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Quality Attributes of Six Wheat Cultivars Grown under Water-Stress Conditions

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Abstract. The response of six local old cultivars of Saudi Arabian wheat in relation to quality of grains was studied, under water stress conditions. Three watering intervals were used; 10, 16 and 22 days. Moisture, fat, protein and amino acid profile were obtained. Results showed that the cultivars have high content of protein and some have high content of glutamic acid. This has an important implication in human nutrition.

Introduction

Triticum aestivum L. is an important contribution to human diet in different parts of the world, having one of the highest protein content among other cereals. Boals [1] stated that wheat has become a world symbol, reflecting the staple food for many millions of people and is equally important as an indicator for economic condition and political stability. Nations with an adequate supply of wheat have, for centuries, been considered nutritionally well off. The protein content of cereals which is greatly influenced by the environmental conditions under which a crop is grown will have a more pronounced effect on quality and performance than the genetic potential of the particular germ plasm involved. The chemical composition of cereals varies depending on environment, soil and variety. Although cereals are regarded as energy foods, they are important source of protein which is one of the most expensive essentials in a diet. It has long been recognised that the human body is in need of protein in sufficient amount and of the essential amino acid composition. The protein content of wheat varies considerably (6-12%), within each varietal group, and is less influenced by heredity than by the edaphic factors [2]. Because of the ward, dry and sandy wind in spring which may cause the water stress condition and its impact on the protein content this work has been conducted.

Materials and Methods

The study was carried out using six local cultivars of wheat obtained from the College of Agriculture, Qassim. These included, Hinta Madani, Sama, Bony, Naimi, Samira and Jalami. All cultivars were seeded on December 28, 1987 in pots using a 2:1 sand loam mixture and kept in a shaded green house. Seeds were sown at approximately a depth of 3 cm. in 17 cm. diameter pots. Each pot contained 10 seeds equally spaced. There were 10 pots for each cultivar, thus a total of 100 plants were used for each. No fertilizers were added, and varietal differences between each cultivar were checked. There were three treatments, (treatment 1 received water after 10 days, treatment 2 received water after 16 days and treatment 3 received water after 22 days). The pots received water at 58% of field capacity.

After the maturity of the plants the seeds were harvested, dried, grinded in an electric grinding mill and the flour of the six cultivars was chemically analysed. Moisture and ash were determined according to the methods recommended by A.A.C.C. [3]. Fats were determined by using the unpounded seeds which were grinded in a reactor with 120 ml of perchlorethylene C_2 Cl_4. After grinding, the fat percentage was measured on the Foss-Let Instrument. (A/S Foss-Electric, Denmark). Total nitrogen and protein were determined using seed flour by Kjel-Foss Automatic (A/S Foss-Electric, Denmark). For amino acid pool, the wheat flour was hydrolysed with 6N HCl in evacuated sealed soda glass tubes which were kept in a vacuum oven at 110°C ± 1°C for 24 hr. The amino acid composition of the protein hydrolysate was determined using the LKB 4000 amino acid analyser. The buffer calibration mixture and ninhydrin reagent used in this work were all from "ULTROPAC" range of chemicals.

Results and Discussion

The grain moisture content ranged between 6.9 to 7.9% which agrees well with that of El-Hinnawy *et al.* [4] on some of the Egyptian varieties of wheat. The ash content, which represents the sum of the mineral content, was found to be between 1.9 to 2.1% which also agrees with the results of Meyer [5]. The fat content was found in the range of 1.9 to 2.8% in line with the results of McCance *et al.* [6], Table 1.

Nitrogen and protein pool

The quality of available soil nutrients is known to affect both the yield of cereal grains and its chemical composition [7]. The amount of available nitrogen in the soil has been found to reflect upon the protein content of the grain [8]. Like wise, cereals grown under conditions of abundant moisture usually have a high starch content. Dry weather and water deficit conditions specially during grain maturation produced hard and flinty grain with a high proportion of nitrogen and protein content. Similar

Table 1. Moisture, ash and fat contents of whole wheat grains of six local cultivars. (% on dry weight basis).

