minimum daily intake of 400g of fruits and vegetables (WHO, 2003). However, it is not clear from the report what proportion of this total daily intake should go to vegetables. Nevertheless, according to the Kobe framework document and an FAO report, the recommended total daily intake is equivalent to five (5) servings of 80g each of fruits and vegetables (FAO/WHO 2004, FAO, 2003). Greens leafy vegetables are also a great source of minerals such as zinc, iron and potassium. In recent studies, it is reported that indigenous leafy vegetables contain non-nutrient bioactive phytochemicals that have been linked to protection against cardiovascular and other degenerative diseases. Nonetheless, Orech et al., (2005) observed that some of these phytochemicals found in some indigenous leafy vegetables consumed in Western Kenya may pose toxicity problems when consumed in large quantities or over a long period of time. Each green vegetable contains a different percentage of each mineral, so it is best to rotate their consumption. In spite of the nutritional contribution of indigenous leafy vegetables to local diets, and their health maintenance and protective properties, there has been very little concerted effort towards exploiting this biodiverse nutritional and health resource to address the complex food, nutrition and health problems of subSaharan Africa. Vegetables are full of water, especially when eaten raw, and when eaten the body does not need to use some of its own water to digest them. This means that the body uses less energy and resources to digest the vegetable and can then assimilate the entire nutrient of the vegetables much faster. This means less pressure is put on the digestive systems (Lussier, 2010). Green leafy vegetables like cabbage, lettuce, dandelion, Moringa, etc. may be eaten raw, boiled or dried. Perhaps the most common use in all parts of the world is boiled vegetable leaves. This process eliminates potential pathogens, sometimes poisonous or irritating substances are neutralized and spoilage is brought to a halt (Martin et al., 1998). In Africa, most people consume indigenous green leafy vegetables such as cocoyam leaves Amaranthus hybridus, Curcubita pepo and Gnetum africana. Gnetum africana is classified as a glabrous woody climber with nodes, Orthortrophic vegetable branches with fibrous roots which adhere for support (Purseglove, 1981). Gnetum africana grows up to 7m or more and bears fruits in the fifth year after planting. They are found in the humid areas and in the rain forest zones (Aguta, 1985). However, literature on the comparative nutritional values of Amaranthus hybridus, Curcubita pepo and Gnetum africana leaves is scanty. The objectives of this research is to evaluate the chemical constituents of undefatted and defatted Amaranthus hybridus, Curcubita pepo and Gnetum africana. Also ascertain if defatting affects the bioavailability of these chemical constituents in the leafy vegetables.

Materials and Methods

Fresh samples of Amaranthus hybridus leaves, Curcubita pepo leaves and Gnetum africana were obtained from the Centre for Biodiversity, Utilization and Development (CBUD) farm at Amanfrom in Ashanti Region of Ghana. The analysis was conducted at the Biochemistry Laboratory, Kwame Nkrumah University of Science and Technology (KNUST), Kumasi. Amaranthus hybridus, Curcubita pepo and Gnetum africana leaves were thoroughly washed with clean tap water. These samples were air-dried at room temperature and then oven dried at 600 C. The leaves were later pulverized using mortar and pestle and were packed in polythene bags. Chemical analyses of the leaves of Amaranthus hybridus, Curcubita pepo and Gnetum africana were carried out to determine the protein, carbohydrate, lipid, fibre, ash and moisture content of each of them using Association of Analytical chemists (AOAC) method, 1990. The flame photometric method was used in determining the sodium (Na) and Potassium (K) content. Spectrophotometric method was used in determining the phosphorus (P) and Iron (Fe) content while complexometric titration method was used in determining calcium (Ca) and magnesium (Mg) content of these three leafy vegetables (Association of Analytical Chemists, AOAC, 1990).

Results and Discussion

The results are presented in the tables below.

Table 1: Proximate analysis of the nutritional composition of undefatted leaves of the vegetables

	A. hybridus	*C. pepo*	*G.africana*
Moisture (%)	8.35 ± 0.05	8.55 ± 0.01	7.60 ± 0.01
Crude lipid (%)	1.60 ±0.02	4.15 ± 0.02	7.10 ±0.02
Crude protein (%)	32.95 ±0.01	20.80 ±0.02	19.67 ±0.01
Crude fibre (%)	19.60 ±0.01	16.35 ± 0.00	27.25 ±0.00
Ash (%)	17.70 ± 0.01	15.20 ± 0.02	8.00 ±0.02
Total carbohydrate (%)	15.40 ±0.02	30.40 ± 0.01	30.38 ±0.01

Table 2: Proximate analysis of the nutritional composition of defatted leaves of Amaranthus hybridus, Curcubita pepo and Gnetum Africana

	A. hybridus	*C. pepo*	*G.africana*
Moisture (%)	17.60 ± 0.01	18.70 ±0.02	15.00 ±0.01
Crude protein (%)	12.04 ±0.00	21.60 ±0.01	4.86 ±0.01
Crude fibre (%)	12.40 ± 0.01	3.16 ± 0.01	13.70 ±0.00
Ash (%)	43.60 ± 0.02	43.60 ± 0.02	47.90 ±0.02
Total carbohydrate (%)	14.36 ±0.01	12.94 ±0.01	18.54 ±0.01

