

## **Chemical Composition of Some Sorghum Grains (*Sorghum bicolor* (L.) Moench, Poaceae) Grown in Gizan Area, Saudi Arabia**

**Abdullah Yahia Basahy**

*Department of Botany and Microbiology, College of Science,  
King Saud University,  
P.O.Box 2455, Riyadh 11451, Saudi Arabia*

**ABSTRACT.** Three local varieties of Sorghum grains (Hamra, Baidha and Shahla) were analyzed for their contents of some organic and inorganic constituents. Qualitative photochemical screening showed important contents. Fats, nitrogen, protein, amino acids and other constituents such as Ca, Na, K, Mg, Mn, Fe and Zn. Preliminary comparisons were made of the content of fat, protein, amino acids and certain minerals for three varieties of *Sorghum bicolor* which grows widely in Southern Saudi Arabia. The results indicate that these grains are nutritive as a staple food, feed and / or fodder.

Sorghum is cultivated in the world, in India, Pakistan, China, Nigeria, Sudan, Egypt, Saudi Arabia, USA, Mexico and Argentina (FAO Year Book 1980 and 1984). Sorghum ranks third following rice and wheat in world production as a cereal grain (Kramer 1959). Martin (1970) reported it ranks fifth in acreage of world crops being surpassed by wheat, rice, maize and barley. Further he reported that it is grown in areas where the average summer temperature exceeds 20°C and the frost free season is 125 days or more.

Vavilov (1957) reported that the greatest variability in both the cultivated and the wild sorghum is found in the North East quadrant of Africa, further it has been suggested that the place of origin of grain sorghum is tropical Africa in view of the concentration of large number of wild and cultivated sorghums in that area.

*Sorghum bicolor* (L.) Moench, is being grown in the southern part of Saudi Arabia as a staple food grain and /or fodder. It is the most commonly used crop in the area, covering about 85% of the cultivated land. Grains form the basic food for the rural population and provide feed for their livestock (El-Khatib 1974). TAVO (1985) reported that at Tihama of Saudi Arabia precipitation was between 50 and 100 mm per year, in wadis rain water is used for flood irrigation and the cultivation of *Sorghum bicolor* is practiced. It is the main cereal crop in the Southwestern region. (Chaudhary 1989). Mandaville (1990) reported that grain sorghum is commonly and widely cultivated as a staple grain in southern and western Arabia.

Various varieties of sorghum were tried among several other introduced species of forage crops, most of the work has been done at Hofuf Agriculture Research Development Project between the Ministry of Agriculture and Water, and the University College of North Wales (Farnworth *et al.* 1972). Hybrid sorghum was tested among several crops by Farnworth (1972). There is a great dearth of information about this crop under investigation in the present study, even the little that is known deals chiefly with the agronomic aspects leaving the knowledge about nutritive value. It is greatly lacking or non-existent (El-Hag *et al.* 1989). So, this study is concerned with the chemical composition of sorghum grains in order to shed some light on their major mineral and nutrient constituents.

### Materials and Methods

The study was carried out using three local varieties of sorghum grains obtained from Gizan Experimental Station at Hakemah. These include Hamra, Baidha and Shahla. The dehulled grains were left to dry at room temperature, the dried grains were ground and the flour of these was separately chemically analyzed. Moisture and Ash were determined according to the methods recommended by A.A.C.C. (1962). All values reported are mean of triplicate analysis.

Most of the analytical methods for fats, nitrogen and amino acids were the same as reported earlier for analysis of wheat grains (Basahy 1990). These methods will be mentioned in brief. Fat was determined by (A/S Foss Electric, Denmark) using perchloroethylene  $C_2Cl_4$  as an extractant. Nitrogen was determined by (Kjel-Foss Electric, Automatic Kjeldahl, Denmark).

For amino acid pool, the whole grain flour was hydrolyzed with 6N HCl in evacuated sealed soda glass tubes which were kept in a vacuum oven at  $110^{\circ}C \pm 1^{\circ}C$  for 24 hr. The amino acid composition of the protein hydrolysate was determined using the LKB 4000

amino acid analyzer. The buffer calibration mixture and ninhydrin reagent used in this work were all from " ULTROPAC " .

For protein analysis, samples were ground and assayed by (A.O.A.C.1965) procedures for nitrogen content where  $6.25 \times \% N = \% \text{ crude protein}$  . All protein values reported on dry weight basis .

