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THE NUTRITIVE VALUE OF TWO SORGHUM CULTIVAR

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ABSTRACT

The study was conducted to investigate chemical composition, protein fractions, mineral profile, tannin content, in *vitro* protein digestibility, and amino acids content of two Sudanese sorghum cultivar (namely feterita and dabar). Chemical composition of the two sorghum cultivars was determined. Feterita cultivar showed significantly ($p<0.05$) high moisture, ash, protein, fiber, and fat while dabar cultivar was significantly higher ($P<0.05$) in carbohydrate contents. The proteins in sorghum were classified into five fractions based on their solubility in different solutions. Feterita showed significantly ($p<0.05$) high globulin and glutelin contents while dabar showed significantly ($p<0.05$) high albumin and residual content. Prolamin (kafirins) represented a considerably greater fraction in both cultivars. Cupper, calcium, iron, phosphorus, potassium, and sodium were determined for the two cultivars. Results revealed that, feterita was significantly higher ($P<0.05$) in cupper, iron, and sodium while dabar was significantly higher ($P<0.05$) in phosphorus, calcium and potassium content. Tannin content in feterita was significantly ($P<0.05$) higher compared to dabar. Regarding *in vitro* protein digestibility (IVPD), dabar (non-tannin) significantly ($P<0.05$) high IVPD compared to feterita (tannin).Inverse relationship was detected between tannin content and IVPD for both cultivars. The essential amino acids content results of both cultivar showed that dabar had the higest amount of threonine, metheonine, valine, tyrosine, and lysine, respectively. While Feterita had the highest amount of isoleucine, leucine, and phenylalanine. Amino acid analysis revealed that both sorghum cultivars protein is rich in glutamic acid, leucien, alanine, and proline, but deficient in lysine similar to other cereal.

Key words: sorghum, mineral, tannin, IVPD, amino acid.

INTRODUCTION

Protein Energy Malnutrition (PEM) continues to be major nutritional problem resulting from undernutrition that affects children in most of the developing world (Muller and Krawinkle, 2008) .The most recent estimates show that more than one billion people worldwide are under nourished (Food and Agriculture Organization (FAO) 2009), Africa is home to over 70 billion undernourished children (World Food Programme (WFP) 2008). In this region, poverty causes food shortages and most vulnerable populations survive predominantly on starchy staples such as maize, wheat, rice, sorghum, millet, and cassava, with little or no meat and dairy products (Mayer, Pfiffer and Beyer 2008). The protein nutritional quality of these staple foods is poor and lysine is the most limiting amino acid (United State Department of Agriculture (USDA) 2008). Among the plant food, cereal are grown over 73.5% of the world harvested area. Diets in developing countries are based mainly on cereal and legumes. Cereal grains contributed over 60% of the world food production and along with pulses and oilseeds form a major bulk of dietary protein, calories, vitamins and minerals to the world population in general and to the developing world in particular (Chavan and Kadam, 1989). With increasing dependence upon cereal grains to provide both energy and protein requirement of human in developing countries, the need for raising the overall nutritional value of cereal grain has become increasingly important and much effort has been made to improve the amount and quality of cereal nutrient .Sorghum (*Sorghum bicolor* (L.) Moench) is considered as one of the most important food crops in the world, following wheat, rice, maize and barley (FAO, 2006). Sorghum provides the staple food of a large population in Africa, India and the semi-arid parts of the tropics. It is commonly consumed by the poor masses of many countries and it forms a major source of proteins and calories in the diet of large segments of the population of India and Africa. Processed sorghum seeds or flour were found to be important sources of calories and proteins to the vast majority of the population as well as for poultry and livestock (FAO, 2006). Sorghum acts as a principal source of energy,

