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Nutrient and Anti-Nutrient Profiles of Landraces, Released and Introduced Sorghum Varieties Grown In Different Agro-Ecologies of Ethiopia

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ABSTRACT

This study aimed at evaluating the proximate composition and tannin content of improved and local sorghum varieties grown in the lowland, intermediate and highland agro-ecologies of Ethiopia. Thirty-four sorghum varieties (6 introduced, 19 released and 9 landraces) were collected and prepared for nutrient and anti-nutrient analysis. The result showed that a significant variation was noticed among the varieties for protein, ash, minerals and tannin contents but did not differ significantly for moisture content. Wetet begunchie variety had the highest crude protein (12.74%) and zinc (30.19 mg/Kg) contents. The landrace variety, 2372 showed the highest iron content and significantly varied from others. A range of 1.47 to 3.1% total mineral content was observed with the largest for the released variety, Wetet begunchie and the lowest for the highland sorghum variety, Chelenko. The tannin content of the samples ranged from non-detectable to 46606 mg per Kg, the highest for the landraces.

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Introduction

Sorghum has been widely grown in tropical and subtropical regions. In addition to its agronomic advantages, which thrives with less rainfall, the grain is gluten free, high in resistant starch and good source of nutrients, and bioactive phenolic such as phenolic acids, flavonoids, and tannins being the dominant groups [1,5]. The sorghum grain is a principal source of energy, protein, vitamins and micronutrients for the people of semi-arid tropics which could contribute for optimal health, growth, and development And is used to make foods such as bread and porridges.

There is a substantial disparity in sorghum varieties for levels of proteins, lysine, lipids, carbohydrates, fiber, calcium, phosphorus, iron, thiamine, and niacin [6]. Efforts are being made to improve the nutritional aspects such as mineral elements like iron, and zinc [7]. Actually, understanding of the chemical composition of foods is crucial to estimate nutrient intake adequacy and nutritional status and health of individuals [8]. In addition, the knowledge of variation in nutrient concentration of different groups of genotypes is important to support plant breeding programs to develop grain cultivars with high nutrient value.

Hence, determination of nutritional composition in sorghum is of paramount importance for improving malnutrition caused by lack of mineral elements, protein, and vitamins in food stuff [9,10]. Reported that breeding for higher concentrations of minerals in

food crops is an alternative method for improving the health of humans suffering from the consequences of mineral deficiency. [11] Obtained a range of 7-19% total protein content for 280 genotypes. In a large number of sorghum accessions, a range of 8.1-18.8% for protein, 1-4.3% for fat, and 61.7-71.1% for starch contents were noticed [12].

Most of the sorghum cultivars grown in lowland areas of Ethiopia contained only 9–11% protein content. The chemical composition of sorghum landraces collected from the western regions of Ethiopia has not yet been adequately studied to meet the needs of growers, consumers, and traders of sorghum for both food and industrial uses. Therefore, exploration of available genetic variation in landraces for chemical composition requires the identification of sorghum accessions before inclusion in sorghum breeding programs. Hence, the objective of this study was to determine the genetic variation in protein, crude fat, mineral composition, and tannin contents among lowland sorghum varieties in Ethiopia.

Materials and Methods

Sorghum Grain Collection and Preparation

Thirty-four (9 landraces, 6 introduced and 19) released sorghum varieties were collected from the National Sorghum Breeding Program, Melkassa Agricultural Research Center (Table 1). The sorghum grains were cleaned to remove all extraneous material. Cleaned sorghum grains were subjected to milling in laboratory grinding mill. A whole sorghum flour was used for nutrient composition determination.

