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NUTRITIONAL QUALITY AND UTILIZATION OF LOCAL AND IMPROVED COWPEA VARIETIES IN SOME REGIONS IN TANZANIA

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ABSTRACT

Cowpeas are grown for their leaves and grains both of which are used as relish or side dishes together with the staple food. Little information is available on the nutritional quality of local and improved cowpea varieties grown in Tanzania as well as the recipes in which they are ingredients. This study was done to investigate cowpea utilization in Iringa and Dodoma regions of Tanzania. A cross-sectional survey was carried out where a total of 517 farmers were interviewed using a pre-tested structured questionnaire. Proximate and mineral composition of different varieties of cowpea grains and leaves were determined using standard AOAC methods. More than half of the households interviewed consumed cowpeas in one or more forms. Most cowpea recipes included them as relish being eaten with rice or stiff porridge (*ugali*), a mixture of dehulled maize and cowpea grains (*kande*) and cowpea buns (*bagia*). Improved cowpea varieties had relatively higher fat content ranging from 8 to 11.2% compared to local varieties (5.4%). Local cowpea grains had higher levels of calcium varying between 958.1 and 992.4 mg/kg than dehulled cowpea (360 to 364 mg/kg) and cowpea flour (303 to 311 mg/kg). Zinc ranged from 32.6 to 31.5 mg/kg, while iron content ranged from 27.6 to 28.9 mg/kg. Fresh cowpea leaves had the highest levels of minerals, with calcium varying between 1800.6 and 1809.6 mg/kg, zinc between 36.1 and 36.0 mg/kg and iron between 497.0 and 499.5 mg/kg. The improved cowpea varieties, IT99K-7212-2-1 (23.8 mg/kg) and IT96D-733 (21.2 mg/kg) had the highest iron content. IT99K-7-21-2-2-1 (32.2 mg/kg) and IT97K499-38 (28.3 mg/kg) had the highest zinc concentration. The *bagia* (cowpea buns), prepared in Dodoma had higher mineral composition, calcium (893mg/kg), zinc (13.7 mg/kg) and iron (16.3 mg/kg) compared to those prepared in Iringa; calcium (32.6mg/kg), zinc (4.96 mg/kg) and iron (5.2 mg/kg). The cowpea daily *per capita* consumption for the majority of the households surveyed ranged from 41 to 200 gm. The contribution of micro and macro nutrients is significant for both developed lines and local varieties but with leaves having greater mineral content than the grains; hence, promotion of consumption of the leaves alongside the grains would be of nutritional advantage. Additionally, farmers should be encouraged to plant the higher yielding cowpea varieties and preferred local varieties.

Key words: local, improved**,** cowpea varieties, nutrients

INTRODUCTION

Mature dry cowpeas (*Vigna unguiculata* L.Walp) are important in the diets of many population groups around the world. Africa alone accounts for 7.5 million hectares of the estimated world total area, of about 10 million hectares under cowpeas. Of the 7.5 million hectares, about 70% lies in West and Central Africa [1]. This food legume is readily available, inexpensive and a popular part of the traditional food system. Cowpeas (*Vigna unguiculata* L.Walp) along with other legumes are recognized as important sources of protein [2]. However, their contribution to the overall diet and dietary mineral needs is less known. Nutritional deficiencies of iron and zinc are often widespread in developing countries, where staple diets are frequently plant-based and consumption of meat and other animal-based food products is low due to high price, which most farmers cannot afford [3]. Cowpea can be consumed as dried, fresh grain, and long stored dried grain, which is cooked; they are also dehulled to remove the seed testa, then ground to obtain flour. The flour obtained can be used to make various dishes or as an ingredient in recipes [4].

The young and tender cowpea leaves are picked and eaten as relish along with the main staples. The grains and leaves are the source of carbohydrates, proteins, fats, ß-carotene, and vitamins B and C, which are necessary for maintaining good health [5]. Young cowpea leaves are consumed in at least 18 countries in Africa, and seven countries in Asia and the Pacific [6]. Cowpea leaves are among the top three or four leafy vegetables marketed and consumed in Africa [7, 8]. The other vegetative parts of the cowpea plant after removal of the grain, are used as feed, forage, hay and silage for livestock. Although cowpea was reported to contain appreciable amount of minerals, most analyses concentrated on a few varieties and on raw samples, hence little information is available on nutrients of some varieties and of cowpea recipes [9]. This paper reports on the extent of utilization of cowpeas and its contribution to the macro and micro nutrients needs of communities that cultivate and consume the legume.

