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Comparative Analysis on the Proximate Composition of Tubers of *Colocasia Esculenta, L. Schott* and *Dioscorea Alata* Cultivated in Ethiopia

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Abstract: Taro and yam are used for different purposes mainly used in south western region in Ethiopia especially in Benchmaji, Keffa and Sheka zones of the country and are underutilized foods for nutrition and income in other parts of the Ethiopia. Traditionally, it has been believed that a cure for hyper tension that is used to minimize the hyper tension, as a snack and etc. Therefore Promoting and supporting the use of taro and yam can make a major contribution to the food security of Ethiopia and of the world as well. The present study focused on, the quantitative determination of proximate compositions of the taro and yam samples cultivated in southwestern Ethiopia (Keffa zone, Benchmaji zone and Sheka zone). The parameters investigated were proximate composition (crude protein, crude fat, crude fibre, carbohydrate, and energy). Proximate compositions were determined by Association of Official Analytical Chemists (AOAC, 2000).The result indicated that, the proximate composition of both raw taro and yam samples in this study were: Crude Protein (4.03-6.22, 3.30-6.44%), crude fat (0.77-1.26, 0.71-1.30%), crude fibre (3.45-5.74, 2.47-4.39%), total ash (2.53-4.82, 1.76-3.27%), utilizable Carbohydrates (77.82-81.18, 75.98-84.07%) and Gross energy (338.79-351.63, 330.12-353.64) Kcal/100g, respectively. Thus, in general, both raw taro and yam had appreciable amount of the proximate composition, and could be a promising crops for securing food supply in the study area under investigation.

Keywords: Crude Protein, Crude Fat, Crude Fibre, Total Ash, Utilizable Carbohydrates, Gross Energy

1. Introduction

Roots and tubers belong to the class of foods that basically provide energy in the human diet in the form of carbohydrates. The terms refer to any growing plant that stores edible material in subterranean root, corm or tuber [1, 2].

Taro (*Colocasia esculenta*) is herbaceous perennial plant belonging to the Araceae family. It is cultivated for its edible corms and is a staple food throughout subtropical and tropical regions of the world. Botanically, Taro is referred to as *colocasia esculenta (L.) Schott*. Colocasia and xanthosoma are together called cocoyams in many parts of the world, especially in Africa, old cocoyam for colocasia and new cocoyam for xanthosoma. Taro (*Colocasia esculenta* (L.)Schott) and tannia (*Xanthosoma sagitiffolium* (L.) Schott) locally known as 'Godare', are tuberous tropical food crops that supply high-energy food. Godare (Taro) has been grown in Ethiopia since time immemorial but how and when it was introduced to Ethiopia remains unclear [3].Taxonomically, Taro (*Colocasia esculenta* (L.) Schott), belongs to Kingdom - Plantae, Family – Araceaeand in the genus colocasia. The common Vernacular names of the species Taro in the world are True taro/old cocoyam in West Africa, Dasheen/Eddoe in West Indies,Taro in Pasific Islands, Elephant's ear/ Yu Tou in Mandarin Chinese, Satoimo in Japanese,Godere/Bakka in Ethiopia and it is often called potato of the tropics in different areas of the world [4].

In the pacific regions, both genera are known as “taro” (FAO, 1999). However both genera appear to be cultivated in Ethiopia where they are known without differentiating between them as “Godere” [5]. Taro is an important staple food crop grown throughout many Pacific Island countries, parts of Africa, Asia and the Caribbean for its fleshy corms and nutritious leaves. In addition to contributing to sustained food security in the domestic market, it also brings in export earnings [6]. However, there is very limited local research on Taro in Ethiopia and its actual contribution to food security and economy is underestimated. Also, its profile on the national research and conservation agenda is miserably low. Similar with many other root crops, taro corms are high in carbohydrate in the form of starch and low in fat and protein and are easily digested foods.It has a great contribution for people with digestive difficulties [7].

Yam (Dioscorea alata) is a common name for several species of the genus *Dioscorea* (family *Dioscoreaceae*) used for food purposes. They are annual or perennial herbaceous vines with edible underground tubers and are the world’s second most important tuber crop. Yam is the second most important root and tuber crop in the world and contributes more than 200 calories daily to million people, particularly in West Africa [8]. Yam is used in the same manner as potato in the western world. The most common use is as a boiled vegetable. It may also be baked, fried, roasted or mashed to suit regional tastes and customs. Yam tubers constitute an important food crop in tropical countries including South America, the Asia and Africa. West Africa is the world’s most prominent region for the production of yams, being only second to cereals in importance [9]. It is composed mainly of carbohydrate, vitamins as well as protein and minerals. Nutrient content varies with species and cooking procedure [10].

