Evaluation of Nutritional Compositions of Cassava Roots

Adugna Bayata[1], Abera Gure[2] and Kassim Kedir[2]

[1]Ethiopian Institute of Agricultural Research, Jimma Agricultural Research Center, P.O. Box 192, Jimma, Ethiopia, [2]Department of Chemistry, Jimma University, P.O. Box 378, Jimma, Ethiopia. Corresponding author: e-mail: adubay2013@gmail.com

Abstract

Cassava is a dominant main food for many developing countries, particularly in humid and sub-humid tropics. In this study, the nutritional composition, toxic heavy metal and cyanide content of cassava roots of plants grown in Jimma Zone, southwest Ethiopia, were investigated. Cassava root samples were collected from five selected Woredas (Districts) of the Zone, where the plant usually grows. Nutritional compositions, such as crude fat, protein and fiber, as well as mineral contents were considered in the study. Accordingly, crude fat, protein and fiber content of cassava roots ranged from 1.38-3.06%, 1.32-1.90% and 1.58-2.96%, respectively. The concentration of mineral elements; including calcium, magnesium iron and copper ranged from 153-436 mg/kg, 65-207 mg/kg, 54.23-127.03 mg/kg, and 0.09-0.36 mg/kg, respectively. In addition, recovery of the minerals and toxic heavy metals was between 81-120%. In general, the results showed that cassava root samples collected from different localities were rich in crude fat, protein, fiber and carbohydrate, as well as in mineral contents. Besides, the level of cyanide, as compared to the limits set by WHO, was also low and, thus, may not cause harmful effect on human health.

Introduction

Cassava (*Manihot Esculenta Crantz*) is a woody shrub native to South America. The plant is known for its edible starchy tuberous roots. It is a drought tolerant, staple food crop grown in tropical and subtropical areas, where many people are afflicted by malnutrition, making it a potentially valuable food for developing countries (Burrell, 2003). Because of its capability in producing efficient food energy, availability throughout the year, tolerance to extreme stress conditions, and suitability to present farming and food systems in Africa, cassava plays a key role to alleviate the African food crisis (Hahn and Keyser, 1985).

Traditionally, cassava roots are processed in various methods to produce numerous products and utilized in various ways according to local customs and preferences. Although its introduction period is not yet known, the crop is widely grown in south, southwest and western part of Ethiopia (Amsalu, 2006). Its use as a potential food crop in Ethiopia has been appreciated since the famine in 1984 (Teshome *et al.,* 2004). In Ethiopia, cassava is usually consumed by boiling the tubers. Cassava is the third most important source of calories in the tropics and the sixth most important food crop after sugar cane, maize, rice, wheat and potato, in terms of global annual production (Anna *et al.*, 2010). Because of its versatile nature, cassava is referred as the drought, war and famine crop to several developing countries. Thus, it is an important crop to insure food security in a time of climate change (Nassar and Ortiz, 2007, Pearce, 2007; Lebot, 2009). Cassava is known in Jimma area in different names and called "Muka Furno".

For Ethiopians, the consumption of cassava as food is of immense importance and regarded as the food security crop for millions of people. However, the nutrient content of cassava roots, which are cultivated in Ethiopia, has not been well studied so far. Currently, the Ethiopian Institute of Agricultural Research (EIAR) (Tewodros and Yared, 2014) has initiated some works on cassava collection, introduction and evaluation of its productivity. However, the nutritional composition, mineral and toxic heavy metal as well as cyanide contents of the collected and introduced accessions have not been properly evaluated and remain unknown to both consumers and producers, though these constituents have direct bearing on human health and can greatly vary with genotype (variety), growth environment and processing method. The objective of this study was, therefore, to evaluate the nutritional composition and to assess the level of some selected minerals and heavy metals in roots of locally available cassava varieties in Jimma area.

Materials and Methods

Sample collection

Cassava root samples were collected from five purposively selected Woredas of Jimma zone (Mana, Sakachekorsa, Dedo, Sokoru and Gomma) and from Jimma Agricultural Research Center (JARC). Two varieties were collected from Gomma Woreda (white and red), but only the white variety was collected from the other four Woredas. On the other side, four known varieties (Chicha, Kello, Qulle, and Hawassa 1) were considered from JARC for comparison.