proteins, vitamins and minerals for millions of the poorest people living in Africa, Asia and the Semi-arid tropics worldwide (Mauder, 2006). It is a gluten-free cereal used as whole grain as well as ground fl our and it is a source of energy, protein, vitamins, minerals, and nutraceuticals such as antioxidant phenolics and cholesterol-lowering waxes (Taylor et al., 2006). Grain quality varies among different types of sorghum and their cultivated environments. Genetic improvement of grain quality can help sorghum to adapt to varying demands for end-use products. Unfortunately, sorghum has low nutritional value and inferior organoleptic qualities due to the presence of anti-nutritional factors which forms complexes with food ingredients (Reed, 1995). In addition, *in vivo* and *in vitro* studies indicate that the proteins of wet cooked sorghum are significantly less digestible than the proteins of other similar cooked cereals such as wheat and maize (Davidson *et al*., 1979; Guathier *et al*. 1982). The factors responsible for poor sorghum protein digestibility are divided into exogenous factors (grain organizational structure, polyphenols, phytic acid, and starch and non-starch polysaccharides) and endogenous factors (disulphide and non-disulphide cross-linking, kafirin hydrophobicity and changes in protein secondary structure. Grains of most cereal species, like wheat, maize and sorghum, which represent the world's largest providers of food and consequently important economical commodities, contain inadequate levels of some essential amino acids, particularly lysine, threonine, tryptophan and methionine. Wide variability has been observed in the essential amino acid composition of sorghum protein, probably because the crop is grown under diverse agroclimatic conditions which affect the grain composition (FAO, 1995). Lysine content was reported to vary from 71 to 212 mg per gram of nitrogen and the corresponding chemical score varied from 21 to 62. The methionine and tryptophan content on average are 87 and 63 mg per gram of nitrogen. These deficiencies arise from the amino acid composition of the grain storage proteins, called kafirins, which account for up to 80% of the total grain proteins (Taylor and Schossler, 1989). These deficiencies are also exacerbated by cooking, which reduces sorghum protein digestibility. Similarly, binding of tannins to proteins can also reduce digestibility in high tannin lines (Taylor and Belton, 2002).The purpose of the current study is to evaluate the chemical composition, mineral profile, and the protein quality of two Sudanese sorghum cultivars.

MATERIAL

Two Sudanese sorghum cultivars namely feterita and dabar were obtained from the local market, Khartoum north, Sudan. The seeds were cleaned and freed from foreign material and broken kernels. The clean seeds were milled in Barabeder Quadrumat Junior Mill (Regulation No 1) into flour to pass a 0.4 mm screen. The flour was stored in polyethylene bags at 4°C for further analysis. Unless otherwise stated, all reagents used in this study are of lab-grade.

METHODS

PROXIMATE ANALYSIS

The determination of moisture, crude fibre, crude fat and ash were carried out according to AOAC (1984) methods while Protein content (N × 6.25) was determined by a Dumas combustion method (Approved Method 46-30.01, AACC International 2010).

PROTEIN FRACTIONATION

The protein fractionation of both cultivars was conducted according to Osborn (1924).

DETERMINATION OF TOTAL MINERALS

Minerals were extracted from the samples by dry ashing method that was described by Chapman and Pratt (1982). The amount of iron, Ca and Cu were determined using atomic absorption spectroscopy (Perkin-Elmer 2380). Ammonium vandate was used to determine phosphorous along with ammonium molybdate method of Chapmann and Pratt (1982). Sodium and potassium contents were determined by flame photometer (CORNIGEEL) according to AOAC (1984)

DETERMINATION OF TANNIN CONTENT

Condensed tannins were determined by the modified Vanillin HCl method of Price *et al* (1978), where the tannins are extracted with acidified methanol. The absorbances of the sample blanks were subtracted to compensate for non-tannin pigments and tannin content was expressed in catechin equiv.

DETERMINATION OF *IN VITRO* PROTEIN DIGESTIBILITY

In vitro protein digestibility was carried out according to Hamakar *et al.* (1978). Accurately weighed samples (200 mg) were digested with P700-100G pepsin, activity 863 units/mg of protein (Sigma- Aldrich) for 2 hr at 37°C. Residual protein was determined by the Dumas combustion method and IVPD was calculated as the percentage of total N that was solubilized under the conditions of the assay.

DETERMINATION OF AMINO ACID CONTENT

The amino acid content of samples content was measured by the Pico-Tag reverse-phase HPLC procedure (Bidlingmeyer et al 1984) after acid hydrolysis.

STATISTICAL ANALYSIS

Each determination was carried out on three separate samples and analyzed in triplicate and figures were then averaged. Data was assessed by the Analysis of Variance (ANOVA) (Snedecor and Cochran, 1987). Duncan Multiple Range Test (DMRT, 1955) was used to separate means. Significance was accepted at $P \leq 0.05$.