Taxonomically, yam belongs to Kingdom - Plantae, Family – Dioscoreaceae, in the genus Dioscorea L. Among the most important yam species, Dioscorea alata L. (purple yam) is dominantly growing and produced in south western parts of Ethiopia. The Common English names of Dioscorea alata are: purple yam, greater yam, winged yam, water yam in other parts of the world and ‘Kechi’ in Ethiopia. Although taro and yam are widely growing in Ethiopia particularly in its southern parts, they are underutilized crop and little is known about their proximate composition. In this study their proximate compositions were determined using standardized analytical methods.

The nutritional value is the main concern when a crop is being considered as a food source. The infant’s death in Africa is related to the malnutrition. This might be due to the nutritionally underestimated root and tubers. Thus it is better to give emphasis to such high nutritional value of the root and tubers. For the utilization diversification as well as for better income-generating means of taro and yam roots to be practically feasible particularly in Ethiopia and to achieve the expected success in the campaign, nutritional composition of the tuber crop must be known by the people.

The objectives of this research were: to investigate the proximate composition of *Colocasia esculenta, L.* (Taro, Godere) and *Dioscorea alata* (Yam); to determine the total energy value of tubers of *Colocasia esculenta, L.* (Taro, Godere) and *Dioscorea alata* (Yam) and to compare the results obtained in the proximate composition of tubers of *Colocasia esculenta, L. (*Taro, Godere) with the results in *Dioscorea alata* (Yam).

2. Materials and Methods

2.1. Sample Collection and Pretreatment

Samples of tubers of taro and yam were collected from south western of Ethiopia (Sheka, Keffa and Benchmaji zones). These areas were selected to represent the area that taro and yam is dominantly produced and consumed in the country. Both taro and yam samples were collected from three similar sites for the sake of comparison. The taro and yam samples selected contained large, middle and small tuber sizes that were not damaged during harvest and which were not attacked by pests. Three different Woreda was selected in each zone and samples were purchased from farmers in three sites in each Woreda and the collected samples were homogenized to represent the bulk sample. Then the collected samples were packaged in to polyethylene plastic bag, labeled and transported to laboratory for further treatment.

2.2. Sample Preparation for Both Taro and Yam Samples

Both taro and yam samples were washed and peeled carefully using stainless steel knives and the peeled taro and yam samples were washed, rinsed with deionized water and then sliced. The slices were dried for 6hours in a hot air oven at 105°C.The dried taro and yam chips were powdered with a mortar and pestle with sieve size of 0.425 mm and packed in polyethylene plastic bags until analysis.

2.3. Proximate Composition Analysis

The methods of Association of Official Analytical Chemists (AOAC, 2000) was used for determination of moisture, crude fiber, protein, fat, ash, carbohydrate and total energy content of all the taro and yam (Kechi) samples [11].

2.3.1. Determination of Moisture Content (AOAC 925.09, 2000)

Accurately 5 grams of each of the sample were weighed into dried weighed crucible. The sample was mixed thoroughly and dried at 100°C for 6 hrs. The dried samples were put into desiccators for 30 min, allowed to cool and reweighed. The process was repeated until constant weight was obtained. The difference in weight was calculated as a percentage of the original sample moisture content.

$$\text{Percentage moisture content} = \frac{W1-W2}{W1}\ x\ 100$$

Where W1= weight (g) of sample before drying; W2=

weight (g) of sample after drying.

2.3.2. Determination of Crude Protein Content (AOAC 979.09, 2000)

Protein content was determined according to AOAC (2000) using the official method 979.09.About 1 g mass of powdered samples were weighed on analytical balance and transferred to the digestion flask. Then 6 mL acid mixture (5:1 Conc. H_3PO4: H_2SO_4) and 3.5 mL of 30% $H_2O_2$was added in to the digestion flask step by step. The tubes were shaken observing a violent reaction. After this violent reaction disappeared 3 gm of the catalyst mixture (0.5:100 Se: K_2SO_4) was added in to the digestion flask. The solution was then digested at 370°C for 1hr. After digestion is completed, the content in the flask was diluted by water and concentrated sodium hydroxide (40%) was added to neutralize the acid and to make the solution slightly alkaline. The ammonia was then distilled in to the receiving flask that consisted solution of excess boric acid (4%). The borate ion was formed as a result of the reaction of the boric acid and the ammonia and this was titrated with the standard acid (0.1N sulphuric acid solution) until the green color changes to pink. The total nitrogen content was calculated using the following formulae:

$$\% \text{ Nitrogen} = \frac{((V2-V1)\ x\ N\ x\ 14.007)}{W}\ x\ 100$$

Where, V2 = Volume in ml of the standard sulphuric acid solution used in the titration of the test material

