

# Phytochemical Investigations and Nutritive Potential of Eight Selected Plants from Ghana

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**Abstract:** In Ghana and most parts of Africa, traditional vegetables and herbs are important sources of proteins, minerals and vitamins for the general population. In order to meet the daily recommended nutritional requirements for the betterment of health and general well being, these vegetables and herbs are seen as an integral part of the diet of the people. In this study, the phytochemical constituents, mineral content and nutritive potential of eight selected plants, *Amaranthus incurvatus* (Amaranthaceae), *Launaea taraxacifolia* (Asteraceae), *Manihot utilissima* (Euphorbiaceae), *Ceiba pentandra* (Malvaceae), *Manniophyton fulvum* (Euphorbiaceae), *Corchorus olitorius* (Malvaceae), *Talinum triangulare* (Portulacaceae) and *Hibiscus sabdariffa* (Malvaceae), were evaluated using standard methods. The results showed that, alkaloids, glycosides, flavonoids, terpenoids, phytosterols and tannins are present in almost all the plant samples. Vitamin C is the abundant vitamin present in the selected plants followed by vitamin A. The crude protein ranged from 7.44 – 31.5% with *A. incurvatus* and *T. triangulare* providing the highest amount. The elemental analysis in mg/100g of dry matter revealed *H. sabdariffa* calyx contained the highest amount of magnesium (Mg) and iron (Fe), providing about 43.48% and 72% of the respective daily value of these minerals. The sodium (Na) and potassium (K) contents of the samples were within recommended daily values except *H. sabdariffa* which exceeded its daily value for potassium (K). The selected plants may therefore be considered as viable and cheap sources of dietary nutrients and their incorporation in diets may be said to be scientifically justifiable.

**Keywords:** Secondary metabolites, haematinic agents, proteins, minerals, vitamins.

## 1. INTRODUCTION

Despite the advancement made in the promotion of nutrition and health globally, malnutrition remains widespread, especially in developing countries, with Sub-Saharan Africa recording the highest rate. Nearly 6 million children die each year from malnutrition and one in three people in Sub-Saharan Africa is malnourished, according to a UN report [1]. The daily diet in many African countries is dominated by starchy staples. Good nutrition is essential for survival, physical growth, mental development, performance and productivity, health and well-being. People with adequate nutrition are more productive and can create opportunities to gradually break the cycles of poverty and hunger. Malnutrition, in every form, presents significant threats to human health [2].

In Ghana, about 5% of the population remains undernourished [3], from both protein-energy and micronutrient (vitamin and mineral) malnutrition. To alleviate the problem, interests have been centered on the development, quantification and consumption of

vegetable food plants [4]. These vegetables are good sources of most of the daily requirements of vitamins including A, B group and C [15]. Many species of indigenous African vegetables are not well known globally, even though vegetables and herbs are an important source of proteins, vitamins and essential amino acids [6]. Currently, there are many well known vegetables in Ghana including cocoyam leaves, garden eggs, tomatoes and okra as well as some herbs including those selected for the study. Their popularity stems from being highly nutritive and containing a number of micronutrients, proteins and a host of antioxidants for good health and prevention of diseases [7]. These lesser known vegetable plants when properly harnessed and utilised could be an antidote to malnutrition, which is an issue of major concern in Ghana and for that matter Africa. In this study, the nutritive potential of 8 selected Ghanaian plants (*A. incurvatus*, *L. taraxifolia*, *M. utilissima*, *C. petandra*, *M. fulvum*, *C. olitorius*, *T. triangulare* and *H. sabdariffa*) as well as their phytochemical constituents were investigated. Knowing the nutritional and medicinal values of these plants may lead to improvement in their cultivation, consumption and conservation. Proper utilisation of such knowledge and resources may aid in the fight against hunger and disease – two major challenges faced by people in the developing world [8].