RESULTS AND DISCUSSION

CHEMICAL COMPOSITION

Table 1 shows the results of the proximate composition of Sudanese feterita and dabar sorghum cultivars. Data are expressed on dry matter basis (per 100 gm material). The moisture content of feterita and dabar cultivars was assessed as 7.29 and 6.67% respectively. These values are comparable to the range of 5.7 to 10% reported by Yousif and Magboul (1972), but significantly lower than the range of 7.49 to 6.77 stated by

Awadelkareem et al (2009) may be due to climatic or location differences. Results show that feterita and dabar sorghum cultivars contain ash 1.78 and 1.28% respectively. The values are lower than the range of 1.5 to 2.6%,1.54-2.29, 1.5 - 3.9% reported by Awad El Kareem (2002); Awadelkareem et al (2009); Hassan (1995), respectively. The crude protein content of two sorghum cultivars feterita and dabar is given in Table 1. Results, however, showed values of 13.44% and 10.21% respectively. The protein content of feterita cultivar is significantly (P< 0.05) higher than dabar cultivars. The values are within the range of 10.20 to 14.00% reported by Awadelkareem *et al*. (2009). The protein content of feterita is higher than the value stated by Awad El Kareem (2002) who reported the protein content of feterita was 13.13.The crude fibre analysis for feterita and dabar showed the values of 2.02 and 1.72% respectively. The fibre content of feterita is significantly (P<0.05) higher than dabar cultivars. The results of fiber content are greater than the results expressed by (Awadelkareem et al, 2009). The fat content of feterita cultivar is significantly (P< 0.05) higher than dabar cultivar. The fat content of both cultivar was lower than the range reported by Awad El Kareem (2002) who stated the fat content of two Sudanese sorghum cultivar (Dabar and Fetarita) ranged between 3.1 and 3.8%. The carbohydrates content of dabar cultivar was significantly (P<0.05) higher than feterita cultivar. The results obtained were in the range reported by Osman (2004) who recorded carbohydrates content of three Sudanese local cultivars (Tabat, mugud and feterita) to be ranging between 71.33 and 78.78%.

Table (1)**: Proximate composition of sorghum cultivars**

Cultivars	Parameter					
	Moistures	**Ash**	**Protein**	**Fat**	**Fibre**	**Carbohydrates**
Fetrita	$7.29^{a}\pm0.02$	$1.78^{a}\pm0.02$	$13.45^{a}\pm0.12$	$3.02^{a}\pm0.01$	2.02 ± 0.05	$72.44^{a}\pm0.04$
Dabar	$6.67^{b}\pm0.05$	$1.28^{b}\pm0.01$	$10.21^{b}\pm0.09$	$2.84^{b}\pm0.07$	1.72 ± 0.10	$77.28^{b}\pm0.29$

Values are means (±SD) of 3 replicates per treatment.
[ab] Means with different superscripts in the same row were significantly different ($P\leq 0.05$).

Table no.2.Protein Fractions of Dabar and Feteri Sorghum Cultivars (%)

Cultivars	Parameter				
	Albumin	**Globulin**	**Prolamin**	**Glutlins**	**Residual**
Dabar	$10.26^{b}\pm0.06$	$6.60^{a}\pm0.08$	$54.65^{a}\pm0.04$	$23.15^{a}\pm0.11$	$5.31^{a}\pm0.06$
Feterita	$11.03^{a}\pm0.05$	$5.51^{b}\pm0.01$	$55.43^{a}\pm0.05$	$21.17^{b}\pm0.12$	$5.82^{a}\pm0.02$

Values are means (±SD) of 3 replicates per treatment.
[ab] Means with different superscripts in the same column were significantly different ($P\leq 0.05$).

