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Nutrient and antinutrient composition of improved sweet potato [*Ipomea batatas* (L) Lam] varieties grown in eastern Ethiopia

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Abstract

Purpose – The purpose of this study is to compare the nutrient and antinutrient content of improved sweet potato varieties released for eastern Ethiopia.

Design/methodology/approach – Matured roots of two sweet potato varieties, namely, *Berkume* and *Adu*, were collected from Haramaya University, *Toni* Research Farm, Ethiopia. The sweet potatoes were ground into flour following standard procedure. Thereafter, proximate, dietary minerals and β-carotene were determined by official methods of analysis. The tannin and phytate contents were determined by colorimetric methods.

Findings – The moisture, protein, fat, fiber, ash, utilizable carbohydrate and gross energy varied from 6.23-6.61 per cent, 2.07-2.76 per cent, 1.25-1.52 per cent, 1.04-1.16 per cent, 3.38- 5.32 per cent, 90.03-91.45 per cent and 382.18-388.07 Kcal/100 g in both the sweet potato varieties. Potassium content (176.17 mg/100 g) was reported to be the highest and registered in *Berkume* variety, while the lowest mineral content (2.18 mg/100 g) determined was zinc in *Adu* sweet potato variety. The highest total carotenoid content (3.39mg/100 g) was recorded in *Berkume* sweet potato variety. The tannin and phytic acid contents ranged from 9.98 to 12.94 mg/100 g and from 0.24 to 0.31 mg/100 g in *Berkume* and *Adu* sweet potato varieties, respectively.

Originality/value – This study showed that the *Berkume* sweet potato variety has high nutritional potential and less antinutrient contents as compared with the nutritional value of many roots and tuber crops documented in the FAO database and hence can contribute to reducing malnutrition in resource-poor settings of Ethiopia. Further work needs to be carried out on value-added products from *Berkume* sweet potato variety for its extensive utilization.

Keywords Food crops, Antinutrients, Food value, Nutrition, Plant foods, Root crops

Paper type Research paper

Introduction

The sweet potato [*Ipomoea batatas* (L.) Lam.] is a dicotyledonous perennial plant which belongs to the family Convolvulaceae (Suraji *et al.*, 2013; Solomon *et al.*, 2015). Both the storage roots and the leaves of sweet potatoes are edible. It is the seventh most important food crop after wheat, rice, maize, potato, barley and cassava (CIP, 2000; Ukom *et al.*, 2011;Suraji *et al.*, 2013), being cultivated in more than 100 countries

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(FAOSTAT, 2012; Eleazu and Ironua, 2013 and Ingabire and Hilda, 2011), with the world's average productivity of 15 ton/ha. Global production of sweet potato is estimated to be over 105 million metric tons annually (FAO, 2008).

Sweet potato is mainly grown in the tropical and subtropical regions, where the bulk of the crop is cultivated and consumed (Eleazu and Ironua, 2013; Ellong *et al.*, 2014). Sweet potato has the advantage of high yield, high resistance to drought and wide adaptability to various climates and farming system (Lou *et al.*, 2006; Namutebi *et al.*, 2003; Hua *et al.*, 2015). For this reason, sweet potato is considered as strategic famine-relief food for countries with unreliable rainfall condition like Ethiopia. Moreover, it is also used as a cash crop and hence it is a means of income generation for rural households to drive their livelihood.

Sweet potato has been cultivated as a food crop in Ethiopia for past several years, and over 95 per cent of the crop produced in the country is grown in the south, south-western and eastern parts where it has remained for centuries an important co-staple for the people, especially during periods of drought (Solomon *et al.*, 2015). Ethiopia ranks 15th in the world in terms of sweet potato production (Dan *et al.*, 2013). Sweet potato ranks third after Enset [*Enset ventricosum* (Wele) Cheesma] and Potato (*Solanum tuberosum* L.) as the most important root crop produced in Ethiopia (Solomon *et al.*, 2015).

In the recent past, several high-yielding, early-maturing and disease-tolerant varieties of sweet potatoes have been developed in Ethiopia (Berhanu and Beniam, 2013; Birhanu *et al.*, 2014; Desalegn *et al.*, 2015; Solomon *et al.*, 2015). However, little is known about their nutritional composition. Moreover, breeding efforts may result in undesirable nutritional effects such as development of high contents of antinutrients in the tuber. Therefore, nutrients' and antinutrients' composition of two improved sweet potato varieties, namely, *Berkume* (TIS 8250-2) and *Adu* (Cuba-2), which were released for eastern Ethiopia where there is recurrent drought in the country, were studied.