V1 = Volume in ml of the standard sulfuric acid used in the titration for the blank determination

N = Normality of the standard sulphuric acid

W = weight in grams of test material

Crude protein content (%) = Nitrogen (%) X 6.25

2.3.3. Determination of Crude Fat Content (AOAC 920.39, 2000)

The flasks used for the extraction were washed and then dried in drying oven at 105°C for 30 min and cooled in desiccators. The masses of the cooled round bottom flasks were measured by analytical balance recorded as M1. Accurately 3 g mass of the powdered sample was weighed in to each thimble lined with cotton at their bottom. The thimble with its sample content was placed in to the Soxhlet extraction apparatus. Then, 150mL of hexane solvent was added in to each flask and the extraction process was done for about 6 hrs followed by removing this flask with its content from the Soxhlet, it was placed in drying oven at 105°C for 30min until constant weight was reached. The flasks with their contents were then placed in desiccators for 30 minutes. The mass of each flask together with its fat contents were measured as M_2. The crude fat contents of all samples were determined by the formula:-

$$\text{Crude fat } (\%) = \frac{(M2-M1)x\ (mcf)}{M}\ x\ 100$$

Where, M2 = (mass of flask and lipid extracted); M1 = mass of dried flask; M = Weight of sample on dry basis, mcf= moisture correction factor

2.3.4. Determination of Crude Fiber Content (AOAC 962.09, 2000)

Crude fiber analysis was conducted using the method of AOAC (2000) official method 962.09. about 2 gram mass of sample was transferred into a 600 ml beaker and about 200 ml 1.25% sulfuric acid was added and boiled for 30 minutes by stirring and rotating it periodically on a hot plate to keep solids from adhering to sides. After 30 minutes, 20 mL of 28% potassium hydroxide was added and again allowed to boil for another 30 minutes. Subsequently, washing was conducted with 1% sulfuric acid and NaOH solution. After filtering, it was dried in an electric oven at 130°C for 2hrs and cooled at room temperature for 30 minutes in a desiccators and weighed as M_1, then transferred the crucibles to muffle furnace for 30 minute ashing at 600°C. Finally, it was cooled again in desiccators and re-weighed as M_2. The crude fiber contents were determined by using the formula:-

$$\text{Crude fiber } (\%) = \frac{(W1-W2)}{W}\ x\ 100$$

Where, W1 = Weight of the sample after drying; W2 = weight of sample after ashing; W= Weight of sample on dry basis

2.3.5. Determination of Ash Content (AOAC 923.03, 2000)

The porcelain crucibles used for analysis were washed by dilute hydrochloric acid on boiling and washed with distilled and de-mineralized water respectively. Then it was dried at 120°C in an oven and ignited at 550°C in furnace for 3 hrs. Then the crucibles were removed from furnace and cooled in desiccators. The mass of the crucibles were measured as M1. About 2 gram mass of samples powder were weighed in to the porcelain crucible and recorded as M. The samples were charred at 120°C for 4 hrs in a hot plate, until the whole content becomes carbonized. Then the samples were placed in a furnace at 550°C until free from carbon and the residue appears grayish white after 8 hrs. The samples were removed from the furnace and placed in desiccators and allowed crucible to cool for 30 min prior to weighing. Finally the mass was weighed as M_3. And the total ash contents of both samples were calculated with the following formulae:-

$$\text{Ash } (\%) = \frac{(M3-M1)}{(M2-M1)}\ x\ 100$$

Where, M1 = mass of the dried crucible; M2 = mass of the crucible and the sample; M3 = mass of the crucible and the ash

2.3.6. Determination of Utilization Carbohydrate Content

The percentage carbohydrate content in both samples was determined by mathematical difference excluding crude fibre as follows:

Utilization carbohydrate (%) = 100 – (moisture + crude protein + crude fat), and crude protein and fat content in the determination of carbohydrate should be without moisture correction factor.

