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Assessing the nutritional value of some African indigenous green Leafy Vegetables in Ghana

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1 SUMMARY

African Leafy Vegetables (ALVs) are the cheapest and most readily available sources of important proteins, vitamins, minerals and essential amino acids in Ghana. This study was conducted to determine the nutritional values of the leaves of cocoyam (Kontomire) (*Xanthosoma sagittifolia),* water leaf "(Bokoboko)" (*Talinum triangulare), "*(Aleefu)" (*Amaranth cruentus) and Moringa oleifera.* Samples of the green leafy vegetables were obtained from the Centre for Biodiversity Utilization and Development (CBUD) farm at Prison Camp at Amanfrom in the Ashanti Region. The parameters determined were moisture, crude fiber, crude fat, protein, total carbohydrate, food energy and minerals (iron and phosphorus). The results showed they all had high moisture content ranging from 72.93 to 91.83% with *Talinum* sp. showing the highest percentage of moisture. The other characteristics like crude fiber ranged from1.00% to 10.40%, fat 1.33% to 3.19%, protein 4.46% to 6.60%, carbohydrate 1.05% to 13.50%, food energy 36.60Kcal/100g to 90.20Kcal/100g, iron 1.00mg/100g to 40.50mg/100g and phosphorus 74mg/100g to 81.90mg/100g. The results showed that no particular green leafy vegetable was superior to the others. It is therefore important to use any of the different varieties of leafy vegetables for food. It is recommended that similar investigations should be carried out on other indigenous leafy vegetables such as cowpea, baobab, kapok and cassava leaves

2 INTRODUCTION

In tropical Africa where the daily diet is dominated by starchy staples, African indigenous leafy vegetables (ALVs) 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 Ghana. 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, labour-intensive 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 ALVs is clearly linked to their nutritional and non-nutrient bioactive properties. ALVs 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). Amaranthus for example is reported to be grown for its leaves which are rich in beta-carotene, calcium, iron and vitamin C (James et al., 2010).

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 ALVs 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 ALVs 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 ALVs 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 sub-Saharan 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 Ghana, most people consume indigenous green leafy vegetables such as cocoyam leaves "Kontomire", Amaranthus leaves "Aleefu" and water leaf "Bokoboko". Moringa is popular in Ghana because of its medicinal characteristics. It has been widely publicized and people are encouraged to use its leaves, beans and oil for food. However, literature on the comparative nutritional values of "Kontomire", "Aleefu", "Bokoboko" and Moringa leaves is scanty. The objective of this study is to elucidate the nutritional value of the leaves of Cocoyam leaves "Kontomire" (*Xanthosoma sagittifolia),* water leaf "Bokoboko" (*Talinum triangulare),* Amaranthus leaves "Aleefu" (*Amaranth cruentus) and Moringa* leaves (*Moringa oleifera).*

3 MATERIALS AND METHODS

Four ALVs (Cocoyam leaves "Kontomire" – *Xanthosoma sagittifoli,* water leaf "Bokoboko" – *Talinum triangulare*. Amaranthus leaves "Aleefu" – *Amaranth cruentus*. *Moringa* leaves – (*Moringa oleifera)* 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.

The proximate composition, mineral composition and caloric values of the composite flours were determined. The moisture content was determined using (AOAC, 1984) methods. Crude fat was

determined by Soxhlet extraction and crude fiber by incineration after acid and base digestion. The total carbohydrate content of the composite flours were determined as the difference between 100 and the sum of the moisture, ash, crude fat, crude protein and crude fiber contents of the samples obtained from proximate analysis. The energy values (calorific values) of the composite flours were determined as kcal per 100g of composite flours based on the energy conversion factors of Ceirwyn (1995); FAO, (2006a). Iron and phosphorus contents were analyzed by spectrophotometric method. Crude protein content was determined using the Kjeldahl method of AOAC (1990). Data was analyzed using Analysis of Variance (ANOVA). Fisher's least significant difference (LSD) test was used to identify significant differences among treatment means ($p<0.05$).