PROTEIN FRACTIONS

The proteins of the sorghum grain are classically divided, based on solubility in different solvents: water-soluble (albumins), salt soluble (globulins), aqueous alcohol-soluble (kafirins), alkaline soluble glutelin (Osborne, 1924). Table 2 presents the protein fractions based on solubility for each fraction, into albumins, globulins, kafirins, and glutelins. From results, it could be noticed that sorghum contain 10.26% to 11.03%, 5.51% to 6.60%, 54.65% to 55.43%, 23.15% to 21.17% for albumins, globulins, prolamins, and glutline, respectively. The albumin and prolamin content of feterita cultivar is significantly (P< 0.05) higher than dabar cultivars, while dabar has higher globulin and glutelin content compared to feterita. One of the major problems of Osborne's fractionation procedure was its low yield of extracted protein. Skoch *et al*,(1970) reported extraction of only 2640% of total proteins in sorghum using Osborne's method. The procedure was subsequently modified by Landry and Moureaux (1970) to yield five fractions. According to Taylor *et al.* (1984a), two important changes were introduced which resulted in much improved protein extraction. These changes were the use of aqueous alcohol plus reducing agent after the aqueous alcohol extraction and a final extraction with basic buffer containing a detergent and a reducing agent. Distribution of protein in fractions extracted with the different solvents suggested that, the two sorghum varieties different in amount of total extractable protein and this is may be due to the differences in total protein. kafirins, represented a considerably greater fraction in sorghum varieties. Results are close to Ejeta et al. (1987), who found that fractionated protein in raw sorghum ranged from 10.00 to 24.00%, 6 to 16% and 11.00 to 31.00% for albumins plus globulins, prolamins and cross linked kafirins, respectively. Raw corn contain 19.50 to 26.20%, 20.90 to 35.30% and 15.20 to 23.80% for albumins plus globulins, cross linked kafirins and cross linked glutline, respectively Abdel Moneium (1996). Sorghum prolamins ranged from 42.50 to 81.80% (Akeson and Stahmanna1964). Since a large percentage of sorghum kafirin storage proteins exist in polymeric forms linked by disulfide bonds in their native state, differences in content of fractions rich in insoluble disulfide proteins, i.e., cross linked kafirin and cross linked glutelin could contribute to protein digestibility differences. The albumin, globulin, prolamin, glutelins, and residual protein had differing amino acid composition .Some major trends were observed by Skoch et al ,(1970) in amino acid composition of the fractions, attributable to differences in protein content of whole grains. Concentration of lysine,arginine, and glycine in the albumin and globulin fractions of sorghum grains were nearly double the level found in the protein of whole grain. The prolamin fractions

of sorghum grain contained less lysine than that of respective whole grain protein.

MINERAL CONTENT

The minerals content of feterita and dabar sorghum cultivars are showen in Table 3. Total sodium content of fetrita and dabar was 5.98 and 4.83 mg/100g respectively. Sodium content of both cultivar agrees with the result stated by (Awadelkareem et al ,2009) and lower than results obtained by Badi (2004) who reported that sodium content of two sorghum cultivars ranged from 6.3 to 7.0 mg/100g and both.. Total potassium for both fetrita and dabar were 247.23 and 307.51 mg/100g, respectively. Dabar cultivar contains much amount of potassium compared to feterita. Potassium content of both cultivars is lower than 441.7 and 450 mg/100g reported by Badi (2004) and 430-458 mg/100g reported by Khalil *et al.* (1984). Total calcium content of feterita and dabar cultivars was 2.73 and 3.33 mg/100g respectively. The results obtained for both cultivars were less than results recorded by Badi (2004) and Khalil *et al.* (1984) who recorded 10.8 and 18 mg/100g, respectively. Total iron contents for Sudanese and Indian cultivars were 14.54 and 11.32 mg/100g respectively. Results obtained from two cultivars were higher than results reported by Badi (2004) who reported iron content of the Sudanese sorghum cultivars (Wad Ahmed and Tabat) as 3.8 and 4.5 mg/100g, respectively, while the results were in agreement with results stated by (Awadelkareem et al.,2009). Total phosphorus content of two feterita and dabar were 257.01 and 310.15 mg/100g respectively, which are less than 407 and 396 mg/100g reported by Khalil *et al.* (1984) and 388 to 756 mg/100g stated by Deosthale and Belvady (1978). Total copper contents were 0.51 and 0.40 mg/100g, respectively. Results obtained were in agreement with Deosthale and Belvady (1978) who reported the copper content of sorghum cultivars to range from 0.39 to 1.58 mg/100g.

Table 3- Minerals content (mg/100g) of feterita and dabar sorghum cultivars

Cultivars	Parameter					
	Cu	**Ca**	**Fe**	**P**	**Na**	**K**
Feterita	$0.51^{a}\pm0.10$	$2.73^{b}\pm0.10$	$14.54^{a}\pm0.10$	$257.30^{b}\pm1.00$	$5.98^{a}\pm0.01$	$247.23^{b}\pm0.0$
Dabar	$0.40^{b}\pm0.01$	$3.33^{a}\pm0.09$	$11.32^{b}\pm0.11$	$310.15^{a}\pm2.05$	$4.83^{b}\pm0.08$	$307.51^{a}\pm1.54$

Values are means (±SD) of 3 replicates per treatment.
[ab] Means with different superscripts in the same row were significantly different ($P \leq 0.05$).

Table 4- Tannin content and In *Vitro* Protein Digestibility (IVPD) of sorghum cultivar:

Cultivars	Tanin (mg/100g)	IVPD%
Feteriat	1.72 ± 0.01^{a}	$61.\pm0.3^{b}$
Dabar	0.09 ± 0.00^{b}	76 ± 0.20^{a}

-Value are mean±SD.
-Means followed by different letter in the same column are significantly different at ($p \leq 0.05$).