Sampling and sample pretreatment

Locally grown representative cassava root samples were collected randomly from the five selected Woredas of Jimma Zone to determine their nutritional value and the level of some heavy metals and anti-nutrients. The analysis was conducted by categorizing

farmland of the different Woredas and from JARC. All the analyses were conducted in triplicate. After collection, the root samples were washed with tap water to remove soil and the outer parts of the root were mechanically removed using knife. Then, the samples were transported to the laboratory, soaked overnight in plastic pot (Amsalu and Esubalew, 2011) and dried in an oven to a constant weight. The dried samples were ground using mortar and pestle and made ready for analysis in triplicate.

Sample digestion

One g of powdered sample was weighed into the digestion tube and 2 mL of HNO_3 (69%), 2 mL of $HClO_4$ (70%) and 3 ml of H_2O_2 was added using a pipette to each sample. Both the spiked and unspiked sample was digested for three hrs in digestion block, colorless aliquot was obtained and the digest was filtered to 50 mL volumetric flask and filled to the mark with distilled water (Novozamsky *et al.*, 1993). The blank sample was digested in the same way as done for the sample and the digest was used for heavy metal and nutrient analysis by atomic absorption spectrophotometer (AAS).

Determination of crude fat and fiber

Dried ground sample loaded to the sample holder was scanned by near infrared spectroscopy (NIRS) and the percent of crude fat and fiber were recorded after spectral reading directly from the NIRS.

Determination of ash

Two grams of the ground sample was weighed into a porcelain crucible (W_a) and the sample was transferred into muffle furnace set at 550^0C and ashed for 4 hrs. The crucible and its content was weighed after ashing (W_b). The percentage ash was calculated as:

$$\% \text{ ash} = (W_b \div W_a) \times 100$$

Determination of crude protein

According to John (1883), 0.5 g of sample was weighed and transferred to digestion tube. 2 mL of H_2SO_4, and Se was added to the sample and digested for 3hrs. Acid digested samples were transferred to macro Kjeldahl flask, 20 ml boric acid solution was measured in Erlenmeyer flask and two drops of indicator solution was added and placed in the condenser. 75 ml of NaOH (40%) was poured to the distillation flask containing digests and 80 ml of distillate was collected. The distillate was titrated against 0.1 N H_2SO_4. Crude protein (CP) was calculated from percentage of nitrogen as: CP = 6.25 x %N.

Determination of carbohydrate

Total carbohydrate content was determined by difference method using the following formula.

$$\% \text{ carbohydrate} = 100 - (\text{ash\%} + \text{moisture\%} + \text{crude fat\%} + \text{crude protein\%} + \text{Crude fiber \%})$$

Determination of cyanide by titration

20 g of grounded cassava root was transferred into a distillation flask and left to stand for 3hrs. It was then distilled until 150 mL of the distillate was obtained. 20 ml of 0.02 M sodium hydroxide was added to the distillate and the volume completed to 250 ml in a volumetric flask using distilled water. Three aliquots, two of 100 ml each and one of 50 ml were obtained. Eight ml of 6 M ammonium solution and 2 ml of 5% potassium iodide were added to the 250 ml aliquots. It was titrated using 0.02 M silver nitrate and turbid color, which indicates the end, was developed. Then, cyanide was determined as follows

$$CN^- = \frac{(A-B)}{C} \times D \times \frac{E}{F}$$

Where: A = ml of $AgNO_3$ for titration of sample, B = ml of $AgNO_3$ for titration of blank, C = ml of sample titrated (250 ml recommended), D = Actual normality of $AgNO_3$ (0.02 N recommended), E = ml of sample after distillation (250 ml recommended) and F = ml of original sample before distillation (500 ml recommended). All the values of each parameter were statistically analysed using SAS software (version 9) and treatment mean separations were done using LSD at 5% P level.

Results and Discussion

Proximate composition of woreda samples

Crude fiber

Results of the nutritional composition and anti-nutritional factors of cassava raw flour showed that crude fiber content of samples from Sokoru and Sekachekorsa Woredas had highest and lowest values (2.96% and 1.58%, respectively), though both samples were white type. On the other hand, variety Gomma Red (GMR) was higher in percentage of crude fiber than the Gomma White (GMW), though both samples were collected from the same Woreda.