4 RESULTS AND DISCUSSION

The proximate composition of the four ALVs is shown in Table 1.

Table 1: Proximate and energy composition of selected leafy vegetables

Leafy vegetables	Moisture (%)	Protein (%)	Fat (%)	Carbohydrate (%)	Fiber (%)	Energy Kcal/100g
Xanthosoma sagittifolia "Kontomire"	85.76 ± 0.05b	4.65 ± 0.02a	3.19 ± 0.02a	6.80 ± 0.04	10.00 ± 0.02a	71.50 ± 0.02
Amaranth cruentus "Aleefu"	72.93 ± 0.05a	4.46 ± 0.03a	3.00 ± 0.01a	10.40 ± 0.02	10.40 ± 0.03a	88.20 ± 0.05
Talinum triangulare "Bokoboko"	91.83 ± 0.04c	5.10 ± 0.01b	1.33 ± 0.04b	1.05 ± 0.03	8.00 ± 0.02	36.60 ± 0.02
Moringa oleifera	75.00 ± 0.05a	6.60 ± 0.02b	1.50 ± 0.05b	13.50 ± 0.03	1.00 ± 0.02	90.20 ± 0.04

*Mean values ± Standard deviation values. a-h means in same column but with different superscripts differ significantly ($p <0.05$)

The moisture content of the four ALVs is very high with *Talinum triangulare* (above 90%). The high moisture content reveals that these vegetables need care for appropriate preservation as they will be prone to deterioration. The vvalues of moisture for the ALVs corroborated with results of Tindal (1983); Woolfe, (1992); Suppiah (1992); Tweneboah (1998); Frank (1997); Fuglie, (2001); Antia et al., (2006); FAO, (2006b). This may be the reason why this vegetable is often sun-dried for few hours before use. The high water content of ALVs when eaten raw helps the body as 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 greens and can then assimilate all the nutrients of the vegetables much faster. Less pressure is therefore put on the digestive system (Lussier, 2010). The results showed that the dry matter content of Moringa leaves was the highest and *T. triangulare* the least. The high moisture content however has a negative correlation on the dry matter content.

The crude fat content was highest in Cocoyam leaves compared to the other three vegetables (Table 1). The fat content observed in *M. oleifera* compared favorably with results of Frank (1997) and Fuglie (2001). The fat content also compared favorably with the fat contents of various sweet potato leaves recorded by Oduro *et al.* (2008). The results of the fat content for Cocoyam and Amaranthus deviated widely from work done by Tweneboah (1998). The difference in values can be attributed to genetic factors such as differences in cultivars as noted by Bruinenberg *et al.* (2001). However, the results for water leaf were comparable to those of Tweneboah (1998). Although all the vegetables had comparatively high fat content, they

are far better than animal fat such as lard, butter and beef fat (Estelle and Karen, 1999).

The protein content of the ALVs ranged between 4.6 and 6.6% with *M. oleifera* showing the highest value among the four vegetables (Table. 1). The results observed for water leaf, cocoyam leaves and Amaranthus were similar to that reported by Tweneboah (1998). The crude protein content of Moringa leaves corroborated with that of Frank (1997) and Fuglie (2001). The crude protein content of these vegetables do not compare favorably with those of sweet potato leaves as recorded by Oduro *et al.* (2008). It is reported that as little as 20g of leaves of Moringa leaf can provide a child with all the vitamin A and C needed daily (Price 2000). A diet including *M. oleifera* should be more palatable than that with sweet potato leaves because dietary fats function to increase food palatability by absorbing and retaining flavours (Lindsay, 1996). A diet providing 1 - 2% of its caloric energy as fat is said to be sufficient to human beings, as excess fat consumption yields to certain cardiovascular disorders such as atherosclerosis, cancer and aging (Davidson et al., 1975; Kris-Etherton et al., 2002).