Cultivars and treatments		Moisture %	Ash %	Fat %
H. madani	T_1	7.42± 0.011	1.94±0.006	2.84±0.003
	T_2	7.41±0.016	1.90±0.012	2.81±0.006
	T_3	7.40±0.006	1.89±0.014	2.80±0.008
Sama	T_1	7.46±0.010	2.20±0.011	2.42±0.006
	T_2	7.42±0.14	2.10±0.008	2.40±0.008
	T_3	7.38±0.006	1.98±0.014	2.39±0.0011
Bony	T_1	7.00±0.006	2.12±0.006	2.62±0.006
	T_2	6.92±0.012	2.09±0.004	2.60±0.011
	T_3	6.90±0.010	2.00±0.008	2.59±0.012
Naimi	T_1	7.14±0.002	2.01±0.004	1.92±0.006
	T_2	7.06±0.16	2.00±0.008	1.90±0.006
	T_3	7.00±0.006	1.92±0.006	1.89±0.008
Samira	T_1	7.81±0.018	1.98±0.010	2.18±0.010
	T_2	7.80±0.006	1.94±0.011	2.04±0.008
	T_3	7.78±0.012	1.90±0.006	2.60±0.006
Jalami	T_1	7.97±0.006	2.18±0.006	2.60±0.006
	T_2	7.94±0.11	2.05±0.002	2.40±0.016
	T_3	7.90±0.016	2.00±0.011	2.00±0.018

Irrigation regimes: T_1 = 10 days
T_2 = 16 days
T_3 = 22 days

observations were made by other authors [9-11], who observed an increase in N and P concentrations with moisture stress, (Table 2). The data revealed that the concentration of nitrogen and protein in grain increased in most cases due to moisture stress. This high protein content may also be due to the high proportion of protein accumulated in the seeds. Moreover it is generally seen in this experiment that most of the cultivars which received water after 22 days had comparatively a high protein content except in case of Bony, 16 days after watering.

Amino acid pool

The amino acid composition of protein hydrolysates was shown in one of the treatments which received water after 16 days. It was observed chromatographically that some amino acids were not completely fractionated and appeared in groups (Table 3). All the amino acids were found in different amounts in all the protein hydrolysate of the wheat kernels under investigation. Glutamic acid, proline, leucine, aspartic acid and glycine were predominated [12], while the other amino acids were observed in lower concentrations to the extent that some of them existed in very minute amounts or even as traces. The present study is just a preliminary

Table 2. Nitrogen and protein analysis of stressed whole wheat grains of different cultivars using the factor 5.7 (17.5%) for wheat, % on dry weight basis.

Cultivars and treatments		Kernel weight 100 seed weight	Nitrogen %	Protein %
H. madani	T_1	4.12± 0.016	3.33±0.008	19.00±0.58
	T_2	3.29±0.010	3.33±0.006	19.10±0.58
	T_3	2.99±0.008	3.35±0.011	20.60±0.11
Sama	T_1	4.47±0.006	3.61±0.006	19.00±0.58
	T_2	3.06±0.008	3.33±0.011	21.42±0.80
	T_3	ND. ±0.011	3.75±0.010	ND. ±0.
Bony	T_1	4.28±0.10	ND. ±0.006	19.10±0.58
	T_2	3.96±0.006	3.35±0.008	21.10±0.12
	T_3	2.18±0.008	3.70±0.010	20.61±0.80
Naimi	T_1	3.62±0.008	3.62±0.008	19.00±0.58
	T_2	3.25±0.006	3.33±0.012	19.70±0.10
	T_3	2.62±0.011	3.45±0.016	20.40±0.80
Samira	T_1	5.02±0.006	3.57±0.006	19.00±0.58
	T_2	3.56±0.008	3.33±0.008	19.10±0.58
	T_3	2.70±0.010	3.35±0.012	19.70±0.80
Jalami	T_1	5.15±0.006	3.45±0.006	19.70±0.10
	T_2	4.11±0.008	3.80±0.011	21.67±0.58
	T_3	ND.	ND.	ND.