TANIN CONTENT

Probably the major distinguishing characteristic among sorghum cultivars is whether or not they contain tannins. Tannins have several highly beneficial effects with regard to sorghum cultivar agronomic attributes, including protection against bird predation, insects, and weathering (Waniska et al 1989). The presence of condensed tannins in sorghum cultivars also greatly affects the functional and nutritional quality of sorghum food products. Despite their possible beneficial effects as antioxidants, tannins have been linked to reduced protein digestibility of sorghum (Duodu et al., 2002), because they bind with proteins and inhibit enzymes (Scalbert et al., 2000). The tannin content of fetrita and dabar cultivars showed in table 3, as 1.71% and 0.09% as catechin equivalent respectively. Feterita cultivar had significantly ($P< 0.05$)higher tannin content compared to dabar cultivar Results obtained for two cultivars agree with Jambunthan and Mertz (1973) who reported that tannin content of high tannin sorghum is 2.69% and for low tannin sorghum is 0.5%. Result findings agreed with Awadelkareem et al (2009) who reported that tannin content of Sudanese and Indian sorghum cultivar ranged between 0.08% to 1.71%. Sorghum varieties are divided into three groups based upon their genetics and chemical analyses (Rooney and Miller, 1982). Type I sorghums (b1b1B2_, B1_b2b2, b1b1b2b2) do not have a pigmented testa, and contain low levels of phenols and no tannins. Types II and III both have a pigmented testa and contain tannins.

IN VITRO PROTEIN DIGESTIBILITY

Digestibility may be used as an indicator of protein availability. It is essentially a measure of the susceptibility of a protein to proteolysis. A protein with high digestibility is of better nutritional value than one of low digestibility because it would provide more amino acids for absorption on proteolysis. Table 4 showed the *in vitro* protein digestibility of Fetrita and Dabar cultivars as 61% and 76%, respectively. Dabar cultivar had significantly ($P< 0.05$) higher *in vitro* protein digestibility compared to fetrita. These results obtained agreed with Chibber *et al.* (1980) who reported that, uncooked and cooked high tannin sorghum varieties both shown to have low *in vitro* protein digestibility. The lowest *in vitro* protein digestibility obtained in case of fetrita cultivar positively correlated to its tannin content, this finding agrees with Chavan *et al.* (1979) who observed significant lowering in *in vitro* protein digestibility (IVPD) in a high tannin cultivar. Results obtained for two cultivars agreed with Awadelkareem et al (2009) who reported that IVPD

of high tannin Indian sorghum cultivar is 49.25% and 55.85% for low tannin Sudanese sorghum cultivar. The low digestibility of sorghum proteins is presumably due to the high protein cross linking. Good quality proteins are those that are readily digestible and contain the essential amino acids in quantities that correspond to human requirements. It appears that the reduction in digestibility was caused by the tannins rendering the sorghum proteins less digestible through binding with them, rather than the tannins reacting with the pepsin. Tannins bind strongly with the sorghum kafirin storage proteins, due to their relatively high proline content (Butler et al 1984; Emmambux and Taylor 2003; Taylor et al 2007).

Table 5-The essential amino acids content of sorghum cultivar (g/100 g protein).

	Isoleucine	Leucine	Threonine	Valine	Phenylalanine	Lysine	Methionine	Tyrosine
Dabar	3.61 ^{b} ± 0.01	12.48 ^{b} ± 0.01	2.64 ^{a} ± 0.19	4.74 ^{a} ± 0.04	4.73 ^{b} ± 0.04	2.31 ^{a} ± 0.05	1.88 ^{a} ± 0.06	3.75 ^{a} ± 0.08
Feterita	3.72 ^{a} ± 0.04	13.48 ^{a} ± 0.16	2.48 ^{a} ± 0.09	4.65 ^{a} ± 0.02	5.100 ^{a} ± 0.08	1.57 ^{b} ± 0.04	1.55 ^{b} ± 0.04	3.72 ^{a} ± 0.09

Values are mean of two replicates. Means in the same column followed by the same letter are not significantly different at ($p \leq 0.05$) level.

Table 6-.The nonessential amino acids content of sorghum cultivar (g/100 g protein).