Ash

Ash value of Woreda samples varied from 4.33% to 1.17%, withe the highest value for Sekachekorsa and the lowest for Mana (Table 2). In this study, samples from Sekachekorsa Woreda had the highest (at least twice) ash content as compared to samples collected from Sokoru, Mana, Dedo and Gomma (Table 2).

Crude protein

In this study, there was difference in the protein level of cassava roots collected from different Woredas. The level of protein in cassava roots ranged from 1.90% for samples from dedo to 1.32% for samples from Sekachekorsa Woreda and were significantly different ($p < 0.05$). The mean value of protein in samples of Dedo Woreda was higher (1.90%) when compared to the values for other Woredas, while the protein content of samples from Mana and Sokoru Woredas did not show significant difference. These results show that cassava roots collected from Sekachekorsa have lower protein, fiber and fat than those collected from other Woredas, except for ash.

Table 1. Recovery values (R) of minerals and heavy metals in cassava roots of different varieties and from the various Woredas.

Cassava variety	R (%)					
	Cr	Cu	Fe	Mn	Ca	Mg
SK	84	96	87	82	108	95
DD	96	97	87	82	100	101
HS 1	97	84	108	107	87	89
GMW	102	108	94	88	119	112
QL	103	102	106	100	104	94
SQ	116	109	81	94	84	82
MN	106	103	101	105	84	90
GMR	99	107	115	104	96	86
CH	120	99	83	97	107	115
KL	114	83	106	85	84	87

Note: GMW= Gomma white, SK= Sokoru, DD= Dedo, SQ= Sakachekorsa, MN= Mana, CH= Chichu, KL= kello, QL= Qulle, HS 1=Hawassa 1.

Moisture content

In this study, the moisture level was in the range of 2.13 % to 1.67 %, where cassava flour of samples from Sokoru Woreda showed the least value, while those from Sekachekorsa had the highest value (Table2). As reported by Albert and Klanarong (2005) and Madubuike *et al.* (2014), moisture content values for cassava recorded in the present study are lower as compared to those recorded in other countries, and this indicates that cassava varieties grown in Jimma area are less perishable and stay for long period of time and are also less susceptible to microorganism reproduction.

Crude fat

There was significant variation in crude fat content between samples collected from different Woredas (Table 2). The range of variation in fat content was from 3.06 % to 1.38%. Both white and red cassava root samples collected from Gomma Woreda exhibited higher values, while the sample from Sokoru Woreda contained the lowest percentage of crude fat.

Carbohydrate content

The mean values indicated that there were significance differences among the Woreda cassava root samples for carbohydrate content. Accordingly, sample collected from Mana Woreda had the highest (92.32%) carbohydrate content, while cassava roots from Sekachekorsa exhibited the least (89.04 %) value (Table 2). The white variety from Gomma had higher (89.33%) carbohydrate content than did the red type from the same Woreda (89.13 %) (Table 2).

,

Woerda	Parameter					
	Ash (%)	Crude fiber (%)	Crude Protein (%)	Crude Fat (%)	Moisture content (%)	Carbohydrate (%)
MN	1.17 ± 0.29	1.69 ± 0.06	1.42 ± 0.08	1.68 ± 0.05	1.73 ± 0.1	92.32 ± 0.33
SQ	4.33 ± 0.76	1.58 ± 0.01	1.32 ± 0.03	1.72 ± 0.03	2.13 ± 0.18	89.04 ± 0.92
SK	2.17 ± 0.29	2.96 ± 0.09	1.37 ± 0.06	1.38 ± 0.10	1.67 ± 0.01	90.47 ± 0.15
GMW	2.00 ± 0.82	2.69 ± 0.03	1.43 ± 0.04	2.64 ± 0.05	1.91 ± .08	89.33 ± 1.08
GM R	1.83 ± 0.58	2.63 ± 0.02	1.55 ± 0.03	3.06 ± 0.07	1.80 ± 0.01	89.13 ± 0.62
DD	1.33 ± 0.29	1.72 ± 0.03	1.90 ±0.05	1.76 ± 0.02	1.91 ±0.06	91.48 ± 0.32
LSD	1.12	0.08	0.10	0.19	0.24	1.27

Note: LSD= Least Significance Difference; GMW= Gomma white, SK= Sokoru, DD= Dedo, SQ= Sakachekorsa, MN= Mana, CH= Chichu, KL= kello, QL= Qulle, HS 1=Hawassa 1. Values are mean ± SD of three individually analyzed samples (n=3) (p < 0.05).