Table 1: List and Classification of Collected Sorghum Samples and Its Agro-Ecology

Name	Classification			
	Introduced	Landrace	Released/improved	Agro-ecology
Melkam			✓	Lowland
AL 70			✓	Highland
Framida	✓			Lowland
B35	✓			Lowland
E36-1	✓			Lowland
Wetetbegunchie		✓		Lowland
Jigurti		✓		Lowland
Macia			✓	Lowland
Redswazi			✓	Lowland
Kari Mtama 1	✓			Lowland
13 Sudan int # 10-1	✓			Lowland
Misikir			✓	Lowland
ETS 2752			✓	Highland
76 T1#23			✓	Lowland
IS9302			✓	Intermediate
Seredo			✓	Lowland
Birimash			✓	Intermediate
Chiro			✓	Highland
Baji			✓	Intermediate
Abshir			✓	Lowland
Chelenko			✓	Highland
Geremew			✓	Intermediate
IS 25542		✓		Highland
IS 38331		✓		Highland
IS 255351		✓		Highland
IS 25555		✓		Highland
Jimma Local-2		✓		Intermediate
SRN-39	✓			Lowland
99 MI 5081			✓	Lowland
IS 25434		✓		Highland
2372		✓		Lowland
Meko-1			✓	Lowland
Gambella 1107			✓	Lowland
Gubiye			✓	Lowland

Moisture content determination

The amount of water present in a sample was determined according to the official method [18]. The empty petridishes were oven dried for 1h at 105 °C, transferred to the desiccators cooled for 30 min, and weighed. The prepared beans flours were mixed thoroughly. About 2.00g of fresh samples were put into the previously dried and weighed petridishes. The dishes and their contents were placed in the drying oven and allowed to dry for 1h at 105°C. Then, after drying, the petridishes and their contents were taken out of the oven and cooled in desiccators and reweighed.

$$\% \text{ Moisture} = \left(\frac{\text{weight wet sample} - \text{weight of dry sample}}{\text{weight of wet sample}} \right) \times 100$$

Protein content determination

The Kjeldahl method was used according to Method 981.10 [18]. Approximately 1 g of sorghum flour was hydrolyzed with 5 mL concentrated sulfuric acid (H_2SO_4) containing 1 g copper catalyst in a heat block at 420 °C for 3 hr to convert the protein nitrogen to $(NH_4)_2SO_4$. After cooling, water was added to the hydrolysates before neutralization and titration to avoid mixing concentrated alkali with concentrated acid and top prevent the digest from solidification. After digestion, the samples were distilled in the presence of boric acid and finally titrated with 0.1N HCl and the volume used for titration was recorded. Sample nitrogen content was calculated using the following formula and finally, the amount of total nitrogen in the flour was multiplied by the conversion factor of 6.25.

$$\%N = \frac{(V_t - V_b) * N * V_1 * 0.014 * 100}{V_2 * m}$$

where, V_t , V_b , V_1 , V_2 represents volume of titrant, blank, total volume of sample prepared and volume of sample used for titration respectively and m represents mass of sample.

Ash determination

The ash content was determined according to the Method 923.03 [19]. Five (5g) of sample was ignited in muffle furnace at 550 °C for 15 hr. The data was calculated as follows;
Weight of Ash = (weight of crucible & ash) – (weight of crucible)
% Ash (wet basis) = (weight of ash/original sample weight)

Mineral analysis

The method described by was used for mineral analysis [20]. Two gram (2g) flour samples were weighed, placed into porcelain crucibles, and oven-dried in a muffle furnace at 550°C to avoid contaminants for 3 hr after which samples were acid-digested by addition of 3 mL of 3M HNO_3 after cooling for determination of zinc (Zn) and iron (Fe). The acid was evaporated to dry from the samples using a sand bath and oven-dried in the muffle furnace again. A total of 10 mL of 1:2 v/v 55% HNO_3 solution was added to the samples to moisten them and were placed in the sand bath for 5 - 10 min to warm it up. The samples were stirred in porcelain crucibles using glass rods and transferred into 100 mL volumetric flasks. The samples were shaken immediately and allowed to dissolve overnight to extract the minerals. The samples were then transferred into glass test tubes and diluted with distilled water. Mineral elements (Fe and Zn) were determined by atomic absorption spectrophotometer.

Tannin determination

Vanillin/HCl method was used to determine the tannin content as described by Price et al. (1978). Just before the reaction, the reagent was prepared by mixing equal portions of methanol solutions of 8% HCl and 1% vanillin. Aliquots of 0.1 mL of sorghum extracts and 0.2 mL of vanillin/HCl reagent were well mixed in

a microplate. The plate was incubated at 30 °C for 20 min and the absorbance was read at 500 nm using UV-Spectrophotometer.

