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Proximate and Some Minerals Analysis of *Colocasia esculenta* (Taro) Tuber in Southern Ethiopia

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ABSTRACT

Proximate and some mineral analysis were carried out on taro cocoyam (*Colocasia esculenta*) tuber to determine its nutritive composition and mineral values. The proximate analysis revealed the moisture content 8.00%, ash 3.5%, crude lipid 5%, crude fiber 5.00%, crude protein 4.5 % and carbohydrate 82%. While mineral analysis gave potassium 372.4mg/100g, sodium 25.6mg/100g, calcium 782.15mg/100g, magnesium 543.9mg/100g, zinc 392.23mg/100g, manganese 221.3mg/100g, copper 231.7mg/100g, nickel 195.4mg/100g and iron 218.5mg/100g. The high mineral content and high carbohydrate contents show that taro tubers are good source of energy. Taro cocoyam could be utilized day-to-day Energy requirements by the different societies by replacing cereals and grains.

[I] INTRODUCTION

In developing nations, numerous types of edible plants are exploited as source of food to provide supplementary nutrition to the livelihood in different environments. Recent studies on agro pastoral societies in Africa indicate that these plants resources play a significant role in nutrition, food security and income generation [1]. According to Raschke *et al*., 2007 Content of a novel online collection of traditional east African (Kenya, Tanzanya and Uganda) food habits (1930s – 1960s): data collected by the Max-Planck-Nutrition Research Unit, Bumbuli, Tanzania : The most common root and tubers cultivated in East Africa during this period included tannia (*Xanthosoma Sagittifolium*), taro (*Colocasia esculenta*) and various yams (*Dioscorea*). More recently introduced roots and tubers include cassava and sweet potato.

Taro belongs to the genus Colocasia, within the sub-family Colocasioideae of the monocotyledonous family Araceae. Because of a long history of vegetative propagation, there is considerable confusion in the taxonomy of the genus Colocasia. Cultivated taro is classified as *Colocasia esculenta*, but the species is considered polymorphic[2]. Taro (*Colocasia esculenta*) is a tuber crop of high food value in many countries of the tropical area of the world.

The main nutrient provided by cocoyam, as with many other root and tuber crops, is the dietary energy supplied by carbohydrates. The protein fraction of cocoyam tubers is low (1-3%) and like most root and tuber crop proteins, sulphur containing amino acids are limiting. Cocoyam corms and cormels are good sources of essential mineral nutrients that contribute to growth as well as health maintenance and general wellbeing [3]. The major mineral nutrient in cocoyam is K [4] and it is rich in Fe, Zn and Ca [5]. Taro is one of the most nutritious and easily digested foods. The starch is 98.8 percent digestible, a quality attributed to its granule size, which is a tenth that of potato, making it ideal for people with digestive difficulties. The corm is an excellent source of potassium (higher than banana), carbohydrate for energy and fiber [6].

The utilization of the starchy roots of tubers is limited in Ethiopia. Its food use has not gone beyond mere cooking for ultimate consumption, while it also serves as an article of commerce in the rural areas as a form of income-generating product for the farmers [7]. It has, however, been observed that the potential use of the starchy roots as a food and as an income-generating product in the rural areas needs to be emphasized, yet the exploitation of the utilization potentials of the roots has received little attention. For the utilization diversification of the roots to be practically feasible, therefore, there is the need to examine the nutritional composition of the root and its flour [8].

Although taro is widely growing in Ethiopia, it is an underutilized crop and little was known about proximate analysis and nutrient profile. This study attempts to solve this problem by studying Given its tremendous uses especially its consumption in form of food, there is need to evaluate its nutritive composition of Taro (*Colocasia esculenta*) from Southern, Ethiopia.

Objective

The major objective of this study was determination of proximate analysis and mineral nutrients profile of Taro (*Colocasia esculenta*) from Southern, Ethiopia.

Specific objectives

To determine the mineral nutrients from Taro (*Colocasia esculenta*) from southern, Ethiopia

To determine the proximate analysis of Taro (*Colocasia esculenta*) from southern, Ethiopia

[II] METHODOLOGY

2.1 Description of study area

The study area is located in South Nation Nationality Peoples region in Ethiopia, Arba Minch City. The samples collected from the study areas were triplicates.

