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The Nutritive Value and Amino Acid Characteristics of *Solanum Aethiopicum* Leaf Protein Concentrates

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Abstract: *Fresh sample of Solanum aethiopicum was purchased and processed for leaf protein concentrates to evaluate its chemical profile and amino acid characteristics. The leaf protein concentrates was produced from this species using village-level, low-cost techniques. The proximate composition, mineral constituents and Aminoacid profile were determine using standard analytical technique. The sample contain Moisture; (5.90±0.03g/100g), Crude fat; (2.77±0.02g/100g), Crude fibre; (2.77±0.02g/100g), Crudeprotein ; (28.92±0.50),Ash; (8.32±0.04g/100g), Nitrogen Free Extract;(47.31±0.48g/100g). Fe and Zn are the abundant minerals in the sample. The amino acid profile reveals the presence of essential and non-essential amino acid including tryptohan and ornithine which are limiting amino acid in some plant sample.*

Keywords: *Leaf protein concentrates, Amino acid, proximate analysis, Solanum aethiopicum,*

1. INTRODUCTION

A large section of the population of the under developing countries live under substandard conditions including nutritionally inadequate diets (Maforah, 1994). In addition, (Aletor, V. A. and Fasuyi, O. A., 1997) and Coffman, C. W. and Garcia V. V. 1977), indicate that the rapid population in most African countries (Nigeria inclusive) has led to serious food crises, especially among the vulnerable groups such as the weanlings, pre-school children, pregnant or nursing mothers, etc. This class of people are particularly prone to dietary protein and vitamin inadequacies. The dietary inadequacies arise mainly from the high cost of animal proteins such as; milk, meat, egg, fish and chicken the consequence of which resulted in malnutrition and wide spread deficiency diseases.This lead to the search for some other conventional protein sources from plant as a means of replacing protein from animal sources.

Furthermore, leaf protein concentrates contain protein prepared from disrupted plant cell further processed into green chloroplasmic or white cytoplasmic protein concentrates using heat coagulation. The need for use of leaf protein concentrates as food for man and animal arise; due to an accelerated food demand and increase in competition between man and animal for the available protein from animal sources. This problem cannot be solved by conventional agriculture alone, as an additional source of protein is required and leaf protein concentrates should be given serious attention because leaves are abundant all the year round in the tropics and many have high protein content with suitable plant material (Arowosoge and Popola, 2006).

Solanum aethiopicum is a fruiting plant found in Asia and Tropical Africa with different and names as Mock Tomato, Garden Eggs, Ogunmo and Ethiopian Night Shade. It is one of the most popular edible non tuberiferous cultivated *Solanum* species. The leaves of *Solanum aethiopicum* are eaten as leaf vegetable, the fruit is eaten both raw and cooked, and the berries are often used as an ornament in Asia.

Moreover, previous studies showed that the fruits of *Solanum aethiopicum* are interesting, for instance, it could be used to obtain benefit for other egg plants genetic improvement(Tappino, L.; Vale, G. and Rotino G. L., 2008) and (Collonier et al., 2001). It is also useful for the nutritional, organoleptic and medicinal purpose, such as high level of antioxidant compounds it contains (Auguste Kouassi, Eric Béli-Sika, Tah Yves-Nathan Tian-Bi, Oulo Alla-N'Nan, Abou B. Kouassi, Jean-Claude N'Zi, Assanvo S.-P. N'Guetta and Bakary Tio-Touré2014). The leaf protein concentrates of this interesting plant however have remained under researched and consequently under-utilized. It was

therefore the objectives of this investigation to determine proximate composition, mineral contents and amino acid analysis of *Solanum aethiopicum* leaf protein concentrates.

2. MATERIALS AND METHODS

Preparation of sample, fresh sample of *Solanum aethiopicum* was obtained from Oje market in Ibadan town of Oyo State, Nigeria. The leaves of the vegetables were plucked and the stems were trimmed. The leaves were then washed with distilled water and pulped by passing it through the locally produced mincer (technically referred to as cell rupture). The pulp was collected and strained through a cotton cloth followed by screw press. The green juice obtained from straining the pulp through the cotton cloth, was heated between $85^oC - 90^oC$ by steam injection, which resulted in the coagulation of all the protein present within the pulp. The coagulum was then centrifuge from the rest of the solution, pressed pulverized and air dried prior chemical analysis.