Data collection and analysis

A duplicate data was used and analyzed using Statistix 10.0 and Tukey's multiple comparison tests was used to determine the significance of variation between treatments at 95% confidence level. Results were given as mean \pm standard deviation.

Results and discussion

The proximate composition of 34 sorghum samples of which six introduced, nine landraces and nineteen released varieties are indicated in Table 1. A non-significant ($p>0.05$) variation was noticed among the investigated samples in their moisture content. A range of 8.88 to 10.72% moisture content was observed, with highest for IS 255351 landrace and the lowest for the ETS 2752 landraces. The released sorghum varieties had the lowest moisture content compared to the landraces. Among the released sorghum varieties, respectively Chiro (10.15%) and Misikir (9.03%) had the highest and the lowest moisture content. Framida (12.85%) and Wetet begunchie (12.84%) insignificantly differed and showed the highest, whereas Chiro and Geremew had the lowest protein content. The total mineral content of the samples ranged from 1.47 to 3.1% with the highest for Wetetbegunchie, which is a landrace potentially grown in lowland area and the lowest for Chelenko, which is released for the highland agro-ecology. Most of the introduced sorghum varieties showed the better ash content than that of the improved and the landraces. Framida (2.94%) and Wetetbegunchie (3.1%) had the larger, and Geremew and Chelenko the lowest ash content with a non-significant difference.

Iron, which is a major component of hemoglobin and naturally present in sorghum grain ranged from 15.71 to 80.58 mg per Kg of sample. A range of 11.69 to 31.06 mg/Kg of zinc was observed among the experimental samples. The introduced varieties, E36-1 and 13 Sudan int # 10-1 exhibited the highest and the lowest content of mineral zinc. Redswazi, Abshir, AL 70, Gambella 1107 and Gubiye released sorghum varieties differed insignificantly in their zinc content. The condensed tannin content of the varieties ranged from non-detectable to 46606 mg per Kg. The landraces showed the highest tannin content than the others. The highest tannin indicates that it could be used to prevent oxidation, fight inflammation, and help to balance blood sugar levels. The difference in nutrient and anti-nutrient composition might be due to genetic variability and agro-ecology in which the varieties grown.

Tasie and Gebreyes (2020) reported a range of 1.12 to 2.29% for ash and 8.2 to 16.47% for crude protein contents of sorghum varieties grown in Ethiopia which is similar result with the present study. Zinc and iron contents of Ethiopian sorghum variety were ranged from 0.69 to 6.48 mg/100g and 2.26 to 14.08 mg/100g, respectively [14]. In a study of Brazilian sorghum cultivars, the tannin content was ranged from 4.4 to 72 mg/g of dry weight sample [15].

Table 1: Proximate composition, minerals and tannin contents of landraces and improved sorghum varieties