2.2 Experimental Methods

2.2.1 Apparatus:

Volumetric flask, Beaker, Filter paper, Magnetic balance, Sparker, Crucible, Knife, Measuring cylinder, Thermometer, Aluminium foil, Sucker, Conical flask, Grinder(mortar and pestle).

2.2.2 Instruments

Atomic absorption spectroscopy (AAS), Atomic emission spectroscopy (AES), Oven, Muffle furnace, Kjeldhal Apparatus.

2.2.3 Chemicals

Sodium sulphate (Na_2SO_4), Magnesium sulphate ($MgSO_4$), Iron sulphate ($FeSO_4$), Calcium chloride ($CaCl_2$), Nickel sulphate ($NiSO_4$), Manganese sulphate ($MnSO_4$), Zinc sulphate ($ZnSO_4$), Potassium nitrate(KNO_3), Copper sulphate($CuSO_4$), HNO_3 conc. (about 69 % LR. Eurostar scientific LTD. Unit 113 century buildings summers road Liverpool, UK), H_2SO_4 (Riedel-Dehaen Ag. Seelze - Aannover, Germany), Sodium hydroxide (NaOH), Petroleum Ether.

2.3. Proximate Analysis

a) Dry ashing

Three gram of sample was placed into a high form porcelain. The temperature was slowly increased from room temperature to 600^oC in one hour until a white or grey ash residue was obtained. The solution was transferred to a 100 ml volumetric flask and made up to volume. A blank control was carried out in the same way.

b) Determination of Moisture content

Two gram of the sample was weighed (W_1) into pre weighed crucible (W_o) and placed into a hot drying oven at 105 degree Celsius. The crucible was removed and cooled in a desiccator and weighed. The process of drying cooling and weighing repeated until a constant weighed (W_2) was obtained. The weight loss due to moisture contain was obtained by the equation.

Percent of moisture= $\frac{W1-W2}{W1-W0} * 100$

Where W_o= the weight of empty crucible (g)

W_1= the weight of fresh sample + empty crucible (g)

W_2=weight of dried sample +empty crucible (g).

c) Determination of Ash Content:

Two gram of the powdered sample was weighed (W_1) into pre-weighed empty crucible (W_0) and placed into muffle furnace until the sample was completely 600 degree Celsius. The ash was removed and cooled in a desiccator and weighed (W_2).

$$\% \text{ Ash} = \frac{W2-W0}{W1-W0}*100$$

d) Determination of crude fiber content: Two grams of the sample was weighed (W_0) into 100 ml conical flask and 20% sulphuric acid was added and boiled gently for 30 minutes. The content was filtered through filter paper. The residue was scrapped back into the flask with spatula and filter paper rinsed with distilled water and 20ml of 10% sodium hydroxide was added and allowed to boil gently for 30 minutes. The content was filtered and residue was washed with hydrochloric acid and rinsed twice with diethyl ether. It was allowed to dry and scrapped into a crucible and dried overnight at 105 degree Celsius in an oven. It was then removed and cooled in a desiccator. The sample was weighed (W_1) and ashed at 600 degree Celsius for 90 minutes, it was removed and cooled in a desiccator and weighed again (W_2). The percentage crude fiber was calculated using the equation.

$$\% \text{ crude fiber} = \frac{W1-W2}{W0}*100$$

Where W_0= weight of sample (g)

W_1=weight of dried sample (g)

W_2 = Weight of Ash sample (g)

e) Determination of Crude Protein Content:

The crude protein of the sample was determined using the micro Kjeldahl method described by AOAC [9]. Thus, % crude protein =% Nitrogen x 6.25. The nitrogen content of the sample is given by the formula,

$$\% \text{ N} = \frac{\text{Tv x Na x 0.014x V1 x 100}}{G \ x \ V2}$$

Where

T_V = titre value of acid (cm3)

N_a = concentration or normality of acid

V_1 = volume of distilled water used for distilling the digest (50cm3)

V_2 = volume of aliquot used for distillation ($10cm^3$),

G = original Weight of sample used in gram

f) Determination of Carbohydrate Content:

The method described by [10]. Thus; % CHO = 100% - (% crude protein + % crude lipid + %crude fiber + % ash)

2.4. Mineral Analysis

2.4.1. Digestion of Sample

The triple acid digestion method of [11] was employed. The solution was used for determination of mineral elements.