2.3.7. Total Energy in Kilo Calories

The total energy content in each sample will be determined as follows:

Total energy (%) = (9 x crude fat + 4 x crude protein + 4 x Utilization carbohydrate)

2.4. Statistical Data Analysis

Data collected were analyzed by ANOVA, while significant differences among the mean were determined using least significant difference (LSD) multiple comparison test and results were considered statistically at $P<0.05$. The results were then presented as mean ± SD.

3. Results

3.1. Determination of Proximate Composition in Raw Taro and Yam

The amounts of proximate composition (protein, fat, fibre, ash and carbohydrate) were analyzed by their own specific methods. The percentage values of both sample taro (*Colocasia esculenta* (L.)) and yam (*Dioscorea alata* species) were clearly shown with their respective %RSD in table 1 and 2. The % RSD results did not differ by more than 10% of the mean which indicated that the analytical method used is precise and reliable. Mean values obtained for *Colocasia esculenta* (L.) species in g/100g dry weight basis were: crude protein, 4.03- 6.22%; crude fat, 0.77-1.26%; crude fibre, 3.45-5.74%; ash, 2.53-4.82% and carbohydrate, 77.82-81.39%. The moisture content of the dry weight ranged 10.48-13.08% in *Colocasia esculenta* (L.) and 11.16-16.39% in *Dioscore aalata.*

Table 1. *Proximate composition of raw taro samples from Benchmaji, Sheka and Keffa sites.*

Proximate composition	Benchmaji raw taro sample (%)		Keffa raw taro sample (%)		Sheka raw taro sample (%)	
	Mean ± SD	%RSD	Mean ± SD	%RSD	Mean ± SD	%RSD
[b]Moisture	12.84±0.02	0.16	10.48±0.12	1.14	13.08±0.24	1.83
[a,b]Protein	6.22±0.11	1.77	5.72±0.14	2.44	4.03±0.05	1.24
[a,b]Fat	1.26±0.01	0.79	1.19±0.03	2.52	0.77±0.02	2.60
[a,b]Fibre	5.74±0.18	3.13	4.13±0.10	2.42	3.45±0.07	2.02
[a,b]Ash	4.82±0.03	0.62	3.50±0.07	2.00	2.53±0.08	3.16
[*a,b]Carbohydrate	77.82±0.98	1.25	81.18±0.83	1.02	81.39±0.84	1.03
[a,b]Total energy (Kcal/100g)	338.79±6.85	2.02	351.63±8.23	2.34	342.93±7.31	2.13

[*]Determined by difference, [a] data were reported in dry basis, [b] mean value ± standard deviation, n=3.

Table 2. *Proximate composition of raw yam samples from Benchmaji, Sheka and Keffa sites.*

Proximate composition	Benchmaji raw yam sample (%)		Keffa raw yam sample (%)		Sheka raw yam sample (%)	
	Mean ± SD	%RSD	Mean ± SD	%RSD	Mean ± SD	%RSD
[b]Moisture	16.39±0.17	1.04	11.16±0.14	1.25	14.92±0.17	1.14
[a,b]Protein	6.44±0.08	1.24	3.30±0.05	1.51	6.24±0.07	1.12
[a,b]Fat	1.30±0.03	2.34	0.98±0.02	2.04	0.71±0.02	2.82
[a,b]Fibre	4.19±0.11	2.63	4.39±0.08	1.82	2.47±0.04	1.62
[a,b]Ash	3.27±0.07	2.14	1.76±0.03	1.70	3.17±0.08	2.52
[*a,b]Carbohydrate	75.98±0.77	1.01	84.07±0.89	1.06	77.76±0.81	1.04
[a,b]Total energy (Kcal/100g)	330.12±6.97	2.11	353.64±9.91	2.82	333.68±7.91	2.37

[*]Determined by difference, [a] data were reported in dry basis, [b] mean value ± standard deviation, n=3.

3.2. Levels of Proximate Composition of Raw Taro Samples

As it can be observed in table 1 and figure1, there is slight difference in percentage of the proximate composition within raw taro samples along with the study area. Among the proximate composition in all raw taro samples, the percentage values of carbohydrate was found to be the highest followed by protein (4.03-6.22%) and fibre (3.45-5.74%). The percentage value of fat in raw taro sample was the least among the proximate compositions. In raw taro sample in all sample sites, protein was observed in high amount in Benchmaji sample followed by Keffa sample.