Variety	Moisture, %	Protein, %	Ash, %	Fe, mg/Kg	Zn, mg/Kg	Tannin, mg/Kg
13 Sudan int # 10-1	9.75±0.35 ^a	11.06±0.79 ^{a-g}	1.72±0.17 ^{k-n}	27.66±0.47 ^{hi}	11.69±0.85 ^o	13.45±3.34 ^v
2372	9.26±0.62 ^a	10.85±0.16 ^{b-h}	2.05±0.08 ^{efg}	80.58±0.82 ^a	24.85±0.20 ^{cdc}	ND
76 T1#23	9.35±0.21 ^a	11.13±0.33 ^{a-g}	2.25±0.07 ^{cde}	25.28±0.55 ^{ijk}	18.26±0.79 ^{k-n}	64.34±1.36 ^u
99 MI 5081	9.91±0.29 ^a	11.29±0.41 ^{a-f}	1.95±0.07 ^{fj}	23.55±0.63 ^{j-m}	18.80±0.28 ^{j-n}	ND
Abshir	9.68±0.19 ^a	12.17±0.24 ^{abc}	1.85±0.06 ^{se-l}	33.82±0.09 ^{d-g}	28.14±0.06 ^{a-d}	6367.6±3.26 ⁱ
AL 70	9.44±0.62 ^a	11.49±0.65 ^{a-f}	2.17±0.11 ^{cde}	34.07±0.39 ^{def}	29.74±0.37 ^{ab}	2661.9±5.68 ^o
B35	9.78±0.29 ^a	10.26±0.37 ^{e-j}	2.27±0.03 ^{cd}	50.47±0.17 ^c	23.14±0.36 ^{e-i}	1060.1±4.31 ^q
Baji	9.20±0.14 ^a	8.42±0.25 ^{klm}	1.76±0.09 ^{j-n}	32.93±0.87 ^{efg}	23.25±0.57 ^{e-i}	3836.1±1.81 ^l
Birimash	10.08±0.3 ^a	8.47±0.66 ^{j-m}	1.75±0.08 ^{j-n}	25.55±0.62 ^{ijk}	22.03±0.88 ^{f-k}	6448.6±54.85 ^h
Chelenko	9.42±0.17 ^a	8.88±0.02 ^{i-m}	1.47±0.04 ^o	21.03±0.38 ^{lmn}	17.86±0.51 ^{lmn}	3028.4±1.51 ^m
Chiro	10.15±0.29 ^a	7.10±0.19 ^m	1.67±0.06 ^{l-o}	24.12±1.4 ^{i-l}	15.11±0.77 ^{no}	5222.2±16.46 ^j
E36-1	9.67±0.46 ^a	10.40±0.57 ^{e-i}	2.15±0.07 ^{c-f}	30.68±0.44 ^{fgh}	31.06±0.88 ^a	367.85±2.61 ^s
ETS 2752	8.88±0.17 ^a	9.13±0.19 ^{b-l}	1.80±0.12 ^{h-m}	74.31±1.13 ^b	24.21±0.26 ^{e-h}	133.03±3.28 ^t
Framida	9.49±0.69 ^a	12.85±0.68 ^a	2.94±0.08 ^a	36.19±0.47 ^{de}	30.41±0.45 ^a	11089±9.54 ^g
Gambella 1107	9.23±0.66 ^a	10.80±0.00 ^{b-h}	2.31±0.16 ^c	36.74±1.75 ^d	28.48±0.17 ^{abc}	ND
Geremew	9.51±0.13 ^a	7.93±0.09 ^{lm}	1.570.04 ^{no}	51.97±1.49 ^c	19.94±0.22 ^{j-m}	2723.4±4.1 ⁿ
Gubiye	9.19±0.27 ^a	11.78±0.54 ^{a-e}	2.30±0.16 ^c	32.93±1.18 ^{efg}	30.08±0.45 ^{ab}	ND
IS 25434	10.17±0.72 ^a	9.45±0.18 ^{g-l}	1.68±0.04 ^{lmn}	25.30±0.98 ^{ijk}	24.15±3.04 ^{e-h}	46606±7.07 ^a
IS 255351	10.72±0.95 ^a	9.17±0.32 ^{h-l}	1.79±0.12 ^{h-m}	22.24±1.35 ^{k-n}	17.06±0.08 ^{mn}	30305±10.6 ^b
IS 25542	9.22±0.25 ^a	9.48±0.16 ^{g-l}	1.75±0.07 ^{j-n}	25.24±1.07 ^{ijk}	22.49±0.71 ^{f-j}	24023±0.45 ^d
IS 25555	10.15±0.21 ^a	9.38±0.53 ^{g-l}	1.77±0.00 ^{h-n}	22.65±0.49 ^{j-n}	16.73±0.38 ^{mn}	28178±7.77 ^c
IS 38331	9.83±1.17 ^a	8.50±0.7 ^{klm}	1.75±0.1 ^{j-n}	15.71±0.4 ^o	12.79±0.29 ^o	ND
IS9302	9.79±0.3 ^a	8.65±0.52 ^{i-m}	1.72±0.04 ^{k-n}	30.21±0.47 ^{gh}	26.40±0.59 ^{b-c}	4793.6±2.7 ^k
Jigurti	9.33±0.47 ^a	10.82±0.39 ^{b-h}	2.53±0.12 ^b	25.37±0.87 ^{ijk}	24.19±0.28 ^{e-h}	568.36±5.3 ^r
Jimma Local-2	9.71±0.4 ^a	8.68±0.45 ^{i-m}	1.82±0.03 ^{h-m}	19.88±0.17 ^{mn}	17.50±0.57 ^{lmn}	18581±19.79 ^k
Kari Mtama 1	9.79±0.27 ^a	12.13±0.17 ^{a-d}	2.07±0.1 ^{def}	24.11±0.55 ^{i-l}	20.55±1.62 ^{h-m}	34.28±1.2 ^{uv}
Macia	9.50±0.14 ^a	10.82±0.11 ^{b-h}	2.32±0.03 ^c	30.68±0.44 ^{fgh}	25.49±0.72 ^{c-f}	141.43±3.1 ^t
Meko-1	9.73±0.35 ^a	11.09±0.93 ^{a-g}	1.96±0.08 ^{f-i}	30.95±1.25 ^{fgh}	24.54±1.57 ^{d-g}	ND
MelKam	9.10±0.19 ^a	10.36±0.55 ^{d-i}	2.06±0.09 ^{ef}	30.56±0.76 ^{fgh}	22.32±1.69 ^{f-j}	2.98±0.02 ^v
Misikir	9.03±0.04 ^a	8.93±0.1 ^{i-l}	1.97±0.04 ^{fgh}	24.93±0.5 ^{ijk}	21.19±1.71 ^{g-l}	12±2.12 ^v
Redswazi	9.35±0.35 ^a	12.45±0.64 ^{ab}	2.33±0.09 ^{bc}	31.63±0.51 ^{fg}	30.64±0.50 ^a	3021. ±92.4 ^m
Seredo	9.24±0.32 ^a	10.04±0.08 ^{f-j}	1.89±0.07 ^{g-k}	25.78±0.68 ^{ij}	26.32±0.77 ^{cde}	2515.3±4.44 ^p
SRN-39	9.29±0.41 ^a	9.87±0.53 ^{f-k}	1.62±0.1 ^{mno}	19.64±0.75 ⁿ	17.45±0.75 ^{lmn}	ND
Weter begunchie	9.12±1.1 ^{aa}	12.74±0.33 ^a	3.10±0.28 ^a	32.58±0.58 ^{efg}	30.19±1.15 ^{ab}	22544±2.23 ^c