Proximate composition of varieties from JARC

Moisture content dry matter basis (DM) of cassava roots of varieties from JARC ranged from 1.85 % - 0.91 % with the highest value for variety Kello and the lowest for variety Chichu (Table 3). Moisture content of variety Qulle and Hawassa 1 did not show significant difference. Crude fiber content of varieties ranged from 2.69 % for Hawassa 1 to 2.23 % for Chichu, indicating that it is so useful to produce and consume Hawassa 1 for improved human health. Crude protein content of roots of variety Hawassa 1, Kello and Chichu was not significantly different ($p < 0.05$), but it was lowest for variety Qulle (Table 3).

Fats are vital to the structure and biological function of body cells and are used as an option for energy source (Apau *et al.,* 2014). In line with this, crude fat significantly varied in content from 2.35 % in variety Kello to 1.72 % in Hawassa 1. Hence, it was significantly higher in Kello (2.35 %) than in the other varieties included in this study. Ash content of cassava roots also significantly varied ($p < 0.05$) among the four varieties and it was higher for Chichu (2.00 %) and lower for both Kello and Qulle (1.17 %). Similarly, root carbohydrate content of variety Chichu was higher (91.58 %) but that of Kello was lower (90.87 %) (Table 3)

Table 3. Proximate composition of Cassava roots of different Varieties from JARC

Variety	Moisture % (FW)	Moisture %	Ash (%)	Crude Protein %	Crude Fat (%)	Crude Fiber (%)	Carbohydrate (%)
CH	32.93 ± 3.20	0.91 ± 0.31	2.00 ± 0.50	1.52 ± 0.08	2.13 ± 0.03	2.23 ± 0.01	91.58 ±0.61
HS 1	39.01 ± 1.98	1.55 ± 0.01	1.33 ± 0.29	1.50 ± 0.04	1.72 ± 0.08	2.69 ± 0.03	91.28 ±0.33
QL	42.21± 2.56	1.67 ± 0.10	1.17 ± 0.29	1.16 ± 0.05	2.17 ± 0.03	2.45 ± 0.07	91.09 ±0.17
KL	33.25 ± 1.38	1.85 ± 0.40	1.17 ± 0.09	1.38 ± 0.12	2.35 ± 0.07	2.24 ± 0.08	90.87 ±0.35

Minerals and toxic heavy metals

Uptake of heavy metals in main food could be from soil, atmosphere or water. Metals like cadmium and copper are cumulative poisons, which cause environmental hazards and are reported to be exceptionally toxic (Apau *et al.,* 2014). The evaluation of minerals in cassava is an important exercise from nutritional to the toxicological point of view. This is because some metals have long-term effects on human health when accumulated in target organs. Apau *et al.* (2014) reported that metal deficiency syndrome like rickets and calcification of bones is caused by calcium deficiency, while magnesium deficiency in human is responsible for severe diarrhea, migranes, hypertension, cardiomyopathy, arteriosclerosis and stroke.

Calcium: In the present study, the concentration of calcium in roots was significantly affected ($P < 0.05$) by variety, where Hawassa 1, followed by Qulle, had the highest and Kello, followed by Chichu, had the lowest values (Table 4). The concentration of Ca in the selected varieties was in the order of 425.39 > 372.04 > 161.94 > 157.18 mg/kg for Hawassa 1, Qulle, Chichu and Kello, respectively. The concentration of calcium in cassava roots collected from different Woredas was in the order of 436.03 > 373.88 > 327.13 > 316.68 > 157.78 > 153.51 mg/kg for Dedo, Mana, Sokoru, Gomma white, Gomma red and Sekachekorsa, respectively, and there was significant difference between Woreda samples for Ca content (Table 4).

Magnesium: The levels of magnesium for root samples obtained from the different Woredas and varieties ranged between 204.82 and 61.27 mg/kg and from 207.94 to 65.85 mg/kg, respectively. The concentration of Mg was significantly affected ($p<0.05$) by both factors (location or Woreda and variety) (Table 4).