METHODS AND PROCEDURES

A survey to determine the utilization of cowpeas

A survey to determine the pattern of utilization of cowpeas was conducted in Iringa and Dodoma region in Kalenga and Msinga villages, respectively. The choice of these village communities was undertaken in collaboration with government extension authorities from the two regions. The communities are well known for the production, sale, local processing and consumption of cowpeas. The two regions fall within two different agro-ecological zones: Iringa being a wet region located in the southern highlands zone and Dodoma being a semi arid region in the central zone of Tanzania. A structured questionnaire seeking information on the quantity, frequency of consumption, type of cowpea dishes and the methods of preparation and consumption of other foods at the homestead was administered to 517 randomly selected farmers. Samples of local cowpea varieties and products prepared from cowpeas were collected and transported to the laboratory at Sokoine University of Agriculture,

Morogoro for analysis. The processing and preparation steps of cowpea recipes and products were documented. Other samples, which were obtained from Ilonga Agricultural Research Institute, were the developed cowpea lines resistance to *Alectra weed*.

Proximate analysis of the samples

The food samples for chemical analysis were ground to pass through a one millimeter screen in a Christy and Norris 20 cm laboratory Hammer Mill (London). Dry Matter percentage (% DM) was determined by drying the sample in an oven at 103ºC – 105ºC for 24 hours. Crude protein percentage (% CP) was determined by Kjeldahl method AOAC method No. 920.87 [10] with the Kjeltec auto 1030 analyzer, Tecator (Sweden) and percentage nitrogen obtained was used to calculate the % CP using the relationship: % CP = % N x 6.25 [6, 11]. Ether extract percentage (% EE) was determined using the Soxlet System HT- extraction technique AOAC method No. 922.06 (AOAC 1995) and percentage ash (% minerals) was determined after the dry matter determination by incinerating the samples in a muffle furnace at 550ºC for four hours. The ash was cooled in desiccators and then weighed. Crude fiber percentage (% CF) was determined by the fiber system and Weende method [10]. Nitrogen free extract percentage (% NFE) was calculated by difference: thus % NFE = 100 - (% moisture + % CP + % EE + % CF + % Ash).

Total minerals

Total mineral content of the samples was carried out after dry ashing. The ash was dissolved in 10ml of concentrated Hydrochloric acid. Total iron, zinc and calcium were determined by atomic absorption spectrophotometer by AOAC method No 970.12 [10].

Data analysis

Data were entered in SPSS 12.0 for Windows computer software. Descriptive statistics was used to determine the measures of central tendency for each cowpea variety. An analysis of variance of the results was done at 95% confidence interval ($P \leq 0.05$) using Tukeys Honestly Significant Difference. Homogeneity test was performed to determine homogenous sets.

RESULTS

Demographic characteristics of farmers

Among the 240 interviewed farmers in Iringa 124 (52%) were males and 116 (48%) females. In Dodoma, 277 farmers were interviewed, 135 (49%) were males and 142 (51%) females (Table 1). Farmer's age in Iringa ranged between 18 to 83 years with a mean of 45±15 years whereas in Dodoma the age varied between 20 and 59 years with a mean of 35±7 years. In both regions, the majority of the farmers had attained primary education level of up to class 7 (57% in Iringa and 88% in Dodoma). Less than 5 % of the interviewed farmers in Iringa and 1.4% in Dodoma did not have formal education. The majority of the households in Iringa (81%) and Dodoma (67%) had six or less family members.