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**Table 1: Qualitative Test for Vitamins**

Samples	Vitamins				
	A	B2	B6	B12	C
<i>Amaranthus incurvatus</i>	+	-	-	+	+
<i>Launaea taraxacifolia</i>	+	-	+	-	+
<i>Manihot utilissima</i>	+	-	-	+	+
<i>Ceiba pentandra</i>	-	-	+	+	+
<i>Manniophyton fulvum</i>	-	+	-	-	+
<i>Corchorus olitorius</i>	-	+	-	-	+
<i>Talinum triangulare</i>	+	-	+	-	+
<i>Hibiscus sabdariffa</i>	-	+	-	-	+

Key: + = present; - = Absent.

## 2. RESULTS AND DISCUSSION

### 2.1. Analysis of Plant Extracts for the Presence of Vitamins

The various plant extracts were analysed for the presence of vitamins using thin layer chromatography as described by Keemia [10]. The result of qualitative analysis for the presence of vitamins B2, B6, B12, A and C is presented in Table 1. *A. incurvatus* and *M. utilissima* leaves showed the presence of vitamins A, B12 and C whereas *M. fulvum*, *C. olitorius* and *H. sabdariffa* contained B2 and C. *L. taraxacifolia* and *T. triangulare* showed the presence of vitamins A, C and B6 with *C. pentandra* showing the presence of B6, B12 and C. Thus the samples contained 2 to 3 of the vitamins tested with vitamin C being present in all of them. Vitamin B2 is primarily found as an integral component of the coenzymes FAD and FMN which play critical roles in the metabolism of carbohydrates, fats, proteins as well as the electron transport chain for the generation of energy [13]. B6 on the other hand is involved in protein metabolism, gluconeogenesis and immune function [14] whereas B12 is required for proper red blood cell formation, neurological function and DNA synthesis [15]. Vitamin A is involved in immune function, vision, reproduction and cellular communication [16] with vitamin C being an important physiological antioxidant [13]. If quantitative analysis of these essential vitamins in the samples, reveals them to be present in amounts recommended for daily serving, these medicinal plants could be useful supplements of these vitamins.

### 2.2. PROTEIN ANALYSIS

The presence of proteins in the extracts was determined using the Kjeldahl method [12]. The protein

content of the samples ranged from 7.44 to 31.5%. *A. incurvatus* and *T. triangulare* had higher amounts compared to the other samples (Table 2). According to Pearson [17], plant foods that provide more than 12% of their calorific value from protein are considered good sources of protein. In that context all the plant samples, except *H. sabdariffa*, could be considered as good protein sources especially for adults and pregnant women who require 34-56 g and 13-19 g protein daily respectively [18]. The protein content of some of the samples (*A. incurvatus* and *T. triangulare*) was comparable to that reported for *M. oleifera*, (27.52%) which is well noted for its nutritional value [7, 19].

**Table 2: Protein Content of Extracts of Plants**

Samples	Percentage protein (%)
<i>Amaranthus incurvatus</i>	31.50
<i>Launaea taraxacifolia</i>	18.38
<i>Manihot utilissima</i>	21.44
<i>Ceiba pentandra</i>	16.19
<i>Manniophyton fulvum</i>	21.06
<i>Corchorus olitorius</i>	20.56
<i>Talinum triangulare</i>	27.63
<i>Hibiscus sabdariffa</i>	7.44

### 2.3. Mineral Analysis of Extracts

The minerals present in the different extracts were analysed using Atomic Absorption Spectrophotometer (model AA240FS) as described by Anan *et al.* [9]. The results for the analysis of the essential elements in the plants are presented in Table 3. The mineral contents of the selected plants varied comparatively. The highest amount of magnesium (Mg), 173.9 mg, occurred in *H. sabdariffa*. Magnesium is an essential