Materials and methods

Experimental materials

Matured roots (about 15 kg) of two improved sweet potato varieties, namely, *Berkume* (TIS 8250-2) (yellow fleshed) and *Adu* (cuba-2) (white fleshed), were randomly collected from Haramaya University *Toni* research farm, Dire Dawa, Ethiopia. The experiments were conducted at Haramaya University Laboratories of Food Science and Postharvest Technology Department, Ethiopia. Analytical-grade reagents and standards were used in the analysis of all parameters.

Sample preparation

The sweet potato tubers were thoroughly sorted to separate damaged samples from the lot. The sweet potato tubers identified to be normal and seem fitting for experimentation were cleaned and washed to remove adhering soil, dirt and extraneous materials. The tubers were peeled and sliced into 2- to 2.5-cm-thick chips using Jagson potato slicer (Food slicer, JAG0100089, CA) to facilitate fast rate of drying and easy milling operations. The sliced tubers were blanched at 60°C for 5 min in a water bath (GLC 400, Grant Instruments, England) to inactivate enzymes that may cause a browning reaction. The blanched tubers were then cooled in cold water and drained which was followed by drying at 60°C for 6 h in an oven (Memmert, 845 Schwabach, West Germany) (Okigbo, 1989; FAO, 2011). The *slices* were then milled by an electric grinder (Nima, model NM-8300, Japan) and sieved through a 300-μm sieve and packed in an air-tight polythene bag at 4°C until used for different chemical analysis.

Chemical analyses

Proximate composition

The moisture content was determined by taking about 5 g of sample by air draft drying (103°C ± 1°C, 6 h) oven-drying method (AOAC, 2000a, 2000b; Method No 925.10). The crude protein content was determined after digestion of about 0.5 g sample by *micro* Kjeldahl method of nitrogen content analysis (HYP-1014 digestion and KDN-102F distillation systems, Shanghai Qian Jian Instruments CO, LTD, China) (AOAC, 2000a, 2000b, Method No 979.09) using urea as a control. Protein (per cent) = N (per cent) × 6.25. Crude fat content was determined by Soxhlet extraction (SZC-C, China) from 3.5 g of sample using n-hexane as a solvent (AOAC, 2000a, 2000b; Method No 920.39). The crude fiber content was determined by taking about 1.5 g of sample as portion of carbohydrate that resisted sulfuric acid (1.25 per cent) and sodium hydroxide (1.25 per cent) digestion followed by sieving (75 µm), washing, drying and ignition to subtract ash from fiber (AOAC, 2000a, 2000b, Method No 962.09). Total ash content was determined after ashing about 5 g of samples in a muffle furnace at 550°C until ashing was complete (AOAC, 2000a, 2000b; Method No 920.03).

Total carbohydrate content was calculated by difference as (100 – per cent of protein + per cent of fat + per cent of ash + per cent of moisture) (AOAC, 2005). All results were expressed as g/100 g of dry matter of sweet potato flour. Energy value (kcal per 100 g) was estimated using the Atwater conversion factors (Osborne and Voogt, 1978). E (kcal per 100 g) = [9 × Lipids (per cent) + 4 × Proteins (per cent) + 4 × Carbohydrates (per cent)].

Dietary minerals analysis

Dietary mineral elements' (iron, calcium, zinc in mg/100 g) contents were determined as described in AOAC (2000a, 2000b) by dry ashing method using atomic absorption spectrophotometer (Model 200, Germany) using air-acetylene as a source of energy for atomization. The absorbance for iron, zinc and calcium was measured at 248.3 nm, 213.8 nm, and 422.7 nm, respectively. The iron, zinc and calcium contents were estimated from a series of 1-5 mg/kg, 0.5-2.5 mg/kg and 2-10 mg/kg standard calibration curve prepared from analytical-grade iron wire, ZnO and $CaCO_3$, respectively. Potassium and sodium were determined by flame photometry method (AACC, 2000), while phosphorus was determined calorimetrically by using Vanado-molybdate method (AOAC, 1984).