Cowpea harvesting, procuring and utilization

Most farmers (83%, Iringa and 98%, Dodoma) either grew and consumed their own cowpeas, or obtained cowpea supplies from friends and relatives. Few farmers purchased cowpeas for home consumption (Table 2). Farmers harvested cowpea amounts ranging from 53 to 118 kg with an average of 75 kg of cowpeas per household. The amount of cowpeas sold per household ranged from 4 to 73 kg with an average of 25 kg per household. The amount of cowpea stored for home consumption ranged from 36 to 97 kg with an average of 52 kg. A substantial proportion of farmers prepared between 100 and 500 grams of cowpeas and between 100 and 1000 grams of cowpea leaves for daily household consumption, depending on the household size. The household per capita consumption of cowpea in Iringa and Dodoma ranged from 40 to 200 gm. At the same time, daily per capita consumption for cowpea leaves ranged from 10 to 500 grams among the households in Iringa and Dodoma.

The cooked cowpeas were consumed with either rice or stiff porridge during lunch and dinner. The prepared cowpea can be stored and consumed the following day for breakfast. More than 50% of households in Iringa and Dodoma consumed cowpeas at least once and up to three times a week (Table 2). The leaves are consumed fresh especially during wet season and in dried form during the lean or dry season. Almost all farmers in both regions consume cowpea leaves. Most cowpea grain recipes included; as a relish eaten with rice or stiff porridge (*ugali*), a mixture of dehulled maize and cowpeas (*kande*) and most frequently, the cowpea buns (*bagia*) (Table 3).

Proximate composition

The proximate composition of the different cowpea varieties are shown in Table 4. Proximate analysis results showed that the cowpea varieties with the highest crude protein content were IT97K499-8 (26.12%) and IT99K-7212-2-1 (26%). Varieties with the lowest protein content included IT00K-1207 (22.01%) and TZA 263 (22.6%). For fats, IT97K499-8 (11.18%) and IT99K-7212-2-1 (10.98%) varieties had the highest levels whereas the lowest were IT97K819-118 (8.17%) and IT96D-733 (8.34%). The highest fibre content was observed in TZA 263 (17.2%) followed by IT97K819-118 (16.1%). The lowest in fibre content were IT97K499-38 (12.34%) and IT99K-7212-2-1 (12.53%) varieties. Among the best new lines with respect to crude protein and fat content were IT97K499-8 and IT99K-7212-2-1.

In comparison with the improved lines and varieties, local cowpeas had comparable levels of dry matter (91%), crude protein (22%) and nitrogen free extracts (48%) (Table 4). However, the levels of fat were relatively lower (5.4%) in comparison to the improved lines/varieties whose fat values ranged from 8% to 11.2%. A similar trend was observed in cowpea leaves. Dehulling of the cowpeas reduced crude fibre significantly with a gradual fall in fat content. There was no significant difference in crude protein between buns made from cowpea in Iringa and Dodoma regions. However, there was a significant rise in fat content (14.3%) for the buns prepared in

Iringa and Dodoma, which probably might be due to deep frying of the cowpea buns employed in both places.

Mineral Content

Cowpea samples were analyzed for the minerals iron, zinc and calcium. Analysis showed that all varieties had significantly different ($p<0.05$) levels of minerals content (Table 5). The cowpea varieties with the highest iron content were IT99K-7212-2-1 (23.8 mg/kg) and IT96D-733 (21.2 mg/kg). Varieties with lowest iron included Fahari (9.24 mg/kg) and TZA 263 (9.9 mg/kg).

For calcium, IT99K-7-21-2-2-1 (1112.9 mg/kg), IT97K499-8 (684.8 mg/kg) and IT96D-733 (630 mg/kg) lines had the highest concentration, whereas TZA263 (320.5 mg/kg) and IT89KD-288 (363 mg/kg) had the lowest levels. IT99K-7-21-2-2-1 (32.2 mg/kg), IT97K499-38 (28.3 mg/kg), B301 (26.9 mg/kg) and IT97K819-118 (26.1 mg/kg) had the highest zinc concentration. The lowest zinc concentrations were observed for FAHARI (17.1 mg/kg) and VULI1 (19.6 mg/kg) varieties. The variety that was best with respect to overall mineral content was IT99K-7-21-2-2-1. All cowpea varieties were significantly different ($p<0.05$) with respect to moisture, ash, concentration of calcium, iron and zinc.