The results are expressed in wet basis. Mean ± SD with different superscripts in a column varied significantly (p < 0.05) between sorghum varieties. ND, not detected.

Table 2: Proximate composition, minerals and tannin contents of landraces

Variety	Moisture, %	Protein, %	Ash, %	Fe, mg/Kg	Zn, mg/Kg	Tannin, mg/Kg
2372	9.26±0.62 ^a	10.85±0.16 ^b	2.05±0.08 ^{bc}	80.58±0.82 ^a	24.85±0.20 ^b	ND
IS 25434	10.17±0.72 ^a	9.45±0.18 ^{bc}	1.68±0.04 ^c	25.30±0.98 ^c	24.15±3.04 ^b	46606±7.07 ^a
IS 255351	10.72±0.95 ^a	9.17±0.32 ^c	1.79±0.12 ^c	22.24±1.35 ^{cd}	17.06±0.08 ^{cd}	30305±10.6 ^{ab}
IS 25542	9.22±0.25 ^a	9.48±0.16 ^{bc}	1.75±0.07 ^c	25.24±1.07 ^c	22.49±0.71 ^b	24023±0.45 ^{bc}
IS 25555	10.15±0.21 ^a	9.38±0.53 ^{bc}	1.77±0.00 ^c	22.65±0.49 ^{cd}	16.73±0.38 ^{cd}	28178±7.77 ^{abc}
IS 38331	9.83±1.17 ^a	8.50±0.7 ^c	1.75±0.1 ^c	15.71±0.4 ^c	12.79±0.29 ^d	ND
Jigurti	9.33±0.47 ^a	10.82±0.39 ^b	2.53±0.12 ^b	25.37±0.87 ^c	24.19±0.28 ^b	568.36±5.3 ^c
Jimma Local-2	9.71±0.4 ^a	8.68±0.45 ^c	1.82±0.03 ^c	19.88±0.17 ^d	17.50±0.57 ^c	18581±19.79 ^d
Weter begunchie	9.12±1.1 ^{aa}	12.74±0.33 ^a	3.10±0.28 ^a	32.58±0.58 ^b	30.19±1.15 ^a	22544±2.23 ^{cd}