**Table 3: Mineral Contents of Plant Materials**

Plant samples	mg/100g				
	Fe	Zn	Mg	Na	K
<i>Amaranthus incurvatus</i>	8	3.0	106.1	0.9	2847
<i>Launaea taraxacifolia</i>	3	17.0	97.7	2.22	1322
<i>Manihot utilissima</i>	0.09	5.0	43.1	0.003	3220
<i>Ceiba pentandra</i>	2	11.0	35.5	0.38	419
<i>Manniophyton fulvum</i>	0.8	33.0	96.7	1.25	868
<i>Corchorus olitorius</i>	6.0	46.0	35.0	0.11	2292
<i>Talinum triangulare</i>	10.0	15.0	30.2	1.84	893
<i>Hibiscus sabdariffa</i>	13.0	22.1	173.9	55.04	5540

mineral for strong bones as well as for maintenance of normal muscle and nerve function [19]. According to the Food and Drugs Administration (FDA) of the USA, the recommended daily value (DV) of magnesium is 400 mg. Vegetable plants which provide between 10-19% of the daily value are described as good sources whereas those providing 5% or less are described as poor sources [20]. Thus with *H. sabdariffa* providing about 43.48% of the daily value, it may be considered as an interesting source of Mg. *A. incurvatus*, *L. taraxacifolia*, *M. utilissima*, *C. petandra*, *M. fulvum*, *C. olitorius* and *T. triangulare* also yielded 27, 24, 11, 9, 24, 9 and 8% of the daily value respectively. *C. petandra*, *C. olitorius* and *T. triangulare*, although not very good candidates compared with the other plants as per their Mg contents, also provided reasonable amounts of magnesium compared with the others. All the selected plants also contained variable amounts of iron (Fe). Iron is useful in the prevention of anaemia and other related diseases. The recommended DV for iron is 18 mg [21]. Foods providing 5% of the DV or less are low sources while foods that provide 10–19% or more of the DV are good sources. *A. incurvatus*, *L. taraxacifolia*, *C. pentandra*, *C. olitorius*, *T. triangulare* and *H. sabdariffa*, yielded 44, 16, 11, 33, 56 and 72% of the daily value and therefore, per this criteria may be considered as good sources of iron. Utilisation of these lesser known vegetable plants can therefore help alleviate iron deficiency anaemia, the most common form of malnutrition in the world, affecting more than 2 billion people globally and highly prevalent in less-developed countries [21]. *M. utilissima* and *M. fulvum* provided only 0.5 and 4% of the DV and may be referred to as being poor sources of iron (Fe). Zinc (Zn) is useful for protein synthesis, normal body development and immune defense whereas sodium and potassium (K) are essential for fluid balance and

nerve transmission [22]. Sodium (Na) is needed in only trace amounts. The maximum safety limit of sodium (Na) is 480 mg whereas the average adult requirement of potassium (K) is 4700 mg [23-24]. Thus from the study, the sodium (Na) and potassium (K) contents of the plant samples were within limits except *H. sabdariffa*, which exceeded its value for potassium (K). The recommended daily allowance of zinc (Zn) for infants and adults is within the range of 3-11 mg. The zinc (Zn) content of *A. incurvatus*, *M. utilissima* and *C. petandra* were within recommended values whereas the others exceeded the recommended daily allowance. Thus the selected plants contain essential micro and macronutrients in considerable amounts for good health.

#### 2.4. Phytochemical Evaluation of Plant Extracts

The phytochemical screening of the plant samples revealed the presence of glycosides, alkaloids, terpenoids, phytosterols, tannins and flavonoids in almost all the samples. These classes of secondary metabolites exhibit a range of bioactivities such as antimutagenic, anticarcinogenic, analgesic, antimicrobial and anti-inflammatory properties [25]. Some of these metabolites act as natural antioxidants to neutralize the harmful effect of oxygen radicals in the body. One of the major classes of natural antioxidants found in plants that remove such free radicals is polyphenols. The phenolic compounds (flavonoids and tannins) are able to neutralize reactive oxygen and nitrogen species and also break down peroxides. The presence of these phenolic metabolites in the selected plant samples are notably helpful as their utilisation would protect the individual from some of the free radical mediated diseases such as Alzheimer's, cardiovascular diseases and cancer [26-27].