Local cowpea grains had the highest calcium, zinc and iron contents followed by dehulled cowpea and cowpea flour in that falling order (Table 6). However, cowpea leaves contained the highest mineral content. Dry cowpea leaves had almost a third of the calcium in comparison to fresh leaves.

DISCUSSION

Macro and micronutrient content

The survey in the two regions revealed that cowpeas are produced by almost half of the farmers and consumed to a relatively large extent by all respondents, which provides an indication of cowpea importance in the two communities. Similarly, the survey revealed that cowpeas are prepared and consumed in a number of ways, including as a relish for stiff porridge and rice, mixed and boiled with maize and cowpea buns. In both regions, the cowpea buns were important as a source of income in a number of households. However, the buns appeared to have lower iron and calcium content, especially those from the Iringa region. This difference between buns may be attributed to the method of preparation of cowpeas in the two regions. In Iringa, the grains are dehulled and soaked for about three hours and then washed in flowing river water for about an hour. This procedure of washing in flowing river water is not practiced in Dodoma. It is thought that these minerals are largely lost during washing [12].

With regard to the deep frying of the cowpea buns, though some nutrients such as proteins and crude fibre were significantly reduced (from an average of 22% to 19% for protein), in the process fats were significantly increased (from 5% to 14%), while nitrogen free extracts and dry matter remained stable. The fat content increase is

attributed to the sunflower oil used to deep fry the buns. Greater oil intake is better as daily activities for the farmers require adequate energy supply. Furthermore, sunflower oil has higher polyunsaturated fats that are preferred as healthy compared to animal fats.

Analysis of the improved cowpea varieties showed relatively higher protein content ranging from 24- 26% and 8-11% for fat content. Similar results have been observed where cowpea seed contained 20-25% protein and was rich in essential and non-essential amino acids [13]. In another study, the reported protein, fat, fiber and carbohydrate contents as the average of eight varieties were 24.8, 1.9, 6.3 and 63.6%, respectively [14]. Improved popular cowpea varieties grown in Nigeria showed similar results, where protein content ranged from 21.3 to 29.9%, but fat content was low (1.2-1.8%) [15]. Cowpea seeds (32 accessions) were investigated and were found to contain protein and tannin contents ranging from 16.4-27.3% and 0.12-2.38%, respectively [16]. In another study on the proximate analysis of various infested cowpea samples, results indicated higher protein and crude fiber and lower moisture, ash, fats and carbohydrates contents when compared with the un-infested samples. Percentage increases in protein and fiber contents ranged between 9.31 and 30.56%, and 1.24-15.11%, respectively; the percentage decrease for moisture was 3.97-10.23%; ash 3.75-12.87%; fats/oil 1.43-10.00%; and carbohydrate 1.88-7.50% [17].

Similarly, the improved cowpeas were relatively high in calcium, iron, and zinc content. However, considerable mineral variation was found among the cowpea varieties. Grains of cowpea varieties were analyzed and it was observed that *Ayiyi*, cowpea variety had the highest calcium concentration of 2096.0 µg/g, whereas Zn was detected in only a few varieties and it ranged between 1501.0 µg/g and 2071.0 µg/g[16]. Analysis of variance showed significant differences ($p<0.05$) among all newly improved cowpea varieties. No defined pattern noted in mineral content among the different varieties of cowpeas. Similar results were obtained with dehulled samples of cowpea varieties, which gave different values for crude protein, fats and minerals [18]. Surprisingly, local cowpea varieties had higher mineral calcium, zinc and iron concentrations compared to the improved lines/varieties. This shows that apart from other merits that the improved cowpeas might have over local varieties such as higher yield and resistance to certain diseases, nutritionally they are equally good or better.

Dehulling of the cowpea grains had an effect on the mineral content, which declined significantly, probably due to the removal of the seed coat (testa). Similar results have been reported where dehulling resulted in a significant increase in protein, starch, resistant starch, phytic acid, stachyose and verbascose content; however, a significant decrease in total dietary fibre, Ca, Cu, Fe, Mg, Mn and tannin content was noted [19, 20].