The results are expressed in wet basis. Mean ± SD with different superscripts in a column varied significantly (p < 0.05) between sorghum varieties. ND, not detected.

Table 3: Proximate composition, minerals and tannin contents of improved sorghum varieties

Variety	Moisture, %	Protein, %	Ash, %	Fe, mg/Kg	Zn, mg/Kg	Tannin, mg/Kg
Abshir	9.68±0.19 ^a	12.17±0.24 ^a	1.85±0.06 ^{c-h}	33.82±1.09 ^{cd}	28.14±0.06 ^{abc}	6367.6±3.26 ^b
AL 70	9.44±0.62 ^a	11.49±0.65 ^{ab}	2.17±0.11 ^{a-c}	34.07±1.39 ^{cd}	29.74±0.37 ^{ab}	2661.9±5.68 ^h
Baji	9.20±0.14 ^a	8.42±0.25 ^{efg}	1.76±0.09 ^{fi}	32.93±0.87 ^{cd}	23.25±0.57 ^{d-g}	3836.1±1.81 ^e
Chelenko	9.42±0.17 ^a	8.88±0.02 ^{def}	1.47±0.04 ⁱ	21.03±0.38 ^f	17.86±0.51 ^{ij}	3028.4±1.51 ^f
Chiro	10.15±0.29 ^a	7.10±0.19 ^g	1.67±0.06 ^{ghi}	24.12±1.4 ^{ef}	15.11±0.77 ^j	5222.2±16.46 ^c
Birimash	10.08±0.31 ^a	8.47±0.66 ^{efg}	1.75±0.08 ^{fi}	25.55±0.62 ^{ijk}	22.03±0.88 ^{c-h}	6448.6±54.85 ^a
Gambella 1107	9.23±0.66 ^a	10.80±0.00 ^{abc}	2.31±0.16 ^{abc}	36.74±1.75 ^c	28.48±0.17 ^{abc}	ND
Geremew	9.51±0.13 ^a	7.93±0.09 ^{fg}	1.57±0.04 ^{hi}	51.97±1.49 ^b	19.94±0.22 ^{ghi}	2723.4±4.1 ^g
Gubiye	9.19±0.27 ^a	11.78±0.54 ^{ab}	2.30±0.16 ^{a-d}	32.93±1.18 ^a	30.08±0.45 ^a	ND
Macia	9.50±0.14 ^a	10.82±0.11 ^{abc}	2.32±0.03 ^{ab}	30.68±0.44 ^d	25.49±0.72 ^{cde}	141.43±3.1 ^j
Meko-1	9.73±0.35 ^a	11.09±0.93 ^{ab}	1.96±0.08 ^{c-g}	30.95±1.25 ^d	24.54±1.57 ^{def}	ND
Melkam	9.10±0.19 ^a	10.36±0.55 ^{bcd}	2.06±0.09 ^{a-f}	30.56±0.76 ^d	22.32±1.69 ^{efg}	2.98±0.02 ⁱ
Misikir	9.03±0.04 ^a	8.93±0.1 ^{def}	1.97±0.04 ^{b-g}	24.93±0.5 ^{ef}	21.19±1.71 ^{f-i}	12±2.12 ^{kl}
Redswazi	9.35±0.35 ^a	12.45±0.64 ^a	2.33±0.09 ^a	31.63±0.51 ^d	30.64±0.50 ^a	3021.9±2.4 ^f
99 MI 5081	9.91±0.29 ^a	11.29±0.41 ^{ab}	1.95±0.07 ^{d-g}	23.55±0.63 ^{ef}	18.80±0.28 ^{hi}	ND
Seredo	9.24±0.32 ^a	10.04±0.08 ^{b-c}	1.88±0.07 ^{efg}	25.68±0.68 ^e	26.26±0.77 ^b	2515.3±4.44 ⁱ
ETS 2752	8.88±0.17 ^a	9.13±0.19 ^{c-f}	1.80±0.12 ^{fi}	74.31±1.13 ^a	24.21±0.26 ^{def}	133.03±3.28 ^j
76 T1#23	9.35±0.2 ^a	11.13±0.33 ^{ab}	2.25±0.07 ^{a-d}	25.28±0.55 ^e	18.26±0.79 ^{ij}	64.34±1.36 ^k
IS9302	9.79±0.3 ^a	8.65±0.52 ^{d-g}	1.72±0.04 ^{fi}	30.21±0.47 ^d	26.40±0.59 ^{bcd}	4793.6±2.7 ^d