	Arginine	Aspartic	Alanine	Proline	Glutamic	Glycine	Serine	Histidine
Dabar	3.61 ^{a} ±0.00	5.28 ^{a} ±0.01	8.69 ^{a} ±0.16	8.16 ^{a} ± 0.26	17.50 ^{b} ± 0.00	3.08 ^{a} ± 0.05	3.85 ^{a} ± 0.04	1.75 ^{a} ± 0.00
Feterita	2.79^{b}±0.08	4.83^{b} ± 0.03	8.70 ^{a}± 0.09	7.70 ^{a} ± 0.05	19.57 ^{a} ± 0.13	2.36 ^{b} ± 0.01	3.77 ^{a} ± 0.03	1.77 ^{a} ± 0.00

Values are mean of two replicates. Means in the same column followed by the same letter are not significantly different at ($p \leq 0.05$) level.

AMINO ACIDS CONTENT

The nutritive value of food, especially protein mostly would depend not only on its amino acid profile in general but also on the quantities of the essential amino acids content in particular. The essential amino acid pattern of two sorghum cultivars is presented in Table 5. The essential amino acids content in sorghum ranged from 3.61 to 3.72, 12.48 to 13.48, 2.48 to 2.64, 4.65 to 4.74, 4.73 to 5.100, 1.55 to 1.88, 3.72 to 3.75 1.57 to 2.31 g/ 100 g protein for isoleucine, leucine, threonine, valine, phenylalanin, methionine, tyrosine, and lysine , ,respectively. Dabar had the higest amount of threonine, metheonine, valine, tyrosine, and lysine, respectively. While Feterita had the highest amount of isoleucine, leucine, and phenylalanine. The results obtained are in agreement with (Afify *et al* ,2012; Mokrane et al. ,2010; and Mardia et al., 2013). Table 6 presents non essential amino acids content inDabar and Feterita sorghum cultivar. Non essential amino acids content in both sorghum ranged from 2.79 to 3.61, 4.83 to 5.28, 8.69 to 8.70, 7.70 to 8.16, 17.50 to 19.57, 3.77 to 3.85, 3.77 to 3.85, and 1.75 to 1.77 g/100 g protein for arginine, aspartic acid, alanine, prolin, glutamic acid, glycine, serine, and histidine. Dabar had the highest amount of arginine, proline, aspartic acid, glycine, and serine. While feterita had the highest amount of alanine, glutamic and histidine. The results obtained of no essential amino acid content were lower than the results explained by Afify et al (2012) and Mokrane et al. (2010). Amino acid analysis revealed that sorghum protein is rich in glutamic acid, leucien, alanine, and proline, but dificent in lysine similar to other cereal. The low sulphur containing amino acids (methionine) is due to the destruction of methionine and cysteine during hydrolysis process. This confirms that lysine is the most limiting essential amino acid in cereals, sorghum having the lowest score. A careful analysis of literature shows that the influence of total sorghum grain *N* on amino acid composition still calls for clarification. Many authors agree that, for a given genotype, amino acid composition can change as a function of *N*, but few (Singh and Axtell 1973, for instance) take this into account in comparing different genotypes. Relationships between amino acids and *N* were first examined by Waggle and Deyoe (1966), who showed that amino acid level in sorghum grain, is linearly correlated with *N*. This means that amino acids in protein change according to quadratic relationships as a function of *N*. However, Eppendorfer et al (1985) concluded that it is not linearly correlated with *N*. The influences of genotype, culture conditions, and environment remain uncertain. The profile of essential amino acids in sorghum protein along with FAO/WHO amino acid pattern and amino acid score. It can be clearly observed that leucine and phenylalanine + tyrosine are presented in excess amounts in sorghum protein, whereas the amount of isoleucine, threonine, valine and sulphur containing amino acids are lower than the values of the FAO/WHO (1973) pattern. The protein lysine content of the Feterita grain *was* much lower than that of the Dabar cultivars. This is most likely related to the fact that the protein content of the sample of Feterita was much higher than that of Dabar cultivars. Kafirins, the major sorghum proteins, contain little if any lysine (Belton et al 2006). Amino acid score in sorghum is based on lysine because lysine is the first limiting indispensable amino acid in sorghum (reviewed by Klopfenstein and Hoseney 1995).

Amino acid score therefore directly followed lysine content.

CONCLUSION

Results showed that both sorghum cultivars differ in their chemical composition and mineral profile. Feterita cultivar has superior chemical composition compared to dabar cultivar. The results showed that, debar has superior protein quality (low tannin, high invitro protein digestibility, high lysine).

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