Cowpea leaves were consumed by almost all farmers in the two communities surveyed. The young leaves are normally picked (usually the first three or four from the cowpea plant). While some consumers chop the leaves into small pieces before

cooking, others boil the whole leaves. The leaves contribute to the dietary intake of calcium, iron and zinc. African Indigenous Vegetables (AIVs) play a highly significant role in food security of the under privileged in both urban and rural settings [21]. AIVs have traditionally played an important role in African diets, as they are used as both medicine and vegetable. Many of these crops are highly nutritious, easy and cheap to grow.

Results revealed twice as much calcium in fresh leaves than in cowpea grains and almost 17 times as much iron. Similar results were reported, where indigenous vegetables showed higher mineral levels [22]. Since iron and zinc levels in cowpea leaves were shown to be significantly higher than in cowpea grains, creating more awareness and encouraging the utilization of cowpea leaves will contribute to alleviation of micronutrient deficiencies from affordable sources especially in resource-poor families. However, it is also important to note that, vegetables that are common in a particular locality do not necessarily have values of iron contents that are comparable. For example, cowpea leaves that were collected from four districts in Tanzania, had values which were quite different that is 179.0 mg in Kongwa, 66.0 mg in Singida, 77.5 mg in Muheza and in 187.0 mg Arumeru, per kg of edible portion [22]. This demonstrates that the amount of minerals found in these vegetables do not only differ due to vegetable type but due to the soil types and location where they were grown. This shows that the soil mineral content influences the mineral uptake of the plants.

Adequacy of cowpea consumed in households

As revealed in the results, the daily *per capita* consumption for the majority of the households surveyed ranged from 41 to 200 grams of cowpea, which means using the Atwater factors (4 kcal/g carbohydrates, 4 kcal/g protein and 4 kcal/g fats) an individual obtained about 135 to 658 kcal per day. Considering that a normal adult requires about 2500 kcal per day to perform moderate activities, the other amount of food eaten in conjunction with cowpeas such as rice or maize flour cannot fill the remaining gap. This means that the amount of cowpeas consumed by most households may not satisfy the daily energy requirements as the quantity eaten is inadequate. By using improved varieties, which are higher yielding and are resistant to Alectra weed, and are accepted by the communities, the amount *per capita* of cowpeas consumed is likely to increase with continued cultivation of the same area of land.

CONCLUSION

Cowpea grains and leaves are widely consumed in the areas surveyed. The contribution of micro and macro nutrients is significant for both improved lines and local varieties but with leaves having greater mineral content than grains. Therefore, raising awareness within the local communities on the importance of consuming cowpea leaves is required. Due to low household production of cowpea, the intake *per capita* is low, and may not meet the RDA for most nutrients. Households have ample land and should be encouraged to plant the higher yielding cowpea varieties in

conjunction with preferred local varieties. Other important nutrients such as vitamins, amino acid profile and levels of antinutritional factors (tannins and phytates) in cowpea should also be investigated further.

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Table 1: Demographic characteristics of farmers interviewed in Iringa and Dodoma

Parameter	Category	Iringa		Dodoma	
		n	%	n	%
Gender	Male	124	51.7	135	48.7
	Female	116	48.3	142	51.3
Education	Class: 3-7	164	70.4	257	92.8
	Class 8-14	58	24.2	16	5.9
	No education	13	5.4	4	1.4
Household size	1-6 members	192	80.8	183	66.8
	7-14 members	48	19.2	94	33.2

Legend: n represents number of respondents

Table 2: Farmers Responses on Cowpeas Utilization

Parameter	Category	Iringa		Dodoma	
		n	%	n	%
Ever eaten cowpeas	Yes	240	100	277	100
How often eaten per week	Once	77	32.1	28	10.1
	Twice	75	31.3	119	43.0
	Thrice	65	27.1	82	29.6
	Four Times	11	4.6	38	13.7
	Five Times	12	5	10	3.6
Where cowpea supplies obtained	Grow cowpea in my farm	124	51.7	131	47.3
	Purchase from the market	41	17.1	6	2.2
	Get from the neighbor	75	31.3	140	50.5
Cowpeas prepared in one meal	100-500 gm	137	57.1	115	76.9
	500-2000 gm	103	42.9	64	33.1
Cowpea leaves prepared in one meal	100-1000 gm	146	61.9	227	89.7
	1000-4000 gm	90	39.1	26	11.3
Cooking time: green cowpea leaves	5-15 minutes	105	44.3	53	20.6
	20 – 90 minutes	133	65.7	214	79.4
Cooking time: dry cowpea leaves	5-15 minutes	26	45.6	44	37.9
	20 – 90 minutes	31	54.4	72	62.1
How leaves are prepared	Chop-wash -cook	23	9.7	155	56.0
	Wash-chop-cook	214	90.7	44	44