The results are expressed in wet basis. Mean ± SD with different superscripts in a column varied significantly (p < 0.05) between sorghum varieties. ND, not detected.

Table 4: Proximate composition, minerals and tannin contents of introduced sorghum varieties

Variety	Moisture, %	Protein, %	Ash, %	Fe, mg/Kg	Zn, mg/Kg	Tannin, mg/Kg
13 Sudan int # 10-1	9.75±0.35 ^a	11.06±0.79 ^{abc}	1.72±0.17 ^{cd}	27.66±0.47 ^d	11.69±0.85 ^d	13.45±3.34 ^e
B35	9.78±0.29 ^a	10.26±0.37 ^{bc}	2.27±0.03 ^b	50.47±0.17 ^a	23.14±0.36 ^b	1060±4.31 ^b
E36-1	9.67±0.46 ^a	10.40±0.57 ^{bc}	2.15±0.07 ^b	30.68±0.44 ^c	31.06±0.88 ^a	367.85±2.61 ^c
Framida	9.49±0.69 ^a	12.85±0.68 ^a	2.94±0.08 ^a	36.19±0.47 ^b	30.41±0.45 ^a	11089±9.54 ^a
Kari Mtama 1	9.79±0.27 ^a	12.13±0.17 ^{ab}	2.07±0.1 ^{bc}	24.11±0.55 ^e	20.55±1.62 ^{bc}	34.28±1.2 ^d
SRN-39	9.29±0.41 ^a	9.87±0.53 ^c	1.62±0.1 ^d	19.64±0.75 ^f	17.45±0.75 ^c	ND

The results are expressed in wet basis. Mean ± SD with different superscripts in a column varied significantly (p < 0.05) between sorghum varieties. ND, not detected.

When statistically analyzed separately, the introduced, landraces and released sorghum varieties did show a significant variation for its nutrient and anti-nutrient contents (Table 2, Table 3 and Table 4). A range of 8.5 to 12.13% for crude protein, 1.62 to 2.53% for total minerals, 15.71 to 80.58 mg per Kg for iron, 11.69 to 31.06 mg per Kg for zinc and from non-detectable to 46606 mg per Kg for tannin contents were noticed among the landraces. Similarly, the improved sorghum varieties ranged 7.93 to 12.85% for crude protein, 1.47 to 3.1% for ash, 21.03 to 51.97 mg per Kg for iron, 15.11 to 30.64 mg per Kg for zinc, and 2.98 to 22544 mg per Kg for tannin contents. Geremew exhibited the least crude protein content among the improved varieties. Framida had the highest crude protein, ash, zinc and tannin contents, respectively 12.85%, 2.94%, 30.41 mg/Kg and 11089 mg/Kg (Table 4) with Framida had the highest tannin content.

Conclusion

Compared to others, the landraces had the highest protein and tannin contents. The introduced variety, Framida had the highest total mineral and zinc contents, whereas the landrace, 2372 had the highest iron content. Redswazi and Wetet begunchie showed the largest crude protein content.

Conflict of Interest

The author declares no conflict of interest.

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