2.1. Proximate Analysis

The proximate analysis of the air dried sample of solanum aethiopicum was determined by the official method of the Association of Official and Analytical Chemist (1990). To determine moisture content, crude protein, crude fat and crude fibre while Nitrogen Free Extract (NFE) was calculated by difference.

2.2. Analysis of Mineral Content

Five grams (5g) of the sample was ashed in a muffle furnace at 550^OC for 12 hours. The resulting ash was cooled in a desiccator. The ash was dissolved in 2ml of concentrated HCl and few drops of concentrated HCl and few drops of concentrated HNO_3 were added. The resulted solution was evaporated almost to dryness in water bath. The content was diluted to the mark level in 100ml volumentric flask with distilled water. Bulk scientific 470 AA atomic absorption spectrophotometer was used to determine each metal reported for this sample after the appropriate dilutions has been made for each element.

2.3. Amino Acid Analysis

The amino acid were determined by using modified method of Sparkman et al (1958). The sample was defatted using 40% petroleum ether followed by hydrolysis using 6M HCl and evaporated in rotary evaporator before loading into Technician Sequential Multisample Amino Acid Analyzer.

3. RESULTS AND DISCUSSION

Table I. *Proximate Composition of Solanum aethiopicum.*

Ingredient	Composition mg/100g
Moisture	5.90±0.03
Crude fat	2.77±0.02
Crude fibre	6.79±0.02
Crude protein	28.92±0.50
Ash	8.32±0.04
Nitrogen Free Extract	47.31±0.48

Note: ±*means the mean deviation of triplicate result*

Table 1 present proximate composition of *Solanum aethiopicum* leaf protein concentrates. The moisture content of the sample is 5.90±0.30g/100g. Moisture in food indicate the keeping quality of food and determines largely rate of food absorption and digestion. The moisture value reported for this sample is lower than 7.6±0.6g/100g reported for *Telfaira occidentalis* leaf protein concentrates (Adeyeye and Omotayo 2011). The value is also lower than 10.67±0.03g/100g reported for dried leaf of *Thaumatococuas daniellii* (Shalom et al., 2014). The lower moisture content of this leaf protein concentrates means that there is a concentration solutes and deceased ability to perishability (Fennema and Tannenbaum, 1996).

The total ash content of *Solanumaethiopicum* was 8.32±0.04 g/100g. The value 7.4±0.2 g/100g and 1.5±0.1 reported for *Amaranth hybridus* and *Manihot esculenta* leaf protein concentrates respectively (Aletor and Adebayo, 2012). Low Ash content means that the mineral content of the food is also low. Samples with high ash content are good in treating or preventing malnourishment. The most abundant mineral in this sample is iron and zinc.

Crude fat concentration of *Solanum aethiopicum* was 2.77±0.02 g/100g. The value is lower than 6.4±0.5 and 9.0±0.3 reported for *Amaranth hybridus* and *Manihot esculenta* leaf protein concentrates respectively (Aletorand Adebayo 2012). It is also lower than 6.80±0.13 g/100g and f6.81±0.49 g/100g reported for *Solanum microcapon* and *Cochorus olitorius* respectively(Falade et al., 2004). Fat in food determines the amount of energy available. It also function in the increase of palatability of food by absorbing and retaining flavour. In addition, a diet providing 1–2g of fat is said to provide caloric energy sufficient to human beings. This indicate that this smple is agood source of dietary fat.