### Analysis of Minerals

The mineral constituents present in sorghum grains were analyzed separately using Atomic Absorption Spectrophotometer of Perkin-Elmer Model-2280. To remove carbon about 5 g of powder flour of grains was taken in procelain container ignited and ashed in the muffle furnace (Gallenkamp Hot Spot) at about 700-750°C for 15 hours. The percentage of the total ash was calculated after the ignition. The ash was dissolved in 5ml conc.  $\text{HNO}_3$  filtered and transferred quantitatively into 100 ml volumetric flask using deionised water. The solution was then analyzed for its chemical composition with the comparison of calibration absorption of the standard corresponding elements.

### Results and Discussion

Grains moisture content ranged between 8 to 12%, shown in Table 1. These results agree with those obtained by Platt (1962) who analyzed food commonly used in tropical countries. Ash content of grains was between 1.7 to 1.8%, similar results were investigated by Yousif *et al.* (1972), studied the nutritive value of Sudanese food stuff. Sorghum are grown for their grain and fodder value, the grains may differ in colour, size

**Table 1.** Moisture, ash and fat content in three varieties of sorghum grains (% on dry weight basis) Mean  $\pm$  SE

Sorghum varieties	Moisture %	Ash %	Fat %
Hamra	11.83 $\pm$ 0.120	1.72 $\pm$ 0.028	0.26 $\pm$ 0.035
Baidha	11.13 $\pm$ 0.352	1.73 $\pm$ 0.032	0.33 $\pm$ 0.037
Shahla	11.43 $\pm$ 0.328	1.78 $\pm$ 0.015	0.26 $\pm$ 0.031

and chemical composition, (Wall *et al.* 1970). Fat content was within the range of 0.2 to 0.4% which is in agreement with that of Bidwell *et al.* (1922) who reported the physical and chemical study of milo and feterita kernels. The variety Hamra contained relatively high amount of protein (14.58%), is not preferred, because the dough made for bread becomes black upon preparation, shown in Table 2. Where as the variety Baidha which is a popular brand of sorghum for bread making in the southern province contained the lesser protein (13.12%).

The mineral content of these varieties shown in Table 3, indicates the presence of many cations such as Ca, Fe, K, Mg, Mn, and Zn. The calcium content was significantly

**Table 2.** Kernel weight, Nitrogen and Protein analysis of three varieties of sorghum grains using the factor 6.25 (17.5%) for sorghum, % on dry weight basis (Mean  $\pm$  SE)

Sorghum varieties	Kernel weight 100 seed weight (g)	Nitrogen %	Protein %
Hamra	2.694 $\pm$ 0.04	2.333 $\pm$ 0.03	14.58 $\pm$ 0.02
Baidha	2.455 $\pm$ 0.03	2.100 $\pm$ 0.01	13.12 $\pm$ 0.01
Shahla	2.599 $\pm$ 0.001	2.166 $\pm$ 0.033	13.54 $\pm$ 0.01

**Table 3.** Mineral contents of three varieties of sorghum grains as mg/100g dry wt.

Mineral Contents	Hamra	Baidha	Shahla
Ca <sup>++</sup>	4.50	4.30	4.95
Na <sup>+</sup>	2.92	3.16	3.00
K <sup>+</sup>	628	650	630
Mg <sup>++</sup>	15.70	15.36	17.08
Mn	0.70	0.72	0.80
Fe <sup>+++</sup>	2.64	1.68	2.84
Zn <sup>++</sup>	4.80	4.76	5.04

lower ranging from 4.3 to 4.9 mg/100g of the grains compared to 10 mg/100g which was analyzed by Adams *et al.* (1976). The elemental analysis of Fe, Mg, Mn and Zn are in conformity with those of McCollough (1972), studied some American sorghum hybrids. Potassium content was significantly higher recorded in the range of 628 mg/100g to 650 mg/100g compared to 400 mg/100g with the analysis results of Mengesha (1966). Most comprehensive data reported by Pinta *et al.* (1963) on the chemical composition of African sorghums and millets (minerals and trace elements) shows that phosphorus, magnesium, potassium are the major minerals in sorghum grain with lesser amounts of calcium and sodium.