2.4.2. Elemental Determination

The elemental analysis was done using instruments; Sodium (Na), potassium (K), and, calcium (Ca), were determined using flame photometer model. Buck Scientific 210VGP AAS was used to determine the other minerals iron (Fe), magnesium (Mg), manganese (Mn), copper (Cu), zinc (Zn) and nickel (Ni). The preparation of standard solutions for elemental analysis was done using the method of Association of Officials Analytical Chemists as shown in the next section [9].

The concentration of the elements in the sample was calculated as:

$$\text{Concentration (mg/100g)} = \frac{(a-b)xV}{10\ x\ wt\ of\ sample}\ x\ 100\%$$

2.4.3. Preparation of standard solution:

a) **Preparation of zinc:** 4.405 g of zinc was dissolved with distilled water up to the mark in 1000 ml volumetric flask.

b) **Preparation of copper**: 3.9 g of copper was dissolved with distilled water up to the mark in 1000 ml volumetric flask.

c) **Preparation of nickel**: 2.23 g of nickel was dissolved with distilled water up to the mark in 500 ml volumetric flask.

d) **Preparation of manganese**: 3.26 g of manganese was dissolved with distilled water up to the mark in 1000 ml volumetric flask.

e) **Preparation of iron**: 2.49 g of iron was dissolved with distilled water up to the mark in 500 ml volumetric flask.

f) **Preparation of magnesium**: 5 g of magnesium was dissolved with distilled water up to the mark in 1000 ml volumetric flask.

g) **Preparation of potassium**: 2.59 g of potassium was dissolved with distilled water up to the mark in 1000 ml volumetric flask.

h) **Preparation of calcium**: 2.78 g of calcium was dissolved with distilled water up to the mark in 1000ml volumetric flask.

i) **Preparation of sodium**: 3.08g of sodium was dissolved with distilled water up to the marking 1000 ml volumetric flask.

2.5. Data analysis

The data generated were analyzed by using Microsoft Excel to compute the mean, standard deviation and linear regression values.

[III] RESULTS AND DISCUSSION

This study was done to determine the nutritive value of taro cocoyam (*Colocasia esculenta*) tubers. The proximate composition was determined as percentage composition and presented in table 1.

Table 1. Proximate and Some Minerals Analysis of *Colocasia esculenta* (Taro) Tuber

Sr. No.	Proximate analysis	%
1	Ash content	3.5
2	Moisture content	79
3	Crude Fiber	5
4	Crude Lipid	5
5	Crude Protein	4.5%
6	Carbohydrate	82%

From the result obtained, the proximate analysis shows that the moisture content is high when compared with the literature value reported by [7] for raw taro (*Colocasia esculenta, L.)* in Ethiopia. This may be because of the difference in the plants and in the environment that the plants were grown. High level of moisture content in cocoyam results in the growth of moulds; therefore, moisture reduction post-harvest technology is required to protect spoilage of the taro cocoyam. The ash content in the cocoyam (3.5%) indicates that the cocoyam is rich in mineral elements. The value obtained in this study is higher compared to 1.4% in white cocoyam reported in literature by [12]. It is also higher than the values reported by [1] for wild edible ceropegia raw yam 3.4g/100g. The high value of ash observed in all the species of tubers is indicated that good sources of minerals when compared to values obtained for cereals and tubers [13].