Crude fibre content of the *Solanum aethiopicum* is 6.79±0.02 g/100g the value is higher compared to 7.20 g/100g in sweet potatoe leaves and 1.3 g/100g *Tribubus terrestris* leaves (Hassan and Umar, 2006). It is also higher than 1.7 g/100g and 1.6 g/100g reported for *Amaranthus hybridus* and *Telfaira occidentalis* leaf protein concentrates (Adeyeye and Omotayo, 2011). The recommended daily allowance of fibre is 18.35g (NRC, 1990) which indicate that *Solanum aethiopicum* will leave to be mixed with food that are richer source of fibe in order to meet up with the recommended value. Dietary fibre in food is helpful to reduce serum cholesterol level, risk of coronary meat disease, colon and breast cancer and hypertension (Ganong, 2003).

Crude protein composition of *Solanum aethiopicum* is 28.32±0.50 g/100g the value is higher than 11.29 g/100g reported for basalm apple (Hassan and Umar, 2006), but fall in range with 28.0±0.1 and 30.9±0.2 reported for *Amaranth hybridus* and *Manihot esculenta*leaf concentrates respectively (Aletor andAdebayo, 2012). Proteins are powerful compounds that build and repair body tissues and its essence is to furnish man with essential amino acids necessary for the maintenance of body tissue. The recommended daily allowance of protein for children, adult males and females are 28.0, 63.0 and 50.0 g/100g respectively (NRC, 1990). This indicate that *Solanum aethiopicum*leaf concentrates can meet the supply of daily requirement of protein by consuming significant quantity of this sample.

Crude carbohydrate content of the *Solanum aethiopicum*leaf concentrates is 47.31±0.48 g/100g. The value is lower compared to some leafy vegetables in the literature like *Tribulus terrestris* 55.67 g/100g and 54.20 g/100g reported for Spinach leaves (Asibey-Berko and Tayie, 1999). The value is however marginal compared to 46.1±0.5 reported for *Amaranth hybridus* but higher than 34.9±0.2 g/100g reported for *Manihot esculenta* (Aletor and Adebayo, 2012). Carbohydrate in food is an important source of energy and dietary fibre. It also contributes to the sweetness, appearance and textural characteristics of many food substances. This indicate that the sample is a good source of dietary carbohydrate.

Table2. *Mineral Composition of solanum aethiopicum leaf protein concentrates*

Mineral element	Na	K	Ca	Mg	P	Fe	Cu	Zn	Mn	Se
Composition mg/100g	0.21±0.00	0.43±0.00	0.23±0.00	0.29±0.0	0.20±0.00	124.95±0.35	2.45±0.21	33.5±0.14	4.05±0.21	0.02±0.00

The mineral composition of *Solanum aethiopicum* were presented in Table 2. The sample has the highest composition of dietary Iron (124.95±0.3 5 g/100g). The value is higher than those reported for most common vegetables and leaf protein concentrates in literature. Iron is required for haemoglobin formation and its deficiency leads to anemia. The recommended dietary allowance for iron for male adult is 10–15 mg (National Research Council, 1990). Theiron content of this sample overshot the daily dietary requirement of Iron. This indicate that this sample should be consumed with care to prevent some health problems associated with excessive Iron in the body or should be subjected to treatment that can alleviate iron content such as blanching before processed for leaf concentrates.

Concentration of zinc in this sample is 33.5±0.14 mg/100g. The recommended daily allowance of zinc is 12 – 15 mg per day (NRC, 1990). The reported value of zinc for this sample is also higher compared to some common vegetables and leaf protein concentrates that appear in literature. This indicates that the sample has to be consumed with care to prevent necessary risk of zinc over dosage. Zinc plays a vital role in gene expression regulation of cellular growth and participate as cofactor of enzymes responsible for carbohydrates, proteins, and nucleic acid metabolism (Gafar et al., 2011).

The concentration of other mineral element in the sample are lower than those reported for some common vegetables and leaf protein concentrates in literature except the manganese, copper and selenium which concentration in food should present in smaller amount (micro minerals) to prevent the risk of metal poisoning.