**Table 4: Phytochemical Evaluation of the Eight Plants**

Plant samples	Alkaloids	Glycosides	Tannins	Terpenoids	Flavonoids	Phytosterols
<i>Amaranthus incurvatus</i>	+	+	+	+	+	+
<i>Launaea taraxacifolia</i>	+	+	-	+	+	+
<i>Manihot utilissima</i>	-	+	+	+	+	-
<i>Ceiba pentandra</i>	-	+	-	-	+	-
<i>Manniophyton fulvum</i>	+	-	+	+	+	+
<i>Corchorus olitorius</i>	+	+	+	+	-	+
<i>Talinum triangulare</i>	+	+	+	-	+	+
<i>Hibiscus sabdariffa</i>	+	+	+	+	+	-

Key: + = present; - = Absent.

### 3. CONCLUSION

This study has shown that the leaves of *A. incurvatus*, *L. taraxifolia*, *M. utilissima*, *C. petandra*, *M. fulvum*, *C. olitorius*, *T. triangulare* and the calyces of *H. sabdariffa*, are a rich source of iron, zinc, potassium, proteins and vitamins A, B2, B6, B12 and C, making them a viable and cheap source of dietary nutrient. They can contribute significantly to the nutrient requirements of humans and may be recommended in diets to aid in the fight against malnutrition.

### 4. EXPERIMENTAL

#### 4.1. Materials, Methods and Techniques

##### 4.1.1. Collection and Authentication of Plant Material

The fresh leaves of *Amaranthus incurvatus*, *Launaea taraxifolia*, *Manihot utilissima*, *Ceiba pentandra*, *Manniophyton fulvum*, *Corchorus olitorius*, *Talinum triangulare* and the calyces of *Hibiscus sabdariffa* were collected from the Ashanti and Eastern Regions of Ghana. They were selected based on availability and frequency of usage and authenticated by Mr. George Henry Sam of the Department of Herbal Medicine, where herbarium specimen with voucher specimen numbers FPPSAI002, FPPSLT003, FPPSMU004, FPPSCP005, FPPSMF006, FPPSCO007, FPPSTT008 and FPPSHS009 have been deposited.

##### 4.1.2. Plant Material Processing and Extraction

The leaves and calyces were washed thoroughly 2-3 times under running tap water and air dried under a shade. They were then grounded to powder and kept in small plastic bags and labeled. The fresh plant

materials were also blended with 70% ethanol and left for 48 hours for maceration and extraction. The macerated samples were then filtered, evaporated to dryness using rotary evaporator and water bath and the crude extracts weighed and transferred into appropriately labeled sample tubes.

##### 4.1.3. Mineral Analysis

An acid digest of each plant species was prepared by oxidizing 0.2 g of the powdered plant sample with nitric/perchloric acid (2:1) mixture (10 ml). 1ml of the acid digests of the plant samples were further diluted to 20 ml with distilled water. Aliquots of the mixture were used to estimate the sodium (Na), potassium (K), iron (Fe), zinc (Zn) and magnesium (Mg) contents using the Atomic Absorption Spectrophotometer (model AA240FS) [9]. The blank and working standards were first run followed by the samples. Each sample was analysed twice, and the data reported as a mean of the analysed samples in mg/l. The various concentrations of elements obtained were projected from the crude extract level to the raw sample level and the amounts converted mg/g of plant material.

##### 4.1.4. Vitamin Analysis

Qualitative test for vitamins were analysed on the plant extracts using thin layer chromatography as described by Keemia [10]. They were tested for the presence of Vitamins A, B2, B6, B12 and C. Pure samples of these vitamins were used as standards. The water soluble vitamins, B2, B6, B12 and C were dissolved in 70% ethanol and the fat soluble vitamin A in chloroform. Each of the pure vitamin solution was co-chromatographed with all the eight (8) ethanolic crude extracts of the plant samples on aluminium precoated silica gel plates 60 F<sub>254</sub> (0.25 mm thick) using diethyl ether/ petroleum ether/ acetone/ glacial acetic acid;

40:60:2:1 (Vitamin A), chloroform/ methanol/ ethyl acetate; 5:5:2 (Vitamin B2), 5% NH<sub>4</sub>OH/ 95% ethanol/ Chloroform/ acetone (1:2:2:2), (Vitamin B6) and 1-butanol/ 2-propanol/ water; 10:7:10 (Vitamin B12) as mobile phases. The developed plates were then dried and the spots detected using the appropriate detection method and reagent (vitamin B6 and C with KMnO<sub>4</sub>) and the rest under UV light.