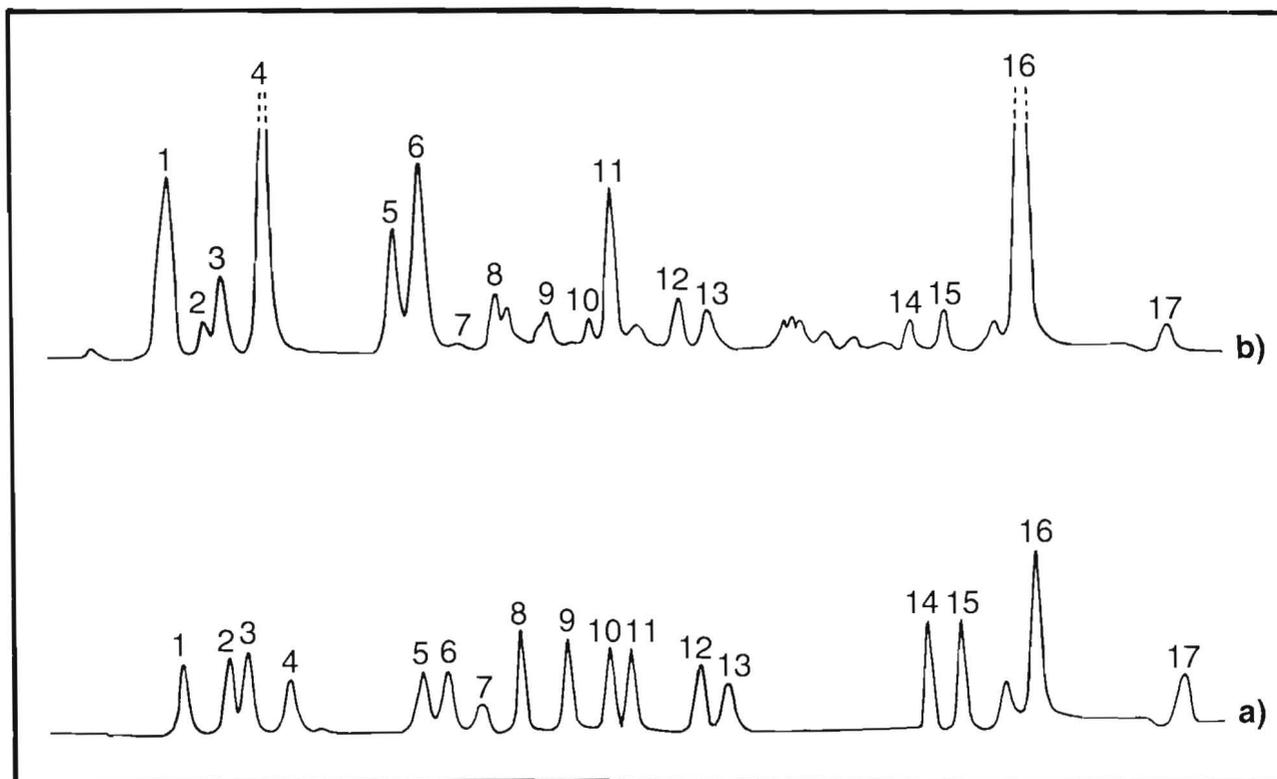
**Amino acid pool:** The amino acid composition of protein hydrolyzates are shown in Table 4. It was observed that in all the varieties investigated as many as 17 amino acids were detected and identified. The protein rich variety Hamra contained the largest concentrations of amino acids. The data in (Fig.1) and (Table 4) show that the concentrations of glutamic acid, leucine, alanine, aspartic acid, tyrosine, valine, isoleucine, pheyalanine and arganine are predominated and are in order of abundance in these varieties of sorghum, while the other amino acids were observed in comparatively lower concentration. Overall the concentrations of essential amino acids in these varieties are fairly good in amount. Our results are in conformity with some of the Sudanese varieties of sorghum analyzed by Hosaney *et al.* (1974).

In conclusion, this work shows the fairly good amount of nitrogen, amino acids, protein and minerals found in these varieties indicating the potential use of these as human food, livestock feed and fodder. As expected, it is shown that sorghum grains are rich in protein and amino acids, the results show that variety Hamra contains more protein and amino acid than Shahla and Baidha. All these varieties are recommended for cultivation in Gizan Area, as these grains contained appreciable amount of protein and amino acid for the consumption of human food and fodder.