Antinutritional factors analysis

Phytic acid content determination

Phytate content was determined as described by Vaintraub and Lapteva (1988) after extraction of sample with 2.4 per cent HCl for 1 h, centrifuged and reacting sample extract (3 mL) with 1 mL of Wade reagent (0.03 per cent $FeCl_3.6H_2O$ and 0.3 per cent sulfosalicylic acid in distilled water). The absorbance of sample was measured at 500 nm using UV-Vis Spectrophotometer (~~DU-64 spectrophotometer, Beckman~~), subtracted from blank absorbance and the phytate content (mg/100 g sample) was estimated from phytic acid AQ: 1 standard curve (5-36 mg/kg).

Condensed tannin content determination

Condensed tannin content was determined by the modified vanillin–HCl–methanol method AQ: 2 (Price *et al.*, 1978; Siwela, 2007). Sweet potato flour sample (~~about~~ 0.2 g) was extracted with 10 mL of 1 per cent HCl (24 h), extract (1 mL) reacted with extracted with 5 mL vanillin–HCl reagent (8 per cent concentrated HCl in methanol and 4 per cent vanillin in methanol, 50:50, v/v), and the absorbance of the color developed was measured after 20-min incubation at 30°C at 450 nm using UV-Vis Spectrophotometer (DU-64 spectrophotometer, Beckman). The tannin content was estimated from catechin calibration curve as milligram of catechin per gram of sample using the following equation:

$$\text{Tannin}\,(\text{mg}/100\text{g}) = \frac{\text{C} \times 10}{200} \times 100$$

where:

C = concentration of corresponding to the optical density;
10 = volume of the extract (ml); and
200 = sample weight.

Total carotenoids content determination

Total carotenoid content was determined as described in Bandyopadhayay *et al.* (2008) from 25 g of homogenate sample after extraction with 20 mL of diethyl ether, and the ether extract was washed twice with 40 mL of distilled water each time. Then, the extract was dried over anhydrous sodium sulfate, and the diethyl ether was evaporated on a steam bath and the dried residue was then re-dissolved in 20 mL of petroleum ether. The color absorbance was measured at a wavelength of 450 nm with a spectrophotometer (Series UV/Vis spectrophotometer PG Instrument Ltd., T80, China), and the total carotenoids content of the samples was determined from the following equation:

$$\text{Total carotenoids}\left(\frac{\text{mg}}{\text{kg}}\right) = \frac{\text{Abs}}{259.2} \times \frac{20\,\text{ml}}{\text{sample weight kg}}$$

where: Abs = absorbance reading, 259.2 = extraction coefficient of β-carotene in petroleum ether 20 mL = volume of petroleum ether used to dissolve carotenoid extract.

Statistical analysis

The experiment was carried out in completely randomized design (CRD) in triplicate using two improved sweet potato varieties in a single-factor arrangement. Triplicate data of each nutrient and antinutrient were analyzed using one-factor analysis of variance (ANOVA), and data were reported as mean ± standard deviation (SD). Mean comparison were conducted by the least significant difference (LSD) test at 0.05, using the Statistical Analysis System (SAS version 9.1, 2008, SAS Institute).

Results and discussion

The nutrient and antinutrient content of two improved and released (yellow fleshed and white fleshed) sweet potato varieties (*Berkume* and *Adu*) for eastern Ethiopia were investigated. The effect of variety was highly significant ($p \leq 0.05$) on the proximate composition of improved sweet potatoes as presented in Table I; while the effect of sweet potato variety on dietary mineral content and antinutrients is summarized in Table ~~III~~ and Table ~~IV~~, respectively. Furthermore, the mineral safety index and dietary mineral bioavailability values of the sweet potatoes were computed and the results were interpreted. T1 AQ: 3

Effect of varieties on proximate composition of sweet potatoes

The moisture contents of sweet potato was 6.23 per cent and 6.61 per cent for *Adu* and *Berkume* (white and yellow fleshed) varieties, respectively. The result shows that the moisture content of *Bekume* (6.61 per cent) is significantly ($p \leq 0.05$) higher than the moisture content of *Adu* (6.23 per cent) variety. The range of moisture content of both sweet potato varieties is reasonably comparable with the moisture content of cassava and taro flour as reported by Tilahun *et al.* (2013) and Adane *et al.* (2013), respectively.

