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Chemical Composition of New Phenotype Sorghum (Sorghum bicolor L) (Locally named Barbarei) Grains and Stover in South and West Darfur States, (Sudan)

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ABSTRACT

The study carried out in2005- 2006-2007 to study the chemical composition of Barbarei grains and Stover. The study area includes Tools, Toil, Um-Mush tour, Um-Grara, and Um-Dafoog from south Darfur State and Um-Dukhn, Furbarnga and Anjokoti from West Darfur State. Samples of grain and Stover were obtained from Tools (South Darfur State) and Um-Dukhn(West Darfur State) for grain and Stover chemical analysis, constituents measured were moisture content, fats, protein content, dry matter , fiber, ash and Nitrogen Free Extract (NFE), in addition to some minerals (N, P, Ca, Mg, K, Na).Barbarei grains were cleaned and freed from foreign materials then used for chemical analysis. Moisture, grain protein, fat, fiber in the samples were determined .Protein was determined by Micro-kajeldahl method, fat was determined using Sochlet Extractor and Petroleum Ether as solvent in addition to ash and fibers. Nitrogen free extract determined by subtraction: NFE = 100- (protein +fats +ash +fibers + moisture).Grain phosphorus was determined by spectrophotometer. Ca^{++} and Ma^{++} were determined by titration with Versenate, while the Flame Photometer determined K^{+} and Na^{+}. Results showed that Barbarei grains moisture was generally low (general mean 5.82%).Results revealed that varieties from Tools area has high fats, protein, fibers and ash percentage compared with the same varieties from Um-Dukhn area, except protein content for Abu- ragaba variety (white) from Tools area (9.81%),whereas, for the variety from Um-Dukhn was (10.93%).For mineral composition results showed that Abu-ragaba from Tools has lower N content (0.77%) and Mg^{++} (0.18%) compared with the same variety from Um-Dukhn. It was observed that NFE was higher for Barbarei grains obtained from Tools (75.2%) compared with other sorghum grains. Barbarei grain protein content ranges from 12.39% to 9.81 %, while fiber ranges between 2.00-2.80% and 2.71-2.19% for fat content. Results showed that protein content was higher in the leaf (17.86%) when compared with stem (7.00%).The same trend was observed for fat and ash content , fiber content was(35.907% and 32.807%) for leaf and stem respectively. NFE was higher in the stem (47.117%) than the leaf (30.243), but dry matter content were similar.

Keywords: *chemical composition, sorghum, new phenotype - Barbarei - grains, Sudan.*

1. INTRODUCTION

Sorghum is used for human nutrition all over the world. Globally, over half of all sorghum is used for human consumption [13].It is a major crop for many poor farmers, especially in Africa, Central America, and South Asia. Grain sorghum is used for flours, porridges and side dishes, malted and distilled beverages, and specialty food such as popped grain. Sorghum is also considered to be a significant crop for animal feeds [6, 7] .Sorghum and millet constitute a major source of calories and protein for millions of people in Africa and Asia [9]. Grain sorghum is dominant summer crop in Sudan; many varieties are grown under rain-fed areas and under irrigation in some central states. In Darfur, as in the other parts of the Sudan, Sorghum is grown as rain-fed summer crop. Many local varieties locally named (Fasikh , Mugod , Dber ,) and varieties improved by Jabel Marra Rural Development Project like B-9 and M-9 and well known varieties obtained from central Sudan like Tabat ,Wad- Ahmed and Gdm-elhmam are grown under rain- fed conditions (during rainy season) .Beside these well known varieties, there is another unique phenotype (or may be unique genotype) of sorghum bicolor species locally named (Barbarei) that widely grown in South and West Darfur States. This species includes wide diversity of varieties (Abu- ragaba and Abu-kunjara) both with different seeds color .The Babarei phenotype seems to have different behavior in comparison with other cultivated species or varieties of sorghum in Darfur that the plants produces flowers and grain only when weather gets cooler (October-November), although the plant heads continue to form normally. Although Barbarei is widely grown in South and West Darfur States and it is an important nutritional and economical and fodder crop but no studies or research were done about it except some attempts that done by staff of faculty of agriculture, university of Zalingei [3].However, information about chemical composition of Barbarei grains and stover in Sudan is lacking. The present work was, therefore, carried out to study chemical composition of Barbarei grains, as this aspect relates directly to the nutritive value of the crop.