Legend: n represents number of respondent

Table 3: Farmers Responses on Cowpea Recipes

Parameter	Category	Iringa		Dodoma	
		n	%	n	%
Cowpea soup with *ugali* or rice	Relish	229	28.8	267	29.2
Cowpea boiled with maize as *kande*	Mixed with Maize	219	27.5	195	21.4
Cowpea roasted		17	2.1	44	4.8
Roasted milled to flour to prepare porridge	Cowpea Porridge	28	3.5	66	7.2
Milled to flour for preparing *bagia*	Cowpea Buns	97	12.2	121	13.3
Milled after soaking to prepare *bagia*	Cowpea Buns	129	16.2	184	20.2

Legend: n represents number of respondent

Table 4: Proximate composition of cowpea grains, leaves and dishes

Variety/Food component	Dry matter (%)	Crude protein (%)	Crude fibre (%)	Ether extract (%)	Carbohydrate (%)
VULI 1*	89.25^{ih}	24.02^{ghi}	13.77^{i}	9.12^{h}	38.18^{i}
IT99K573-1*	88.92^{e}	23.32^{e}	14.51^{k}	8.36^{f}	38.85^{j}
IT97K818-35*	88.94^{e}	25.35^{jk}	13.19^{gh}	9.75^{i}	36.55^{d}
IT96D-733*	88.54^{d}	23.44^{ef}	14.91^{l}	8.34^{f}	37.68^{efg}
IT89KD-288*	88.93^{e}	24.08^{hi}	14.23^{j}	9.11^{h}	37.64^{ef}
IT97K819-118*	89.10^{f}	23.65^{efg}	16.10^{m}	8.17^{e}	37.24^{e}
FAHARI*	89.29^{j}	25.46^{jk}	13.45^{h}	10.33^{k}	35.86^{b}
TUMAINI*	89.13^{gh}	25.96^{lm}	13.83^{i}	9.89^{i}	35.23^{a}
IT00K-1207*	87.95^{b}	22.01^{c}	15.66^{m}	8.46^{f}	37.82^{hi}
IT97K499-8*	88.41^{c}	26.12^{m}	12.34^{f}	11.18^{m}	34.70^{a}
TZA263*	89.21^{ih}	22.60^{d}	17.21^{o}	8.86^{g}	36.45^{d}
VULI 2*	89.53^{k}	25.64^{kl}	13.10^{g}	10.25^{jk}	36.53^{d}
IT97K499-38*	88.93^{e}	25.14^{j}	13.27^{gh}	10.13^{j}	36.41^{cd}
B301*	90.11^{m}	23.75^{fgh}	14.85^{l}	8.39^{f}	38.85^{j}
IT99K-7212-2-1*	89.68^{l}	26.00^{lm}	12.53^{f}	10.98^{l}	35.89^{bc}
Local cowpea grains	90.77^{n}	22.22^{cd}	10.37^{e}	5.38^{d}	48.52^{l}
Dehulled cowpea grains	90.84^{n}	24.40^{i}	2.11^{b}	4.83^{c}	56.96^{p}
Dehulled cowpea flour	87.75^{a}	22.53^{d}	1.11^{a}	2.07^{b}	54.30^{n}
Cowpea buns (*bajia*) Iringa	92.15^{q}	18.81^{a}	3.60^{cd}	14.31^{o}	51.95^{m}
Washed cowpeas for preparing buns	91.65^{p}	19.43^{b}	3.49^{c}	8.37^{f}	56.40^{o}
Cowpea buns (*bajia*) Dodoma	91.44^{o}	19.72^{b}	3.84^{d}	12.52^{n}	51.58^{m}
Cowpea leaves	91.49^{o}	22.04^{c}	16.82^{n}	1.60^{a}	44.75^{k}