The low level of moisture content of *Adu* (White fleshed) variety (6.23 per cent) could be related to the extent of drying during the sample preparation stage. This implies that, flour prepared from *Adu* variety has good shelf stability. However, the impact of moisture content on the shelf stability of any food is determined by water activity. The variation of moisture content between the two sweet potato varieties might also be attributed to the inherent differences between the varieties.

The protein content of sweet potatoes analyzed in this study was 2.07 and 2.76 per cent for *Adu* and *Berkume* (white and yellow fleshed) varieties, respectively. The analysis of variance shows that the protein content of the two sweet potato varieties (*Adu and Berkume*) was not significantly ($p \geq 0.05$) different from each other. The protein content of sweet potato varieties registered in the present study is higher than the result reported by Ingabire and Hilda (2011), and in agreement with the result reported by Eleazu and Ironua (2013), however, lower than the protein content of sweet potato cultivars investigated by Ji *et al.* (2011) in the study of analysis of nutrient composition and antioxidant activity of different sweet potato cultivars. The protein content recorded in both sweet potato varieties confirmed as root and tuber crops ~~indicates that these~~ are not good choices to improve the protein content of food during formula development and hence indicates the need for supplementation with other protein-rich foods such as legumes to enrich the protein content of the final product. The result also indicates the need for more quality improvement-breeding programs considering the nutritional value, including protein quantity and quality improvement in development of varieties with good agronomic performance.

The crude fat content of *Adu* and *Berkume* (white and yellow) sweet potato flours was 1.52 and 1.25 per cent, respectively. Analysis of variance shows that there was no significant ($p \geq 0.05$) difference between the crude fat contents of *Adu* and *Berkume* sweet potato varieties. This result is close to the crude fat content reported by Isaac *et al.* (2012), with values ranging from 0.37 to 1.55 per cent for sweet potato flours; however, the fat content of the sweet potato varieties are higher than the fat content reported by Tilahun *et al.* (2013) and Adane *et al.*(2013), in cassava and taro roots, respectively. This implies that sweet potato has good performance in its functionality in various food applications. Generally, the crude fat contents of both sweet potato varieties were comparable to the crude fat contents of many roots and tuber crops like potato and cassava (Udensi *et al.*, 2008).

The crude fiber contents of sweet potato varieties were found to be significantly ($p \leq 0.05$) different from each other. *Berkume* (yellow fleshed) sweet potato had greater crude fiber contents (1.16 per cent) than *Adu* sweet potato (1.04 per cent). The crude fiber content

Variety	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Fiber (%)	CHO (%)	Energy (kcal/100 g)
Adu	6.23 ± 0.02^{c}	5.32 ± 0.09^{a}	2.07 ± 0.13^{b}	1.52 ± 0.16^{b}	1.04 ± 0.02^{b}	90.03 ± 0.21^{b}	382.18 ± 1.16^{c}
Berkume	6.61 ± 0.01^{b}	3.38 ± 0.01^{b}	2.76 ± 0.34^{b}	1.25 ± 0.06^{b}	1.16 ± 0.03^{a}	91.45 ± 0.33^{a}	388.07 ± 0.43^{b}
CV	1.32	3.14	9.52	9.78	5.05	0.43	0.32
LSD	0.23	0.19	0.73	0.35	0.08	0.78	2.51

Notes: CV = coefficient variation; LSD = least significance difference. Values are means ± standard deviation; means followed by the same letter in the column are not significantly different at the 5% level of significance

Table I. Proximate composition of *Adu* and *Berkume* sweet potato flours in dry basis except moisture content recorded in this study is lower than the crude fiber content of sweet potato varieties reported by Ji *et al.* (2011), indicating that these sweet potato varieties are poor sources of dietary fiber. Dietary fiber has recently gained much importance, as it is said to reduce colon cancer, diabetes, heart diseases and the level of low density lipoprotein cholesterol in blood (Rose and Vasanthakaalam, 2011). *Berkume* variety with relatively higher fiber content can be considered in breeding programs to improve other nutritional components to use in development of various functional foods.

The ash contents of sweet potato varieties were significantly ($p \leq 0.05$) different with the value of 5.32 and 3.38 per cent for *Adu* and *Berkum (white and yellow)* sweet potato varieties, respectively. The ash content of sweet potato varieties in our study is lower than the value reported by Olayiwola *et al.* (2009). It is however higher than the value reported by Isaac *et al.* (2012). Total ash content is a reflection of the mineral contents preserved in food material. Therefore, the ash content in the present study suggests that *Adu* sweet potato variety contains an appreciable deposit of dietary minerals.