The fresh green leafy vegetables had fiber content ranging from 1.0% to 10.40% for *M. oleifera* and "Aleefu" respectively. The study indicated that, Moringa leaves had 1.0 percent fiber unlike very high value of about 19.25% recorded by Oduro *et al.*, (2008). Nevertheless, Frank (1997) also obtained 0.9% fiber content of Moringa leaves. The differences in value could be attributed to the age of the leaves used. The analysis showed that cocoyam leaves provided 10.0% fiber which is not in line with the 2.1% fiber content of cocoyam leaves by Tindal (1983). The difference can be linked to the soil nutrients available for the formation of fiber in leaves. If the nutrient is not in adequate amount, the fiber content of the leaf can be affected (Bruinenberg *et al.,* 2001).

The study revealed carbohydrate contents similar to results obtained by Hashin *et al.* (1990), Suppiah (1992); Tweneboah (1998) and Fuglie (2001). The phosphorus content of the vegetables compared favorably with results of Tindal (1983) and Suppiah (1992). *oleifera* recorded the lowest value for phosphorus. Nevertheless the results deviate slightly from that of Frank (1997) and Fuglie (2001). The difference as noted by Motherwell and Bullock (1986) could be associated with fertilizer application and the amount of phosphorus which was already in the soil before cultivation. Fertilizers such as NPK which has phosphorus content can increase the level of phosphorus in the soil and consequently the level of phosphorus in plant tissues. The phosphorus content of vegetables can decrease during cooking, which is attributed to the leaching of mineral into the cooking medium. Care must be taken during preparation and stock used for cooking if phosphorus level is to be maintained.

The study revealed that the iron content of the ALVs was very high except for *M. oleifera.* However, similar results were observed in study by Frank (1997) but deviated from what was observed by Fuglie (2001). Nevertheless, the results compared well with that of Tindal (1983) and Suppiah (1992). The symptoms of iron deficiency anemia include fatigue, inability to concentrate, pale coloration, weakness and listlessness. The mineral composition of the leaves (Table 2) unravels a high concentration of iron and phosphorus. Children, women of reproductive age and pregnant women are most vulnerable to micronutrient deficiency and anaemia (GDHS, 2004). Hence, they need food with high iron content. When these green leafy vegetables with enough iron content are eaten in dishes, there is no need for iron supplements. There is a risk of iron toxicity when iron supplements are over- dosed which results in damage to liver and pancreas, and even sudden death in young children (Estelle and Karen, 1999).

Table 2: Mineral composition of selected leafy vegetables

Leafy vegetable	Iron mg/100g	Phosphorus mg/100g
Xanthosoma sagittifolia	14.64 ± 0.05	80.10 ± 0.03
Amaranth cruentus	40.50 ± 0.02	78.90 ± 0.03
Talinum triangulare	28.21 ± 0.05	81.90 ± 0.03
Moringa oleifera	1.00 ± 0.01	74.00 ± 0.05

For the fresh green leafy vegetables the caloric value obtained ranged from 36.6 Kcal/100g to 90.20 Kcal/100g for *T. triangulare* and *M. oleifera* respectively. *X. sagittifolia* obtained 71.50 Kcal/100g and *A. cruentus* had 88.20 Kcal/100g. The caloric values obtained corroborated with the results of Frank (1997) and Fuglie (2001) and Tindal (1983) (Table 1). The study indicated that cocoyam leaves registered 71.50 kcal/100 g caloric values which are in consonance with the 72kcal/100g recorded by Tindal (1983). The energy content of the leaves of water leaf according to the study was 36.60kcal/100g energy. This analytical value is in line with the 38.1kcal/100g indicated by Suppiah, (1992). *M. oleifera* samples recorded the highest energy value of 90.20 Kcal/100g followed by Amaranthus leaves of 88.20 Kcal/100g, cocoyam leaves had 71.50 Kcal/100g then the leaves of water leaf had the least value of 36.60 Kcal/100g.

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