*grains

Values with different superscripts along columns are significantly different ($p \leq 0.05$)

Table 5: Mineral content of 15 improved varieties of cowpeas

	Moisture (%)	Ash (%)	Ca (mg/kg)	Zn (mg/kg)	Fe (mg/kg)
VULI 1	11.25^{l}	3.66^{h}	577.78^{k}	19.59^{b}	12.33^{c}
IT99K 753-1	11.04^{i}	3.38^{c}	479.68^{e}	25.28^{j}	14.73^{g}
IT97K818-35	11.59^{n}	3.09^{a}	517.72^{g}	24.68^{h}	15.89^{i}
IT96D-733	11.42^{m}	3.28^{b}	630.00^{m}	23.13^{d}	21.23^{m}
IT89KD-288	10.74^{f}	3.38^{c}	363.41^{b}	24.21^{e}	14.71^{h}
IT97K819-118	11.09^{j}	3.40^{d}	481.60^{f}	26.05^{l}	13.14^{d}
FAHARI	10.77^{g}	3.65^{g}	568.85^{i}	17.09^{a}	9.24^{a}
TUMAINI	11.01^{h}	3.47^{e}	478.25^{d}	25.21^{i}	13.05^{f}
IT00K-1207	10.74^{f}	3.78^{k}	550.46^{h}	25.92^{l}	11.44
IT97K499-8	11.20^{k}	3.54^{f}	684.81^{n}	24.31^{f}	17.77^{l}
TZA 263	10.69^{d}	3.70^{j}	320.47^{a}	21.94^{c}	9.86^{b}
VULI 2	10.40^{b}	3.47^{f}	388.59^{c}	25.81^{k}	16.28^{k}
IT97K499-38	10.70^{e}	3.67^{i}	602.11^{l}	28.34^{n}	14.67^{f}
B301	9.67^{a}	3.91^{l}	575.79^{j}	26.89^{m}	16.06^{j}
IT99K-7-21-2-2-1	10.41^{c}	3.86^{k}	1112.94^{o}	32.17^{o}	23.79^{n}

Values with different superscripts along columns are significantly different ($p \leq 0.05$)

Table 6: Mineral content of local cowpea grain and leaves obtained from Iringa and Dodoma

	Moisture (%)		Ash (%)		Ca (mg/kg)		Zn (mg/kg)		Fe (mg/kg)	
	Iringa	Dodoma	Iringa	Dodoma	Iringa	Dodoma	Iringa	Dodoma	Iringa	Dodoma
Local Cowpea	9.56^{d}	9.40^{d}	3.66^{b}	3.89^{c}	992.43^{k}	958.14^{j}	32.56^{f}	31.45^{e}	27.61^{g}	28.90^{h}
Dehulled cowpeas	10.33^{e}	10.28^{e}	4.23^{de}	4.32^{e}	359.66^{d}	363.78^{f}	27.90^{c}	28.00^{cd}	26.05^{f}	25.02^{e}
Cowpea Flour	7.18^{b}	7.23^{b}	4.13^{d}	4.25^{e}	310.87^{c}	302.93^{b}	27.99^{c}	28.32^{d}	18.76^{d}	18.03^{c}
Fresh Cowpea leaves	5.61^{a}	5.59^{a}	7.32^{i}	6.28^{g}	1809.63^{m}	1800.60^{l}	36.13^{h}	35.95^{h}	499.52^{l}	497.03^{k}
Dry Cowpea leaves	8.34^{c}	10.15^{e}	4.82^{f}	6.67^{h}	551.74^{h}	525.94^{g}	32.93^{g}	31.27^{e}	240.05^{j}	233.83^{i}
Bagia	25.79^{f}	35.35^{g}	2.97^{a}	3.01^{a}	32.58^{a}	893.08^{i}	4.96^{a}	13.67^{b}	5.22^{a}	16.34^{b}

Values with different superscripts along columns are significantly different ($p \leq 0.05$)

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