The total carbohydrate content is significantly ($p \leq 0.05$) lower (90.03) in *Adu* sweet potato variety compared to *Berkume* sweet potato variety having higher value (91.45) as shown in Table I. The carbohydrate content of both sweet potato varieties (90.03-91.45 per cent) is similar to the previous values reported by Astawan and Widowatib (2011) in their evaluation of nutrition and glycemic index of other varieties of sweet potatoes. Furthermore, the value of carbohydrate content recorded in both sweet potato varieties compares favorably with the reported value of 90.54-93.45 per cent while evaluating the proximate composition of two cassava varieties (Tilahun *et al.*, 2013). From the result, one can easily understand that the *Berkume* sweet potato variety is a very good source of carbohydrate. The difference in the carbohydrate content of the two sweet potato varieties might be related to the inherent variation of cultivars.

The gross energy (GE) value of *Adu* sweet potato (409.82 kcal/100 g) is significantly ($p \leq 0.05$) higher than the gross energy value of *Berkume* sweet potato (388.07 kcal/100 g). The gross energy value of sweet potato varieties in the present study is comparable with the value reported by other authors in different root and tuber crops (Udensi *et al.*, 2008; Adane *et al.*, 2013; Tilahun *et al.*, 2013). Higher gross energy value in *Adu* sweet potato variety is accounted by the high crude fat content in the aforementioned sweet potato variety as can be evidenced from the value of crude fat content in Table I.

Effect of variety on the dietary mineral and total carotenoid contents of sweet potatoes

The dietary mineral contents of the flours of sweet potatoes are presented in Table II. The data show that both sweet potato varieties contain significant amounts of dietary mineral nutrients, such as iron (5.09-10.18 mg/100 g), zinc (2.18-3.18mg/100 g), calcium (20.70-25.09mg/100 g), phosphorus (5.54-5.14 mg/100 g), sodium (40.44-42.29 mg/100 g), potassium (175.10-176.17 mg/100 g) and total carotenoid (2.69-3.39mg/kg), and suggests that sweet potato could be used in the human diet for supplying these micronutrients where there is a prevalence of nutritional deficiency of these nutrients through food based-approach. T2

All the dietary mineral nutrients and β-carotene showed significant difference ($p \leq 0.05$) between the two sweet potato varieties. Higher levels for almost all the minerals analyzed in both varieties indicate the importance of both sweet potato varieties as a good source of nutrition for consumers. *Berkume* (yellow fleshed) sweet potato variety contains relatively higher concentration of most mineral nutrients analyzed. However, as compared to the mineral contents recorded in bitter and sweet cassava varieties amounting 30-33(Ca), 52-88 (P), and 18-30(Fe) mg/100 g, the values are lower (Sarkiyayi and Agar, 2010).

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Variety	Fe	Zn	Ca	P	Carotenoids (mg/kg)	Na	K	Na/K	Ca/P
Adu	10.18 ± 0.39^{a}	2.18 ± 0.04^{b}	20.70 ± 0.26^{c}	5.54 ± 0.03^{a}	2.69 ± 0.02^{b}	$40.44^{b} \pm 0.01$	$175.1^{b} \pm 0.01$	0.23	3.74
Berkume	5.09 ± 0.19^{c}	3.18 ± 0.07^{a}	25.09 ± 0.20^{b}	5.14 ± 0.04^{b}	3.39 ± 0.05^{a}	$42.29^{a} \pm 0.01$	$176.17^{a} \pm 0.01$	0.24	4.88
CV	5.86	5.76	1.12	1.39	2.64	0.06	0.04		
LSD	0.95	0.23	0.74	0.13	0.11	0.03	0.13		

Notes: CV = coefficient of variation, LSD = least significance difference; Values are means ± standard deviation; means followed by same letter in the column are not significantly different at the 5% level of significance; Values are means ± standard deviation

Table II. Dietary mineral contents (mg/100 g) and total carotenoid (mg/kg) of improved sweet potatoes

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The iron content estimated in the present study is within the range previously reported in taro root flour Adane *et al.* (2013); however, zinc, calcium and phosphorus are lower while sodium was reported to be higher than its content in *Berkume* sweet potato variety. The iron and zinc contents of sweet potatoes recorded in this study were higher than the iron and zinc contents reported by Olayiwola *et al.* (2009) in sweet potato foods for indigenous consumption in which the iron content ranged from 1.61 to 8.82 mg/100 g and zinc from 0.09 to 0.12 mg/100 g; however, the result reported for calcium content with the range of 20.33-27.99 mg/100 g is closer to the calcium content of sweet potato varieties investigated in this study.