2. MATERIALS AND METHODS

The study carried out in 2005-2006-2007. Barbarei production areas in South and West Darfur States are considered as the only Barbarei production areas in Sudan till the date of the study (2005) .The production areas include Tools, Toil, Um-Mush tour, Um-Grara, and Um-Dafoog from south Darfur state and Um-Dukhn, Furbarnga and Anjokoti from West Darfur State. This area is located within the zone of rich savannah. The warm rainy season starts on July and extends to the end of

October with annual rainfall 500-600mm, 60% of which falls in the period of July –August. The dry cool season starts on November and extends to the end of February the time of Barbarei crop maturity and harvest. The soils of Barbarei production areas ranged from sandy clay loam to sandy clay and clay soils at different depths and have high ability of water retention for a long time in root system zone. Soil reaction is slightly acid, soil P^H ranged between 7.09-5.66. Ca^{+2}, Mg^{+2} and Na^{+1} content of these soils are slightly different (results of soil analysis done by authors).White and red color Barbarei grains were obtained from Tools, South Darfur state and Um-Dukhn, West Darfur state for grain chemical analysis. Whereas, the Stover obtained from Tools only. Constituents measured were moisture content, fats, protein content, dry matter determination, fiber, ash and Nitrogen Free Extract, in addition to some minerals (N, P, Ca, Mg, K, and Na).Barbarei grains were cleaned and freed from foreign materials then used for chemical analysis. Moisture, protein, fat, fiber in the samples were determined by the methods of [1] protein was determined by Micro-kajeldahl method, fat was determined using Sochlet Extractor and Petroleum Ether as solvent in addition to ash and fibers. Nitrogen free extract (NFE) determined by equation: NFE = 100- (protein +fats +ash +fibers + moisture). Phosphorus was determined by Spectrophotometer method. Ca^{+2} and Ma^{+2} were determined by titration with Versenate, while K^+ and Na^+ were determined by the Flame Photometer method [4].

3. RESULTS AND DISCUSSION

Results in Tables (1 and 2) showed that Barbarei grains moisture was generally low (general mean 5.82%) this might be due to the good dryness before analysis .Results revealed that varieties from Tools area has high fats, protein, fibers and ash percentage compared with the same varieties from Um-Dukhn area, except protein content for Abu- ragaba variety (white) from Tools area (9.81%).Whereas, for the variety from Um-Dukhn was (10.93) Table (1). For mineral composition results showed that Abu-ragaba from Tools has lower nitrogen (0.77%) and Mg (0.18%) compared with the same variety from Um-Dukhn. It was observed that NFE was higher for Barbarei grains obtained from Tools (75.2%) compared with other sorghum grains, this might be due to low soil nitrogen content which might reflected in decreasing of nitrogen percentage and increasing nitrogen free extract . Results revealed that Barbarei grain protein content ranges from 12.39% to 9.81 %, while fiber ranges between 2.00-2.80% and 2.71-2.19% of fat content. [5] Stated that protein content and composition varies due to genotype and water availability, temperature, soil fertility and environmental conditions during grain development. The protein content of sorghum is usually 11-13% but sometimes higher values are reported, as reported by [8] that protein percentage for white sorghum cultivar was 15.3% while, for the reddish cultivar was 15.9% . Sorghum is a good source of fiber (mainly the insoluble 86.2%) and crude fat content of sorghum averages about 3% [5,12] reported 8.10-9.99% ,0.92-1.75% ,1.4-2.70% ,8.9-11.02% and 2.30-2.80% for moisture content, ash, crude fiber, protein and fat content respectively for different four sorghum varieties, while [11] recorded values of 9.95 ,9.42,10.06 for protein% , 3.32 , 2.82 , 3.35 for fat% ;1.44 , 1.40 , 1.22 for ash% and 1.83 , 1.97 , 1.62% for fiber content for colored sorghum varieties (brown red, white and pale yellow respectively),similar to these results were recorded by [10]. The differences between chemical constituents of wheat, sorghum, millet and maize grains (Table 4) as cited by [9] were small. Results in (Table 3) revealed that there was no significant difference between the two Barbarei varieties Abu- ragaba (white) and Abu-kunjara (red) in protein, fiber, ash, NFE. Whereas, the differences were significant ($p \leq 0.05$) between the two Barbarei varieties and Wad-Ahmed (well known variety) which has higher protein content compared with the tow Barbarei varieties, this might be due to genotype differences and environmental requirements for the sorghum varieties. Results of the Stover chemical analysis (Table 5) showed that protein content is higher in the leaf (17.863%) when compared with that in the stem (7.00%) ,the same trend was observed for fat (2.287and 0.673%) and ash (13.60 and 5.993%)for leaf and stem respectively. Whereas, fiber was (35.907 and 32.807%) for leaf and stem respectively.NFE was higher in the stem (47.117%) than leaf (30.243%), but dry matter was similar for the leaf and stem. Results of Chemical analysis of sorghum Stover (Tabat variety) recorded by [2] 96.7±0.83, 4.65±0.39 for dry matter and crude protein percentage, and 42.98±0.01, 9.99±0.89 and 40.96±1.24 for crude fiber, ash and nitrogen free extract percentage respectively.