#### 4.1.5. Phytochemical and Crude Protein Analysis

Preliminary screening for various classes of secondary metabolites was carried out using standard procedures described by Khandelwal [11]. The Kjeldahl method [12] was used to determine the protein content.

## 5. AUTHENTIC REFERENCE

### 5.1. Vitamins

Vitamins A, B2, B6, B12 and C were obtained from Sigma Aldrich Co Ltd. UK.

### 5.2. Chemicals

Unless otherwise specified, chemicals were analytical grade and purchased from Sigma Aldrich Co Ltd. UK. Organic solvents were analytical grade and purchased from BDH Laboratory Supplies, UK.

### 5.3. Apparatus

Minerals were analysed using Atomic Absorption Spectrophotometer (model AA240FS).

## REFERENCE

- [1] Fickling D. Saharan malnutrition worse than 10 years ago-UN report 2005. Available at <http://www.guardian.co.uk/world/2005/nov/22/hearafrica05.development>.
- [2] World Health Organisation. Nutrition and health. Geneva: World Health Organization. p. 7. (<http://www.emro.who.int/nutrition/index.htm>, accessed on 20 May 2011).
- [3] Agle R, Bader E, Solal-Céligny, Palma G. Ghana Nutrition Profile – Nutrition and Consumer Protection Division, Food and Agriculture Organization of the United Nations 2009. Available at <ftp://ftp.fao.org/ag/agn/nutrition/ncp/gha.pdf>
- [4] Dini I, Tenore GC, Dini A. Nutritional and antinutritional composition of Kancolla seeds: an interesting and underexploited food plant. *Food Chem* 2005; 92: 125-32. <http://dx.doi.org/10.1016/j.foodchem.2004.07.008>
- [5] Shei LC. An Evaluation of Native West African Vegetables Conference on International Research on Food Security, Natural Resource Management and Rural Development, University of Hohenheim 2008.
- [6] Martin FW, Ruberte Meitner LS. Edible Leaves of the Tropic, Educational concerns for Hunger organization, INC 1998; pp. 1-8.
- [7] Oduro I, Ellis WO, Owusu D. Nutritional potential of two leafy vegetables: *Moringa oleifera* and *Ipomoea batatas* leaves. *Scientific Res Essay* 2008; 3(2): 057-060.
- [8] Ijeh II, Chukwunonso ECC. Current perspectives on the medicinal potentials of *Vernonia amygdalina* Del. *J Med Plants Res* 2011; 5(7): 1051-61.
- [9] Annan K, Kojo AI, Cindy A, Tunkumngnen BM. Profile of heavy metals in some medicinal plants from Ghana commonly used as components of herbal formulations. *Phcog Res* 2010; 2: 41-44. <http://dx.doi.org/10.4103/0974-8490.60579>
- [10] Keemia M. Determination of vitamins using thin layer chromatography, 2008. Available at [tera.chem.ut.ee/~koit/arspr/vita\\_en.pdf](tera.chem.ut.ee/~koit/arspr/vita_en.pdf)
- [11] Khandelwal KR. Practical pharmacognosy, 19<sup>th</sup> ed., Nirali Prakashan 2008; pp. 157-161.
- [12] AOAC. Official methods of analysis, Association of Official Analytical Chemists, Washington, D.C., USA. 15<sup>th</sup> ed., 1990, pp. 807-928.
- [13] McCormick DB. Riboflavin. In: Shils M, Olson JA, Shike M, Ross AC, Eds. *Modern Nutrition in Health and Disease*. 9<sup>th</sup> ed. Baltimore: Williams and Wilkins 1999; pp. 391-399.