Chromium: Chromium is used in leather tanning industries, manufacturing of catalysts, pigments and paints, fungicides, ceramics and in glass industries. As shown in Table 4, Cr concentration in Woreda samples varied from 0.25 for Manna to 0.92 mg/kg for Sokoru Woreda. Similarly, the concentration of Cr in cassava roots ranged from 0.39 for Kello to 1.20 mg/kg for variety Qulle. Hence, the concentration of Cr was found to be higher in the released varieties (1.20 mg/kg) than in the Woreda samples (0.92 mg/kg), though its values greatly varied with both factors. Cadmium: Cadmium occurs naturally in Zn, Pb, Cu and other ores that act as its source to ground and surface waters. In this study, Cd was not detected in cassava root samples, as it was below the detection limit of the instrument.

Copper: High concentration of Cu causes metal fumes fever, hair and skin discolorations, dermatitis, respiratory tract diseases, and some other fatal diseases in human beings. The concentration of Cu in Woreda samples ranged from 0.09 to 0.34 mg/kg Mana and Sokoru Woredas, respectively, while its value for the released varieties varied from 0.20 (for Kello) to 0.36 mg/kg (for Hawassa 1). This shows that the concentration of Cu is relatively higher (0.36mg/kg) in the samples collected from JARC than in the Woreda samples (0.34mg/kg) (Table 4), and the variation could be due to intensive field management at the research center. As Obueh and Kolawole (2016) have reported it, the concentration of Cu in cassava root was 3.84 mg/kg, but in the present study, the maximum concentration in both samples from Woredas (0.34 mg/kg) and released varieties (0.36 mg/kg) was lower than the reported value. Although higher level of Cu has adverse effects, it is essential element, which is required for hemoglobin synthesis and in the catalysis of metabolic growth. The highest concentration of Cu determined in cassava root samples in the present study was 0.36 mg/Kg, which is far below the limit (40 mg/Kg) that has been set by WHO for foods (Hayford *et al.*, 2016).

Iron: Fe is essential in the body for carrying oxygen to human blood cells. About two-thirds of the body iron is found in hemoglobin. The concentration of Fe in cassava roots of Woreda samples ranged from 54.23 for Manna to 97.55 mg/kg for Gomma red, while for the JARC varieties it ranged from 69.78 for Kello to 127.03 mg/kg for Qulle (Table 4). According to Apau *et al.* (2014), the level of iron in cassava was 29.908 mg/kg, which is lower than the results found in the present study. As shown in Table 4, the mean values of iron were significantly different ($p < 0.05$) for both Woreda and variety. Although Fe is an essential metal for the body, excess intake may lead to colorectal cancer (Senesse *et al.*, 2004). Accordingly, all the cassava root samples analyzed for iron in the present study were found to have more than the acceptable limit.

Table 4. Concentration (mg/kg) of minerals and toxic heavy metals

Woreda and Variety	Parameters (mg/kg)						
	Ca	Mg	Cr	Cd	Cu	Fe	Mn
GMR	157.78 ± 3.32	204.82 ± 5.82	0.33±0.06	ND	0.16 ± 0.03	97.55 ± 1.48	0.93 ±0.07
SK	327.13 ± 1.93	195.29 ± 8.70	0.92±0.08	ND	0.34 ± 0.03	81.16 ± 2.73	0.59±0.06
DD	436.03 ± 3.74	136.99 ± 5.23	0.87±0.12	ND	0.27 ±0.04	91.90 ± 1.04	1.06 ±0.07
SQ	153.51 ± 6.69	97.20 ± 4.41	0.43 ± 0.02	ND	0.24 ± 0.04	75.23 ± 4.89	0.78 ±0.14
GMW	316.68 ± 4.96	92.62 ± 1.65	0.90 ±0.06	ND	0.31± 0.04	84.61 ± 3.21	0.83±0.06
MN	373.88 ± 3.74	61.27 ± 1.46	0.25 ± 0.02	ND	0.09 ± 0.03	54.23 ± 1.45	0.26 ±0.04
CH	161.94 ± 3.90	130.20 ± 3.90	0.48± 0.03	ND	0.21 ± 0.05	86.60 ± 3.47	0.70 ± 0.12
KL	157.18 ± 3.86	65.85 ± 4.13	0.39 ± 0.04	ND	0.20 ± 0.05	69.78 ± 4.00	0.53 ± 0.07
QL	372.04 ± 7.32	207.94 ± 3.58	1.20 ± 0.11	ND	0.31 ± 0.02	127.03 ± 3.71	1.06 ± 0.07
HS 1	425.39 ± 6.08	102.34 ± 4.41	1.18 ± 0.09	ND	0.36 ± 0.07	75.26 ± 3.35	0.76 ± 0.14
LSD	12.65	7.99	0.09		0.05	8.28	0.04

Note: LSD= Least Significance Difference; ND= not detected, GMW= Gomma white, SK= Sokoru, DD= Dedo, SQ= Sakachekorsa, MN= Mana, CH= Chichu, KL= kello, QL= Qulle, HS 1=Hawassa 1. Values are mean ± SD of three individually analyzed samples (n=3) (p < 0.05).