Sodium and potassium contents of sweet potato varieties showed significant ($p \leq 0.05$) differences. ~~Higher~~ sodium content (42.29 mg/100 g) was determined in *Berkume* sweet potato and lower sodium content (40.44 mg/100 g) was registered in *Adu* sweet potato. Potassium content (176.17 mg/100 g) was found to be higher in *Berkume* sweet potato and lower (175.1 mg/100) in *Adu* sweet potato variety.

Potassium was the most abundant dietary mineral (176.17 mg/100 g) which was determined from *Berkume* sweet potato variety, while the lowest concentration of dietary mineral (2.18 mg/100 g) reported was for zinc in the *Adu* sweet potato variety. However, this concentration level of zinc is higher as compared to the zinc content of many plant-based food commodities and implies that this variety has high potential in supplying sufficient quantity of zinc to tackle the prevalence of zinc-related nutritional deficiency problems using food-based approach in a sustainable manner. Iron, zinc and calcium are the main important nutrients for normal healthy, growth and reproduction for human beings. Even though the majority of root crops like sweet potatoes are not appreciable sources of minerals, the above information on the level of each dietary mineral will give sufficient benchmark information to characterize the new sweet potato varieties and consider these data for possibilities of taking into account in subsequent breeding programs.

The total carotenoid contents of the two varieties of sweet potato flour showed significant ($p \leq 0.05$) difference, and higher value (3.39mg/kg) was recorded in *Berkume* (yellow fleshed) sweet potato variety and lower (2.39 mg/kg) was recorded in *Adu* (white fleshed) sweet potato variety. The total carotenoid contents of the two improved varieties of sweet potato were lower than the value reported by Eleazu and Ironua (2013) on their report of physicochemical composition and antioxidant properties of a sweet potato variety. On the other hand, the total carotenoid contents of the sweet potato varieties recorded in this study were higher than the values reported by Ellong *et al.* (2014), with values ranging from 0.01 to 1.47 mg/kg on their report of comparison of physicochemical, organoleptic and nutritional abilities of eight sweet potato varieties.

The ratio of sodium to potassium (Na/K) and that of calcium to phosphorus (Ca/P) are presented in Table II. The ratio of sodium to potassium (Na/K) varied from 0.23 to 0.24 for *Adu* and *Berkume* (white and yellow fleshed) sweet potato varieties, respectively (Table II). The sodium to potassium ratio (Na/K) is of great importance in controlling high blood pressure (Yusuf *et al.*, 2007). As compared to the recommended level of sodium to potassium ratio (Na/K), which is less than 1 (Aremu *et al.*, 2006), the values computed in both sweet potato varieties are good. This indicates that regular consumption of both sweet potato varieties would be beneficial for hypertensive patients to control high blood pressure.

The ratio of calcium to phosphorus (Ca/P) ranged from 3.72 to 4.88 for *Adu* and *Berkume* (white and yellow fleshed) sweet potato varieties, respectively (Table II). These values are greater than the recommended level of Ca/P which is above 1. Food is considered "good" if the ratio of calcium to phosphorus is above one and "poor" if the ratio is less than 0.5 (Nieman *et al.*, 1992). Low Ca/P ratio (low calcium and high phosphorus intake) more than the normal amount of calcium may be lost in the urine, lowering the calcium concentration in bones. The Ca/P ratio (3.72-4.88) in this study is greater than 1, indicating that both sweet potato varieties can serve as a good source of minerals (calcium and phosphorus) for bone formation.

Effect of variety on the antinutrient content and implication on the bioavailability of sweet potatoes

T3 The antinutrient compositions of improved sweet potatoes are indicated in Table III. The tannin content of *Adu* sweet potato variety (12.94 mg/100 g) is significantly ($p \leq 0.05$) higher than the tannin content in *Berkume* sweet potatoes variety (9.94 mg/100 g). The tannin content recorded in this study is higher than the value reported by Sarkiyayi and Agar (2010) and Tilahun *et al.* (2013) in sweet and bitter cassava varieties. However, the tannin content of both sweet potato varieties in the present investigation is much lower than the tannin content reported in taro corms (Adane *et al.*, 2013).