- [14] Mackey A, Davis S, Gregory J. Vitamin B6. In: Shils M, Shike M, Ross A, Caballero B, Cousins R, Eds. *Modern Nutrition in Health and Disease*. 10<sup>th</sup> ed. Baltimore, MD: Lippincott Williams and Wilkins 2005.
- [15] Subar AF, Krebs-Smith SM, Cook A, Kahle LL. Dietary sources of nutrients among US adults, 1989 to 1991. *J Am Diet Assoc* 1998; 98: 537-47. [http://dx.doi.org/10.1016/S0002-8223\(98\)00122-9](http://dx.doi.org/10.1016/S0002-8223(98)00122-9)
- [16] USDA. U.S. Department of Agriculture, Agricultural Research Service. USDA National Nutrient Database for Standard Reference, Release 24, 2011. Nutrient Data Laboratory Home Page, <http://www.ars.usda.gov/ba/bhnrc/ndl>
- [17] Pearson D. *The Chemical Analysis of Foods*. 7<sup>th</sup> ed. Churchill Living stone, London 1976.
- [18] Wacker WE, Parisi AF. Magnesium metabolism. *N Engl J Med* 1968; 278: 658-63. <http://dx.doi.org/10.1056/NEJM196803212781205>
- [19] Saris NE, Mervaala E, Karppanen H, Khawaja JA, Lewenstam A. Magnesium: an update on physiological, clinical, and analytical aspects. *Clin Chim Acta* 2000; 294: 1-26. [http://dx.doi.org/10.1016/S0009-8981\(99\)00258-2](http://dx.doi.org/10.1016/S0009-8981(99)00258-2)
- [20] Institute of Medicine. Food and Nutrition Board. *Dietary Reference Intakes: Calcium, Phosphorus, Magnesium, Vitamin D and Fluoride*. National Academy Press. Washington, DC 1999.
- [21] Stoltzfus RJ, Dreyfuss ML. Guidelines for the use of iron supplements to prevent and treat iron deficiency anaemia, International Nutritional Anaemia Consultative Group (INACG), 2012. Retrieved on 24/05/2012 from the website [http://www.who.int/nutrition/publications/micronutrients/guidelines\\_for\\_Iron\\_supplementation](http://www.who.int/nutrition/publications/micronutrients/guidelines_for_Iron_supplementation)
- [22] Ogbe AO, Affiku JP. Proximate study, mineral and anti-nutrient composition of *Moringa oleifera* leaves harvested from Lafia, Nigeria: potential benefits in poultry nutrition and health. *J Microbiol Biotechnol Food Sci* 2011; 1(3): 296-308.
- [23] Krauss RM, Eckel RH, Howard B. AHA dietary guidelines. Revision: A statement for healthcare professionals from the Nutrition Committee of the American Heart Association. *Circulation* 2000; 102: 2284-99. Retrieved from the website: <http://www.umm.edu/altmed/articles/potassium-000320.htm#ixzz1vmRANw3o>
- [24] Institute of Medicine. *Dietary reference intakes for water, potassium, sodium chloride, and sulfate*. 1<sup>st</sup> ed. Washington, DC: The National Academies Press 2004.

- [25] Yen GC, Duh PD, Tsai CL. Relationship between antioxidant activity and maturity of peanut hulls. *J Agric Food Chem* 1993; 41: 67-70.  
<http://dx.doi.org/10.1021/jf00025a015>
- [26] Cartea ME, Francisco M, Soengas P, Velasco P. Phenolic Compounds in *Brassica* Vegetables. *Molecules* 2011; 16: 251-80.  
<http://dx.doi.org/10.3390/molecules16010251>
- [27] Rizwani GH, Shareef H. The Genus *Allium*: Potential nutritive and therapeutic source. *J Pharm Nutrit Sci* 2011; 1: 158-65.

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