Manganese: The level of Manganese for samples from different Woredas and varieties of JARC ranged between 0.26-1.06 mg/kg for Mana and Dedo Woredas and 0.53-1.06 mg/kg for variety Kello and Qulle, respectively, and its value was significantly ($P < 0.05$) affected by both Woredavor location and variety. Excessive intake of metals like iron could result in complications ranging from gastro-intestine irritation, vomiting to tissue damages and skin pigmentation, while excessive intake of manganese can cause diseases of brain and nervous system, muscular rigidity and slow, imprecise movement (Audul *et al.*, 2012). It is well known that such metals and other elements can be naturally present in food or can enter food because of human activities such as industrial and agricultural processes.

Cyanide concentration

The concentration of cyanide in edible portion of the cassava roots ranged from 3.83-0.91 mg/l for Woredas (Table 5). The result showed that the level of its toxicity was significantly higher for Skachekorsa (3.13 mg/l) and lower for Dedo Woreda (0.91 mg/l). The concentration of this anti-nutrient could be reduced through processing such as grinding, soaking and drying. The level of cyanide in the non-edible portion of cassava roots also significantly differed with Woreda. Nevertheless, the concentration of cyanide was higher in the edible part than in the central part of roots sampled from the same Woreda (Table 5). This implies that the cyanide concentration increases from the internal part to the outer part (Tweyongyere and Katongle, 2002).

Table 5. Concentration of cyanide in cassava roots of edible and non-edible portions from the different Woredas and varieties

Woreda	Cyanide in edible portion (mg/l)	Cyanide central portion (mg/l)	Variety	Cyanide in edible portion (mg/l)	Cyanide in central portion (mg/l)
MN	2.16 ± 0.04	0.55±0.04	KL	5.02 ± 0.10	0.59 ± 0.07
SQ	3.83 ± 0.03	0.45 ± 0.03	CH	0.83 ± 0.04	0.34 ± 0.04
GMR	1.15 ± 0.04	0.39 ±0.04	QL	1.87 ± 0.14	0.63 ± 0.03
GMW	1.33 ± 0.1	0.53 ± 0.05	HS 1	0.83 ± 0.05	0.43 ± 0.05
SK	3.13 ±0.03	0.42 ± 0.03	LSD	0.13	0.09
DD	0.91± 0.08	0.63 ± 0.07			
LSD	0.16	0.08			

Note: LSD= Least Significance Difference; GMW= Gomma White, SK= Sokoru, DD= Dedo, SQ= Sakachekorsa, MN= Mana, GMR= Gomma Red, CH= Chichu, KL= kello, QL= Qulle and HS 1= Hawassa 1. Values are mean ± SD of three individually analyzed samples (n=3) (p < 0.05).

On the other hand, varietal difference was also significant ($P < 0.05$) and the concentration of cyanide was highest in variety Kello (5.02 mg/l) and lowest in both Hawassa 1 and Chichu (0.83 mg/l). As compared to the findings of Ojo *et al.* (2015) in Nigeria (7.92 - 15.40 mg/kg), the level of cyanide determined in the present study was by far lower. Different countries have different safe levels of cyanide, for example, the acceptable limit in Indonesia is 40 mg/kg, but WHO has set safe level of cyanide to 10 mg/kg (Amsalu and Esubalew, 2011). Therefore, based on the limit set by WHO (<10mg/kg), the level of cyanide in the released varieties and in samples collected from different Woredas is at safe level if consumed.