The concentration of sodium (0.21±0.00 mg/100g), potassium (0.43±0.00 mg/100g), calcium (0.23±0.00 mg/100g), magnesium (0.29±0.00) and phosphorus (0.29±0.00 mg/100g) while manganese (4.05±0.21), copper (2.45±0.21 mg/100g) and selenium (0.02±0.00 mg/100g) respectively appears to be smaller than those reported for some leaf protein concentrates and green vegetables by some author in the literature. The values are also lower when compared to the recommended dietary allowance values. These indicate that significant quantity of this leaf concentrates would be consumed if daily dietary allowances of these element have to be met or by mixing with the food that are richer in these mineral elements.

Table3. *Amino acid content of Solanum aethiopicum leaf protein concentrates*

Amino acid	**Composition g/100g**
Histidine	2.96±0.02
Aspartic acid	1.65±0.02
Threonine	0.47±0.03
Arginine	1.07±0.02
Lysine	2.03±0.01
Ammonia	0.78±0.02
Proline	0.76±0.02
Glutamic acid	1.78±0.02
Glycine	0.57±0.02
Alanine	0.24±0.01
Cysteine	1.88±0.02
Valine	7.11±0.02
Methionine	1.25±0.02
Leucine	8.14±0.02
Norleucine	N.D.
Tyrosine	4.64±0.01
Phenyl alanine	7.44±0.02
Tryptophan	0.55±0.03
Seleno cysteine	N.D
Alanine	0.24±0.01
Cystone	1.95±0.03
Ornithine	0.16±0.01
Serine	0.78±0.02

Table4. *Essential amino acid present in Solanum aethiopicum*

Amino acid	**Composition g/100g**
Leucine	8.14±0.02
Isoleucine	3.75±0.02
Lysine	2.03±0.01
Methionine	1.25±0.02
Phenylalanine	7.44±0.02
Threonine	0.47±0.03
Tryptophan	0.55±0.03
Valine	7.11±0.02
Histidine	2.96±0.02
Tyrosine	4.64±0.01
Selenocysteine	N.D
Ornithine	0.16±0.01
Total	**38.5**

Table5. *Non-essential amino acid present in Solanum aethiopicum*

Amino acid	**Composition g/100g**
Alanine	0.24±0.01
Arginine	1.07±0.02
Aspartic acid	0.47±0.03
Cysteine	1.88±0.02
Glutamic acid	1.78±0.02

Glycine	0.57±0.02
Proline	0.76±0.02
Serine	0.78±0.02
Total	**7.08**

Table6. *WHO Reference Value of amino acid*

Amino acid	**Composition g/100g**
Lysine	5.8
Methionine + cysteine	2.5
Threonine	3.4
Tryptophan	1.0
Valine	3.5
Leucine	6.6
Isoleucine	2.8
Phgnyl alanine tyrosine	6.3
Total	**7.08**

The amino acid profile of *Solanum aethiopicum* were presented in Table 3. The sample contain significant quantity of Leucine (8.14 g/100g) phenylalanine (7.44±0.03 g/100g) and Valine (7.11±0.02 g/100g). The recommended daily allowance of glutamic acid is 21.6g for males and 20.0g for female. These values were higher than 1.78±0.02 g/100g reported for this sample. This indicated that large amount of this leaf protein concentrates would be consumed to meet up with recommended daily allowance or the food that are rich in glutamic acid could be mixed with this sample to meet up with the recommended daily allowance.

The total essential amino acid content of the sample outweighed the proportion of the non-essential amino acid. The percentage essential amino acid is 84.49% while the percentage value of non-essential amino acid is 15.54%. However, the values of some of the amino acid of the sample is lower when compared with World Health Organisation (WHO) Reference value as contained in Table 6. In addition, the sample contain tryptophan and ornithine which are predominant in animal protein.

4. CONCLUSION

Leaf protein concentrates of *Solanum aethiopicum* needs to be handle with care in the diet especially in the area of mineral elements it contained but during cooking the high concentration of zinc and iron could be reduced to a tolerable amount. Further research work could be investigated to determine the anti-nutrient composition of this leaf sample, experimental animal could also be used to determine effect of all the nutritional composition of *Solanum aethiopicum* leaf concentrates in the diet or as food ingredients

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