The cocoyams contain crude lipid 5%, which is higher than that of *Dioscorea rotundata* (white yam) tubers 0.63% reported for by [14]. The crude protein content 4.5% obtained from the present study is lower compared to 6.30% in water spinach, 7.6% [15], White yam (*Dioscorea cayenensis*), Elephant yam (*Amorphophallus aphyllus*) but higher than Cassava (*Manihot esculenta*) as reported by [16]. The crude fiber content 5.00% is slightly higher as compared with the range between 1.0 – 4.0% reported in Raffia palms and pumpkin leaves [17]. The carbohydrate content in the cocoyams is considerably high, 82% when compared to some other tubers such as *Dioscorea rotundata* (white yam) tubers was 73.22% [14], but was smaller as compared to Cassava (*Manihot esculenta*) analysed was 83.84 and 82.34 mg/100g in two different parts of Nigeria [18]. The result confirmed the fact that yam is a carbohydrate food.

The results of the minerals estimation of the taro tubers are presented in table 2. All the mineral elements were found in considerable quantity in both samples. This study shows that nickel was the least abundant mineral in the taro cocoyam. The taro cocoyam (*Colocasia exculenta*) analysed in this study contained remarkably high amount of calcium and magnesium (›500mg/100g dry weight). The concentration of calcium in large amounts in the taro cocoyam makes it an important food for formation and maintenance of bones and normal functioning of nerves and muscles in humans and other vertebrates.

Table 2. Proximate and Some Minerals Analysis of *Colocasia esculenta* (Taro) Tuber

Sr. No.	Name of Minerals	Mineral contents in(mg/100g)
1	Na	25.6
2	Mg	543.9
3	Ca	782.15
4	Fe	218.5
5	Zn	392.23
6	Mn	221.3
7	Cu	231.7
8	Ni	195.4
9	K	372.4

Manganese is mineral which is found in different foods sources it is an activator of enzymes important to general metabolism, e.g. phosphatases, arginase [19]. The manganese content of tuber was slightly higher as compared to *Manniholt esculenta crantz* in ohawuku and Iboko regions in Nigeria [18].

The tuber shows less than adequate level of K and Ni but it is richest source of zinc. Concentration of Mg and Zn, which are indispensable in numerous biochemical pathways as important cofactors for certain enzymes compared well in the samples. So, the highest values of minerals concentrations of Zn and Mg content obtained in this study are higher than as compared to other tubers i.e.7.8-13.2 mg/100g as reported by [18] for *Manihot esculenta crantz*, and for false yam [20].

Iron is an important trace element for hemoglobin formation, normal functioning of the central nervous system and in the oxidation of carbohydrates, protein and fats [21]. The results clearly indicate that tuber was high in iron content as compared to other tubers i.e. 45.6-83mg/100g as reported by v for *Dioscorea rotundata* (white yam) which is 83mg/100g and Deshmukh and Rathod, 2013 for 45.6 and 49.04 mg/100g for *Ceropegia bulbosa* and *Ceropegia hirsute* respectively.

Cu is a micronutrient required because it is a component of many redox and lignin-biosynthetic enzymes. Sodium is the principal cation in extracellular fluids, regulates plasma volume and acid-base balance, involved in the maintenance of osmotic pressure of the body fluids, preserves normal irritability of muscles and cell permeability, activates nerve and muscle function and involved in Na+/K+-ATPase, etc. [22]. In addition, the tuber was found to be rich in Na and Cu. The results obtained in this study for Cu were high as compared to results Cocoyam (*Xanthosoma sagittifolium*) were low 6.7mg/100g and Cu was not detected in Yam (*Dioscorea spp*). The results obtained in this study for Na was found to be higher than the values reported for Cassava (*Manihot esculanta*) and Sweet potatoes (*Ipomoea batatas L.*) as 0.24 and 0.37 mg/100g [23].

The results of this study potentially indicate that the taro cocoyam studied nourished with essential nutrients required for human consumption. Nutrient rich foods are vital for proper growth in both adults and children, so Taro cocoyam (*Colocasia esculenta*) tubers will be the food of the future for Ethiopia and the world.

[IV] CONCLUSION

Taro cocoyam (*Colocasia exculenta*) tubers analysed have contained more crude fiber, crude protein and carbohydrates as compared with other similar tubers. The tuber was also found to be fairly good sources of dietary minerals. These results suggest that the less familiar Taro cocoyam in southern Ethiopia can be good sources of dietary energy should not be ignored. Rather it can be used as a good alternative source of food to alleviate hunger and malnutrition alongside with the other foods alternatives of the people.

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