Conclusion and Recommendations

Cassava root flour is a potential substitute for other types of flour or it can be used by mixing with other flours for human consumption. Its unique adaptability to different ecological conditions makes it the most important famine crop reserve. In the present study, it was observed that protein, fiber, fat and carbohydrate contents of cassava roots were higher in Woreda samples than in the samples (varieties) collected from Jimma agricultural research center. Cassava roots contain some minerals like Ca, Mg and Fe, which are essential for human body. The presence of Fe in low concentration plays a vital role in the body. The low concentration of cyanide in all the samples (below the WHO permissible limit) could also make these samples to be safely consumed. It was concluded that the nutritional status, mineral contents and cyanide levels of all the cassava samples considered in the present study were in acceptable ranges for human consumption.

References

Audu1 AAM, TT Waziri, and Olasinde. 2012. Proximate Analysis And Levels Of Some Heavy Metals In Cassava Flour Processed By Roadside Drying Along Abuja-Lokoja Highway, *Nigeria. Indian Journal of Fundamental and Applied Life Sciences*, 2: 55-58

Albert LC and STH Klanarong.2005. proximate composition, mineral content, hydrogen cyanide and phytic acid of 5 cassava genotypes. *Food chemistry*, 92: 615-620

Amsalu A. 2006. Caring for the Land Best Practices in Soil and Water conservation in Beressa Watershed, Highland of Ethiopia. *Trop. Resource Management*,76

Amsalu N and Esubalew G. 2011. Soaking and Drying of Cassava Roots Reduced Cyanogenic Potential of Three Cassava Varieties at Jimma, Southwest Ethiopia. *World Journal of Agricultural Sciences*, 4: 439-443

Anna B, G Roslyn, C Julie, Z Anabela, and C Timothy.2010. Cassava: The Drought, War and Famine Crop in a Changing World. *Sustainability*, 2: 3572-3607

Burrell MM. 2003. Starch: the need for improved quality or quantity An overview. *Journal of experimental Botany*, 218: 451-456

Hahn S K and J Keyser.1985. Cassava: a basic food of Africa. *Outlook on Agriculture*, 4: 95-100

Hayford O, T Charles, TA Paa, and A Jonathan.2016. Trace metal and Aflatoxin concentrations in some processed cereal and root and tuber flour *International Journal of Food Contamination*, 3: 2-6

Apau JA, JA Acheampong, E Appiah, and Ansong. 2014. Levels and Health Risk Assessment of Heavy Metals in Tubers from Markets in the Kumasi Metropolis, Ghana. *International Journal of Science and Technology*, 3: 534-539

John KZ. 1883. A new method for the determination of nitrogen in organic bodies. *Analytical Chemistry*

Lebot V. 2009. Tropical Root and Tuber Crops: Cassava, Sweet Potato, Yams and Aroids; CABI: *Wallingford, UK*

Madubuike PC,CT Onyema, SC Odinma, and CE Sokwaibe.2014. Evaluation of Mineral Elements, Cyanide and Proximate Composition of Cassava (*Mannihot Esculenta Crantz*) From Ebony State, Nigeria. *Journal of Environmental Science, Toxicology and Food Technology*, 8: 41-43

Novozamsky IV, JG Houba, and JJ van der Lee. 1993. A convenient method of digestion forelemental analysis of soil and plant material. *Comm*. *Soil Science and Plant Analysis*, 24: 2595 2605

Obueh HO and EE Kolawole.2016. Comparative Study on the Nutritional and Anti- Nutritional Compositions of Sweet and Bitter Cassava Varieties for Garri Production. *Journal of Nutrition and Health Sciences*, 3: 3-7.

Ojo O, MB Ogundiran, and L Adebayo Oluwafemi.2015. Toxic and Essential Metals in Staple Foods Commonly Consumed by Students in Ekiti State, South West, Nigeria *International Journal of Chemistry*, 155-160

Pearce F. 2007. Cassava comeback. *New Scientist*, 38-39.

Senesse P, S Meance,V Cottet, J Faivre, and MC Boutron-Ruault'.2004. High dietary iron and copper and risk of colorectal cancer: a case control study in Burgundy. *France. Nutrition Cancer*, 49: 66-71

Teshome S, Demel T, and Sebsebe D. 2004. Ecological study of the vegetation in Gamo Gofa zone, southern Ethiopia. *Journal of Tropical Ecology*, 45: 209-221

Tewodros M and Yared D. 2014. Nature of gene action in elite cassava genotypes (*Manihot esculenta Crantz*) in South Ethiopia. *Sky Journal of Agricultural Research*, 3: 67-73