One can easily understand that *Berkume* sweet potato variety with lower tannin content (9.94 mg/100 g) is nutritionally preferable from the nutrient utilization point of view. Tannins exert a negative effect on the bioavailability of proteins, minerals, particularly iron, by precipitating proteins, inhibiting digestive enzymes, interfering with mineral absorption (iron), affecting utilization of vitamins in plant-based foods; foods containing high tannin content are considered to be of low nutritional quality (Tinko and Uyano, 2001) and this implies that *Berkume* is preferable for its low tannin content.

Likewise, the phytic acid content of the two sweet potato varieties was significantly ($p \leq 0.05$) different from each other. The phytic acid of sweet potatoes in this study ranged from 0.31 to 0.24 mg/100 g for *Adu* and *Berkume* sweet potatoes varieties. The value of phytic acid in this investigation is in agreement with the work of Olayiwola *et al.* (2009) who reported low levels of tannin and phytic acid of sweet potato. On the other hand, the phytic acid level of both sweet potato varieties in this study is much lower than the value reported in other roots and tuber crops such as cassava and taro (Tilahun *et al.*, 2013; Adane *et al.*, 2013).

Even though phytic acid usually forms insoluble salts with mineral elements such as calcium, zinc and iron to prevent their bioavailability and subsequent utilization by the body, the low content of this antinutrient in both sweet potato varieties in the present study would therefore permit the absorption of these elements. Hence, low value of phytic acid registered in this study is of acceptable nutritional quality in terms of the level of phytic acid concentration as compared to many other roots and tuber crops.

The molar ratios, namely, phytate:calcium (Phy:Ca), phytate:zinc (Phy:Zn), phytate:iron (Phy:Fe), are presented in Table III. Higher value (0.00091 ± 0.01) for Phy:Ca molar ratio was recorded in *Adu* sweet potato variety where this value is by far below the critical molar ratio of 0.17 (Umeta *et al.*, 2005). The critical molar ratio for Phy:Zn is 15 (WHO, 1996) and the higher value registered in both sweet potato varieties is 0.0136 ± 0.01 which is

Variety	Tannin (mg/100 g)	Phytic acid (mg/100 g)	Phytate: Ca (Molar ratio)	Phytate: Zn (Molar ratio)	Phytate: Fe (Molar ratio)
Adu	12.94 ± 0.30a	0.31 ± 0.01a	0.00091 ± 0.01	0.0136 ± 0.01	0.00258 ± 0.01
Berkume	9.98 ± 0.26b	0.24 ± 0.01b	0.00058 ± 0.01	0.0119 ± 0.01	0.00399 ± 0.01
CV	4.15	5.68	2.01	2.25	2.10
LSD	0.83	0.02	0.24	0.56	0.26

Table III. Antinutrient contents and molar ratio of phytic acid to dietary minerals of improved sweet potato varieties insignificant to compromise zinc absorption. Furthermore, the molar ratios of Phy:Fe in both sweet potato varieties is below 1, the level which is said to be adequate for iron absorption (Hurrell, 2004). In general, both phytate contents and molar ratios Phy:Ca, Phy:Zn and Phy:Fe in both sweet potato varieties were by far below the level likely to inhibit the absorption of these minerals as compared to the cutoff values.

Conclusion

The study aimed to investigate the nutrient and antinutrient compositions of two improved sweet potato varieties released for drought-prone areas of Ethiopia. It is confirmed that both sweet potato varieties are good, both in their nutrient and antinutrient contents. However, *Berkume* (yellow fleshed) sweet potato variety has high nutritional potential both in macro and micronutrients as compared to the nutrient content of many roots and tuber crops listed in FAO database. Moreover, this variety contains lower contents of antinutrients which cannot significantly interfere with the bioavailability and absorption of essential nutrients. Therefore, one can easily observe that this variety has high potential to be used in value-added sweet potato products. Further work needs to be carried out on the possibility of developing value-added sweet potato products using *Berkume* sweet potato variety by blending with other food ingredients.

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