Irrigation regimes: T_1 – 10 days
T_2 – 16 days
T_3 – 22 days

ND. - Not determined due to paucity of wheat flour samples.

work undertaken to obtain information about the protein and amino acid content of local cultivars. It is hoped that more extensive work be undertaken in future to fractionate this important glutamic acid and its sodium salts, to be used as a flavouring agent in bakries. The effect of different treatments were not analysed due to paucity of material.

Table 3. Amino acids content in wheat grains of 6 local cultivars for 16 days water interval (g/100 g protein)

Amino acids	H.madani	Sama	Bony	Naimi	Samira	Jalami
Phenyl alanine	3.58±0.01	4.07±0.10	4.00±0.05	3.42±0.08	3.82±0.02	4.18±0.06
Leucine	4.92±0.02	5.95±0.18	5.28±0.13	4.59±0.11	4.57±0.16	5.91±0.02
Isoleucine	2.87±0.15	3.11±0.13	3.04±0.06	2.50±0.08	2.56±0.10	2.26±0.14
Methionine	0.84±0.03	0.92±0.24	0.96±0.04	0.63±0.01	0.74±0.03	1.12±0.07
Valine	3.67±0.06	3.81±0.16	3.91±0.04	3.41±0.04	3.28±0.09	3.97±0.31
Tyrosine	1.47±0.17	2.26±0.12	1.61±0.12	1.90±0.02	1.69±0.03	1.65±0.21
Proline	10.88±0.45	9.89±0.14	9.40±0.12	9.98±0.04	7.05±0.03	11.23±0.25
Hydroxyproline						
Alanine	2.87±0.12	3.00±0.12	2.16±0.09	2.53±0.03	2.37±0.03	2.92±0.31
Glutamic acid	27.93±0.62	33.33±0.93	32.66±0.74	26.99±0.03	25.19±0.23	35.30±0.09
Threonine						
Serine	3.22±0.09	3.29±0.07	3.68±0.23	3.14±0.11	2.94±0.02	3.06±0.03
Glycine	3.38±0.27	3.60±0.12	3.06±0.10	2.98±0.02	2.94±0.04	3.13±0.04
Arginin						
Aspartic acid	4.71±0.08	4.96±0.14	4.70±0.13	4.14±0.07	3.94±0.12	5.01±0.01
Histidine	1.98±0.16	2.12±0.09	2.03±0.02	1.72±0.08	1.61±0.04	2.27±0.08
Lysine	2.15±0.15	2.23±0.07	2.13±0.08	2.03±6.08	2.00±0.04	2.23±0.08
16 Cystine	1.29±0.02	1.18±0.31	1.42±0.08	1.07±0.03	1.00±0.18	1.40±0.06
Cysteine						
Ammonia	4.46±0.13	4.55±0.17	4.53±0.09	3.78±0.02	3.73±0.02	4.74±0.16

N.B.
1) Calculated as leucine
2) Calculated as proline
3) Calculated as glutamic acid
4) Calculated as glycine
5) Calculated as arginine.

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خاصية الجودة لستة أنواع محلية من القمح المنماة تحت ظروف الإجهاد المائي

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ملخص البحث. درست جودة المحصول في ستة أنواع من القمح المحلي «المملكة العربية السعودية» زرعت تحت ظروف مختلفة من الإجهاد المائي امتدت ما بين عشرة واثنين وعشرين يومًا. هذا وقد دلت النتائج على أن البروتين بمحصول هذه الأنواع تميزه نسبة عالية من حمض الجلوتاميك ذي القيمة الغذائية الكبيرة في غذاء الإنسان.