In general, the percentage value of the proximate composition in raw taro samples was decreased in the order: Benchmaji: carbohydrate > moisture > protein > fibre > ash > fat, Keffa: carbohydrate > moisture > protein > fibre > ash > fat, Sheka: carbohydrate > moisture > protein > fibre >ash > fat. The percentage values of both taro and yam are shown in table 1 and 2 respectively.

3.3. Levels of Proximate Composition of RAW Yam Samples

As it is shown in table 2 and figure 1, there is slight variation in proximate composition of yam samples with the study area. Like that of raw taro samples, the percentage of fat in raw yam samples was the least in all sample sites. Among the analyzed proximate composition in raw yam samples, carbohydrate (75.98-84.07%) was the highest followed by protein (3.30-6.44%) and fibre (2.47-4.39%).protein was found to be the highest in amount in Benchmaji followed by Keffa samples.

The percentage values of yam sample were shown in decreasing order: Benchmaji: carbohydrate > moisture > protein > fibre > ash > fat, Keffa: carbohydrate > moisture > fibre >protein > ash > fat, Sheka: carbohydrate > moisture >

protein > ash > fibre > fat.

The percentage difference of each proximate composition from sample site to sample sites are most likely because of a variation in at least one of the following factors: bioavailability, physical property of the soil, soil pH and mineral content of the soil, etc [12,13].

4. Discussion

Comparison of the proximate composition levels between taro and yam samples

The percentage of proximate composition of both taro and yam samples were compared and analyzed as follows:

The moisture contents of both taro and yam samples had comparable percentage values. Among the studied area Sheka taro and Benchmaji yam had the highest values of moisture contents.

The moisture contents of raw taro (10.48%-13.08%) and yam (11.16%-16.39%) in this study were higher than the values of raw taro and yam reported by [14-16]. However, this value was lower than the moisture contents of raw taro reported by [17]. Food with high moisture content could lead to food spoilage through increased microbial action [18]. Thus, it is better to dry such foods with suitable temperature and store safely for long period of time. The observed difference might be related with the methodology, the environmental factors, varietal difference bioavailability, physical property of the soil, soil pH and mineral content of the soil, etc [12, 13].

4.1. Crude Protein

The protein contents of the raw tubers of *Colocasia esculenta* (L.) from all sampling sites were comparable with yam (*Dioscorea alata*). As it has been clearly indicated from table 1 and 2, the protein content of taro and yam in Benchmaji, Keffa and Sheka were: 6.22, 6.44; 5.72, 3.30 and 4.03, 6.24%, respectively. The protein content of taro was found highest in Benchmaji sample and lowest was observed in Sheka sample. Sheka yam was the highest among the studied area in terms of protein content. The recommended dietary allowances of protein intake of 0.83 g/kg body weight per day would be expected to meet the requirements of most (97.5%) of the healthy adult population [19]. The range of the protein content of raw taro (4.03-6.22%) and yam (3.30-6.44%) in the present study were approximately comparable with raw taro and sweet potato reported by [20, 21] and higher than the raw cassava and Anchote reported by [22-26] and also slightly lower than the values of raw taro (7.79%) and yam (10.27%) reported by [14,15]. The observed difference in the protein contents might be related to climatic factors, the soil type, and the varietal difference. Thus, in general, raw taro and yam had valuable amount of protein contents.

4.2. Crude Fat

As it is depicted in from table 1 and 2, the fat contents of both taro and yam were almost comparable and low in amount in comparison to the reported data of taro, yam and other tuber and root foods [14-16]. Among the sampling sites, Benchmaji samples of taro and yam were observed to be the highest value of fat content in comparison to the studied sampling sites even though the values of both taro and yam were low in amount in comparison to other reported values of tuber and roots food. The crude fat contents of both taro (0.77-1.26%) and yam (0.71- 1.30%) were approximately in a good agreement with the values in cassava (0.71-1.49%); yam (1.15%) and sweet potato (1.02-1.72%) [15, 21, 24] and this value was slightly lower than the fat content in Anchote (0.19%) [27].

Thus, both taro and yam were poor source of fat content which was in a good agreement with the reported data [14, 22].