Table 1: Chemical composition of Barbarei grains (two varieties) obtained from Tools and Um-Dukhn areas (2005-2006)

Area	variety	Moisture content %	Fat %	Protein %	Fiber %	Ash %	NFE%
Tools	Abu- ragaba	6.65	2.52	9.81	2.90	1.74	76.38
	Abu-kunjara	5.09	2.64	12.39	3.66	3.03	74.80
Um-Dukhn	Abu- ragaba	6.65	2.71	10.93	2.79	1.92	75.0
	Abu-kunjara	5.92	2.19	10.94	3.63	2.00	75.34
General mean		5.82	2.49	11.34	3.41	2.34	74.60

NFE : nitrogen free extract

Table 2: Mineral composition of Barbarei grains (two varieties) obtained from Tools and Um-Dukhn areas (2005-2006)

Area	variety	N%	P%	K%	Na%	Ca%	Mg%
Tools	Abu- ragaba	0.77	0.01	0.40	0.01	0.10	0.18
	Abu-kunjara	1.98	0.02	0.48	0.01	0.10	0.29
Um-Dukhn	Abu- ragaba	1.75	0.01	0.48	0.02	0.10	0.27
	Abu-kunjara	1.75	0.01	0.46	0.01	0.10	0.26
General mean		1.72	0.014	0.46	0.012	0.10	0.26

Table 3: Chemical composition of sorghum grains for varieties obtained from Tools area (2006-2007)

Variety	Moisture content %	Fat %	Protein %	Fiber %	Ash %	NFE%
Abu- ragaba (white Barbarei)	9.367a	3.750c	12.503a	1.617a	1.863a	74.63a
Abu-kunjara (red Barbarei)	8.737b	4.143b	12.167a	1.667a	1.880a	71.41a
Wad-Ahmed	9.300a	4.507a	9.233b	1.117b	1.450b	74.39a
C.V.%	0.65	2.03	3.84	8.08	1.79	4.53
LSD	0.083	0.110	0.568	0.155	0.041	4.35

NFE: nitrogen free extract

Table 4: comparison of nutrients in 100- edible portions of various cereals at 12% moisture *

Cereal	Protein (g)	Fat (g)	Fiber (g)	Ash (g)	Calcium (mg)	Energy (kcal)
Wheat	11.60	2.00	2.00	1.60	30.00	348
Maize	9.20	4.60	2.80	1.20	26.00	358
Sorghum	10.90	3.20	2.30	1.60	27.00	329
Pearl millet	11.00	5.00	2.20	1.90	25.00	363

*source: Leder (2013)

Table 5: Chemical composition of Barbarei Stover obtained from Tools area (2006-2007)

Part analyzed	Dry matter %	Fat %	Protein %	Fiber %	Ash %	NFE%
Leaf	96.800	0.673	17.863	13.600	32.807	30.243
Stem	96.700	2.287	7.000	5.993	32.907	47.117

NFE: nitrogen free extract

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