The present study is part of a continuing work to obtain information about the protein, amino acids and mineral contents of sorghum grains. It is hoped that a more extensive work would be undertaken in future to calculate the biological value (BV), net protein utilization (NPU), protein efficiency ratio (PER) and chemical score for other grains.

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**Fig. 1.** (a) Standard amino acids run.

(b) Quantitative Determination of amino acids in the protein hydrolysate of Hamra variety of sorghum grains.

- |                  |            |                |                   |              |
|------------------|------------|----------------|-------------------|--------------|
| 1) Aspartic acid | 5) Glycine | 9) Methionine  | 13) Phenylalanine | 17) Arginine |
| 2) Threonine     | 6) Alanine | 10) Isoleucine | 14) Histidine     |              |
| 3) Serine        | 7) Cystine | 11) Leucine    | 15) Lysine        |              |
| 4) Glutamic acid | 8) Valine  | 12) Tyrosine   | 16) Ammonia       |              |

**Table 4.** Amino acid contents in protein hydrolyzates in three varieties of sorghum grains as (mg/g total N)

S. Nos.	Amino Acids	Hamra	Baidha	Shahla
1	Aspartic acid	409	399	578
2	Threonine	191	186	190
3	Serine	273	277	224
4	Glutamic acid	1408	1310	1381
5	Glycine	168	140	165
6	Alanine	565	540	510
7	Cystine	108	103	104
8	Valine	255	240	240
9	Methionine	96	87	80
10	Isoleucine	242	209	236
11	Leucine	840	824	836
12	Tyrosine	278	271	264
13	Phenylalanine	240	238	235
14	Histidine	150	135	115
15	Lysine	162	138	115
16	Arginine	220	218	204
17	Ammonia	161	142	135

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## التركيب الكيميائي لبعض حبوب الذرة الرفيعة النامية في منطقة جيزان من المملكة العربية السعودية

عبدالله يحيى باصهي

قسم النبات والأحياء الدقيقة - كلية العلوم - جامعة الملك سعود - الرياض  
ص. ب. (٢٤٥٥) - الرياض ١١٤٥١ - المملكة العربية السعودية

يعتبر محصول الذرة الرفيعة والتي تزرع في الجزء الجنوبي الغربي من المملكة العربية السعودية (منطقة جيزان) من أهم المحاصيل الزراعية حيث يستخدم هذا النوع على نطاق واسع كغذاء للإنسان وكأعلاف للماشية . ويغطي هذا المحصول مساحة تقدر بأكثر من ٨٥٪ من الأراضي الزراعية في تلك المنطقة . وكما هو معلوم أن هذا المحصول يشكل المرتبة الخامسة في الإنتاج العالمي بعد محصول الأرز، القمح، الذرة، الشعير .

تم في هذا البحث إجراء بعض التحاليل الكيميائية على بعض الحبوب لتقدير محتواها الرطوبي والرمادي وأجريت أيضاً بعض التحاليل الكيميائية لمعرفة المحتوى العضوي وغير العضوي لهذه الحبوب .

ودلت النتائج أن المحتوى الرطوبي لحبوب الذرة الرفيعة يتراوح ما بين ٨ - ١٢٪ بينما محتواها الرمادي يتراوح ما بين ٧,١ - ٨,١٪ .

وأوضحت نتائج البحث أن هذا النوع من الحبوب يحتوي على نسبة عالية من الدهون والنيروجين والبروتين .

وأظهر تحليل العناصر مثل الكالسيوم - الصوديوم - البوتاسيوم - الماغنسيوم - المنجنيز - الحديد والزنك أن بعض هذه العناصر وجدت بتراكيز عالية مثل الماغنسيوم والبوتاسيوم بينما بقية العناصر الأخرى وجدت بتراكيز قليلة .

وسجلت الدراسة حوالي ١٧ نوعاً من الأحماض الأمينية تراكيز بعضها كبير مثل حمض الجلوتامين - الليوسين - الألانين - الفنايل أمين - الثيروسين - السيرالين - والأرجنين ، بينما وجدت أحماض الثيرونين - الجلوسين - الستين - الميثيونين - الليسين بتراكيز قليلة .

وأكدت نتائج هذا البحث أن هذا النوع من الحبوب يعتبر مادة غذائية هامة للإنسان والحيوان .