4.3. Crude Fibre

As it is depicted in table 1 and 2, the highest crude fibre level of both taro and yam were observed in Benchmaji and Keffa respectively. The lowest values of both samples were found in Sheka samples in comparison to the studied area. The values of crude fibre for both taro (3.45-5.74%) and yam (2.47-4.39%) in the current study were comparable with other reported values of the same type [14-16]. However, the values of crude fibre in the current study were slightly higher than the values of raw taro, yam and cassava [15, 22-24, 26, 28].This value however, was slightly lower than the fibre content of sweet potato [21].

The recommended daily allowances of crude fibre intake ranging from 19-25 g/day of total fibre for young children whereas intakes for adolescents range from 26-38 g/day, the lower figures being for girls. Adult intakes are recommended to be 25 g/day for women and 38 g/day for men. Intakes for adults more than 51 years are 20% lower whilst for pregnant and lactating women, 12% higher [29]. Fibre is an essential nutrient that offers a number of health benefits including reducing the risk of cardiovascular disease, help to manage the body weight and improving bowel movements. Report have shown that increase in fibre consumption might have contributed to the reduction in the incidence of certain diseases such as diabetes, coronary heart disease, colon cancer and various digestive disorder [30].

4.4. Ash Content

The ash content of both taro and yam were highest in Benchmaji samples. The level of both taro and yam had comparable amount of ash percentage. The ash contents of taro (1.56-5.70%) that [14, 17, 26] was approximately in a good agreement with the ash contents of taro (2.53-4.82%) and yam (1.76-3.27%) in the current study and the total ash contents of taro and yam were slightly comparable with the values of cassava (1.30-2.80%), taro (1.56-5.70%), yam (2.93%) and Anchote (2.19%) [15, 23, 24, 28]. This value on the other hand, was higher than the raw taro (1.60%) and sweet potato (0.50-1.52%) [21, 22].

From the contents of the taro and yam samples studied, one can easily understand that taro and yam could contain appreciable amount of minerals. Ash on food determines largely the extent of mineral matters likely to be found on food substance. Ash is reflection of the amount of mineral present in samples. The observed difference in the ash contents may be related to climatic factors, the soil type, and the varietal difference. Thus, both taro and yam had valuable mineral content.

4.5. Carbohydrate

Carbohydrates are an important source of energy in human diets comprising some 40 – 80% of total energy intake. The values of carbohydrate for both raw taro (77.82-81.18%) and yam (75.98-84.07%) in present study were higher than the values raw taro, sweet potato (20.28-35.12%) and Anchote (16.86%) [21-22, 26-27] and slightly lower than the values of raw taro (85.65-86.11%) and cassava (80.1-87.35%) [14, 16, 23-24]. However, carbohydrate contents of raw yam (76.57%) [15] which was within the range of both taro and yam samples in the current study. The values of carbohydrates content in these samples per 100g can provide a high calorie of energy.

The brain is the only true carbohydrate-dependent organ in that it oxidizes glucose completely to carbon dioxide and water. The IOM report indicated that the RDA for carbohydrate is based on the average minimum amount of glucose that would provide the brain with an adequate supply of glucose fuel without the requirement for additional glucose production from ingested protein or triacylglycerols, which is set at 130 g/day for adults and children [29]. The carbohydrate rich foods like taro and yam could supply appreciable amount of energy per given mass of food consumed and are a potential candidate for the food security in the country level.

4.6. Total Energy

As it can be seen in table1, 2 and figure 2, the total energy contents of both taro and yam samples were observed in decreasing order as follows: Keffa yam > Keffa taro > Sheka taro > Benchmaji taro > Sheka yam > Benchmaji yam. Keffa yam and taro were found to be the highest in energy contents whereas Benchmaji yam was the least in energy contents among all studied sites.

The total energy of both raw taro (338.79-351.63 Kcal/100g) and yam (330.12-353.64 Kcal/100g) in the present study were higher than Irish potato (316Kcal/100g), yam (318 Kcal/100g) and sweet potato (351Kcal/100g)and lower than total energy of cereal crops like: rice (397 Kcal/100g), sorghum (393 Kcal/100g), wheat (355 Kcal/100g) and maize (374 Kcal/100g) in different cultivar [20]. However, Root crops contain an appreciable amount of carbohydrate and minerals and may have a competitive production advantage in terms of energy yield per hectare over cereals produced in ecologically difficult conditions [1]. Root and tuber crops are naturally energy rich and have been known to save lives during drought and famine [31]. In general, both taro and yam in the current study had appreciable amount of energy and they are a potential candidate for the food security in the country level.