Table 3: Mineral composition of undefatted leaves of Amaranthus hybridus,Curcubita pepo and Gnetum Africana

Mineral	Concentration (Mg/g)		
	A. hybridus	*C. pepo*	*G.africana*
Sodium (Na)	64.60	38.60	10.50
Potassium (K)	11.05	9.08	3.40
Magnesium (Mg)	13.68	11.52	3.60
Calcium (Ca)	28.80	32.00	13.60
Iron (Fe)	87.50	65.25	78.75
Phosphorus (P)	0.99	1.15	0.35

Table 4: Mineral composition of defatted leaves of Amaranthus hybridus, Curcubita pepo and Gnetum Africana

Mineral	Concentration (Mg/g)		
	A. hybridus	*C. pepo*	*G.africana*
Sodium (Na)	24.80	17.50	6.14
Potassium (K)	8.65	4.64	4.10
Calcium (Ca)	26.40	28.40	12.80
Magnesium (Mg)	12.48	2.18	3.36
Phosphorus (P)	8.57	1.12	0.18
Iron (Fe)	0.81	45.00	37.50

Table 5: Cyanogenic glycoside content of undefatted leaves of A. hybridus, C.pepo, and G. Africana

	Concentration of undefatted (Mg/100g)		
Cyanogenic glycoside	*A. hybridus*	*C. pepo*	*G.africana*
	2.16 ±0.01	2.59 ± 0.00	1.73 ±0.01

Table 6. Cyanogenic glycoside content of the undefatted leaves of A. hybridus, C.pepo, and G. Africana

	Concentration of defatted (Mg/100g)		
Cyanogenic Glycoside	*A. hybridus*	*C. pepo*	*G.africana*
	1.72 ± 0.01	2.16 ±0.00	1.29 ±0.02

The undefatted A. hybridus, C.pepo had higher percentage of moisture when compared with G. africana. The high moisture content provides for greater activity of water soluble enzymes and coenzymes needed for metabolic activities of these leafy vegetables. G. africana had 7.10 ±0.02% of crude lipid when compared with A. hybridus, C.pepo with 1.60 ±0.02% and 4.15 ±0.02% respectively. This shows that G. africana contains more lipid biomolecules than A. hybridus and C.pepo. A hybridus had 32.95 ±0.01% crude protein when compared with 20.80% ±0.02% and 19.67 ±0.01% of crude protein in G. africana and C. pepo. The high crude protein content in A. hybridus suggests its richness in essential amino acids. These amino acids serve as alternative source of energy when carbohydrate metabolism is impaired via gluconeogenesis. G. africana had 27.25 ±0.00% of crude fibre when compared with A.hybridus and C. pepo with crude fibre values of 19.60 ± 0.01% and 16.35 ±0.00%. The high fibre content justifies the leathery nature of G. africana leaf and its use as a laxative when cooked and eaten in large amount during constipation (Bako et al, 2002). The ash content of A. hybridus was 17.70 ±0.01% while C. pepo had 15.20 ±0.02% and G.africana had at least 8.00 ±0.02%. This confirms that there are more minerals in A. hybridus and C. pepo than G. africana. These minerals act as inorganic cofactors in metabolic processes. In the absence of these inorganic cofactors there could be impaired metabolism. The total carbohydrate content was 30.40 ±0.01% in C. pepo, 30.38 ±0.01% in G. africana higher than 15.40 ±0.02% in A. hybridus. Carbohydrate metabolism is needed in the generation of reducing potentials required to carry out biosynthetic activities in the plant. The moisture content of A. hybridus, C. pepo and G. africana in a defatted form was far higher than the moisture content of undefatted A. hybridus, C. pepo and G. africana. The crude protein content of undefatted A. hybridus, C. pepo and G. africana was higher than the crude protein of defatted A. hybridus, C. pepo and G. africana. In the course of defatting these leafy vegetables, the non-polar amino acids that were constituents of the macromolecule protein may have been extracted thereby reducing the percentage of crude protein in these leafy vegetables. The crude fibre content of undefatted A. hybridus, C. pepo and G. africana.was higher than the crude fibre content of defatted A. hybridus, C. pepo and G. africana. The total carbohydrate content of undefatted A. hybridus, C. pepo and G. africana was higher than the total carbohydrate content of defatted A. hybridus, C. pepo and G. africana. The variations in composition of other chemical constituents either in undefatted or defatted forms of these leafy vegetables suggests some correlation between the crude lipid and other chemical constituents in these leafy vegetables. There was not much variation in Sodium, potassium, magnesium, calcium, iron, and phosphorus content in both the undefatted and defatted forms of A. hybridus, C. pepo and G. africana. Though the concentration values of these minerals in both undefatted and defatted shows that the minerals are predominate in the undefatted form than the defatted form. The cyanogenic glycoside which is an anti-nutritional factor was more prevalent in the undefatted than the defatted forms of these leafy vegetables. The reduced level of the cyanogenic glycoside in the defatted vegetables could be there partial solubility in lipid. In conclusion, it is preferable to consume these leafy vegetables in the undefatted form, since the undefatted form retains a higher level of these chemical constituents than the defatted form.

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