The percentage difference of each proximate composition from sample site to sample sites are most likely because of a variation in at least one of the following factors: bioavailability, physical property of the soil, soil pH and mineral content of the soil, etc [12, 13].

The comparison of proximate composition analyzed between raw taro and yam samples is shown in figures 1 and 2 as follows:

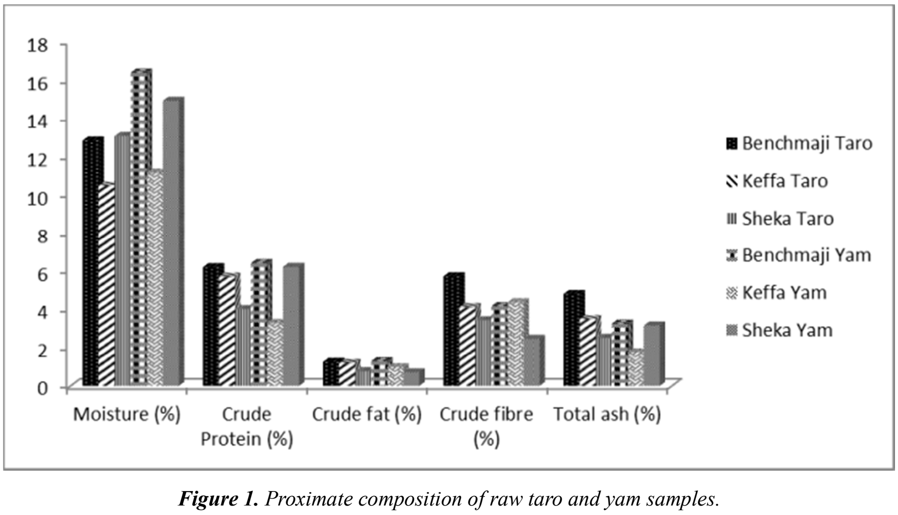

Figure 1. *Proximate composition of raw taro and yam samples.*

As it is depicted from figure 1, table 1 and 2, among the six analyzed samples in all three sampling sites, Benchmaji yam samples were observed to be the highest in protein, fat and moisture contents whereas Benchmaji taro samples were also obtained to be highest in fibre and ash contents. Benchmaji yam was the highest in the contents of protein while that of Keffa yam was the least among the six samples. Sheka yam was the least in fat and fibre content while Keffa yam was the least in protein and ash. As it is observed from figure 1, moisture contents of Benchmaji yam were higher than taro samples with some discrepancy in the studied area.

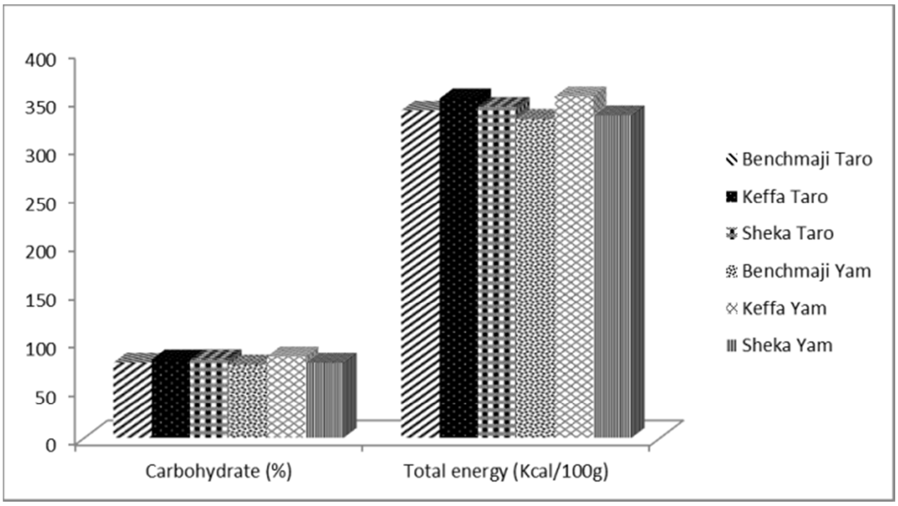

Figure 2. *Carbohydrate (%) and total energy (Kcal/100g) contents in raw taro and yam samples.*

As it can be seen from the figure 2, Keffa raw yam contains the highest level of carbohydrate amongst the studied sites in both raw taro and yam samples. As it has been clearly observed in figure 1 and 2, the mean percentage of carbohydrate was obtained at the highest level ranging from 75.98% (Benchmaji yam) to 84.07% (Keffa yam) than protein, fat, fibre and ash contents in all the three sample sites of both taro and yam samples.

Protein content was observed to be the 2^{nd} highest mean percentage ranging from 3.30% (Keffa yam) to 6.44% (Benchmaji yam) in all sampling sites. The crude fat contents of both taro and yam in all the three sampling sites had the lowest mean percentage ranging from 0.71% (Sheka yam) to 1.30% (Benchmaji yam).

The percentage patterns of the six samples could be shown in decreasing order as follows: carbohydrate: Keffa yam > Sheka taro > Keffa taro > Benchmaji taro > Sheka yam > Benchmaji yam, Protein: Benchmaji yam > Sheka yam > Benchmaji taro > Keffa taro > Sheka taro > Keffa yam, Fat: Benchmaji yam > Benchmaji taro > Keffa taro > Keffa yam > Keffa taro > Sheka yam, Fibre: Benchmaji taro > Keffa yam > Benchmaji yam > Keffa taro > Sheka taro > Sheka yam, Ash: Benchmaji taro > Keffa taro > Benchmaji yam > Sheka yam > Sheka taro > Keffa yam, Moisture: Benchmaji yam > Sheka yam > Sheka taro > Benchmaji taro > Keffa yam > Keffa taro and total energy in (Kcal/100g): Keffa yam > Keffa taro > Sheka taro > Benchmaji taro > Sheka yam > Benchmaji yam.

As Figure 2 clearly shown that, the Carbohydrate (84.07%) and total energy (353.64 Kcal/100g) contents of Keffa yam were the highest followed by Carbohydrate (81.18%) and total energy (351.63 Kcal/100g) contents of Keffa taro in all analyzed samples where as Benchmaji yam was the least in both Carbohydrate (75.98%) and total energy (330.12 Kcal/100g) in all the three sampling sites. Keffa yam, Sheka yam and Keffa yam were the least in protein, fat and ash contents, respectively.

From this trend, it is possible to conclude that raw yam samples contains relatively higher percentage of carbohydrate, protein, fat, moisture contents and total energy values in (Kcal/100g) as compared to raw taro samples with the exception of fibre and ash content in which the raw taro samples were higher than raw yam samples. Thus, in general, both raw taro and yam had appreciable amount of the proximate composition and could be a promising crops for securing food supply in the country level besides their role in saving millions of people during drought and famine season.

5. Conclusion

In this study, proximate composition (crude protein, fat, fibre, total ash, carbohydrate and Gross energy) of raw taro (*Colocasia esculenta* (L.)) and yam (*Dioscorea alata*) samples were determined by AOAC, 2000 Analytical method.

The percentage of proximate composition of both taro and yam samples were compared and analyzed accordingly. Among the six analyzed samples in all three sampling sites, Benchmaji yam samples were observed to be the highest in protein, fat and moisture contents whereas Benchmaji taro samples were also obtained to be highest in fibre and ash contents. Benchmaji yam was the highest in the contents of protein while that of Keffa yam was the least among the six samples. Sheka yam was the least in fat and fibre content while Keffa yam was the least in protein and ash. The mean percentage of carbohydrate was obtained at the highest level ranging from 75.98% (Benchmaji yam) to 84.07% (Keffa yam) than protein, fat, fibre and ash contents in all the three sample sites of both taro and yam samples. The percentage of Carbohydrate (84.07%) and total energy (353.64 Kcal/100g) contents of Keffa yam were the highest followed by Carbohydrate (81.18%) and total energy (351.63 Kcal/100g) contents of Keffa taro in all analyzed samples whereas Benchmaji yam was the least in both Carbohydrate (75.98%) and total energy (330.12 Kcal/100g) in all the three sampling sites. Keffa yam, Sheka yam and Keffa yam were the least in protein, fat and ash contents, respectively.

In the present study, it is possible to conclude that raw yam samples contains relatively higher percentage of carbohydrate, protein, fat, moisture contents and total energy values in (Kcal/100g) as compared to raw taro samples with the exception of fibre and ash content in which the raw taro samples were higher than raw yam samples. Thus, in general, both raw taro and yam had appreciable amount of the proximate composition and could be a promising crops for securing food supply in the country level besides their role in saving millions of people during drought and famine season.

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Conflict of Interest and Funding

The authors declare that they have no competing interests.

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