Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 4, No. 6, p. 185-189, 2014
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Assessment of essential amino acids in wheat proteins: a case study

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Article published on June 12, 2014

Key words: Protein, Amino acids, Wheat.

Abstract

The protein and amino acid composition of six most yielding varieties of wheat, commonly grown in Khyber Pakhtunkhwa (KP) were analyzed to correlate the protein with its Essential and non essential amino acid contents. The wheat protein is rich in non-essential glutamic acid and proline, whereas deficient in most of the essential amino acids, such as lysine, tryptophan, threonine, methionine and histidine. Lysine, and tryptophan had a significant (p=0.01) negative correlation with protein. While glutamic acid and proline had a significant (p=0.01) positive relation with the protein. The association of these amino acids with the protein was greater as compared to all other amino acids. In order to improve the nutritive value of wheat protein the essential amino acid content should be enhanced by mutation breeding.

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Introduction

Wheat (*Triticum aestivum)* is a major food crop and an economical source of protein and calories. Cereals are the basic source of plant protein and represent 62% of the world protein supply. It is imperative now to improve the nutritional quality of food crops, so that to maintain the health of our people.

Wheat (*Triticum aestivum*) and rice (*Oryza sativa*) surpasses all the other food crops in their importance. Wheat has the highest global average, with an annual production of 560 million tons. It is estimated that nearly 73 million people would be added to the world's population every year from now until 2020 Andersen *et al* (1999). The situation will cause a tremendous increase in global demand for food to fulfill that demand. Agriculturists have a challenge to tackle this situation and to provide 40% more grains in future. Wheat is a major source of dietary energy and protein for people whose daily diet is composed of cereal products. It is staple food, consumed world wide in the form of bread, biscuits, chapatti etc. It is the predominant cereal produced and the main staple food of Pakistan. It contributes 68-75% of the total food intake in the daily diet and provides 75% of the total protein requirements (Aslam and Shams, 1982).

The quality and quantity of wheat depends upon the nutritive value of its protein. From nutritional point of view a balance between essential amino acids in the protein complex is important. The protein and amino acid composition of wheat varies with the crop varieties, application of fertilizers, irrigation practices, the soil and climatic conditions of the area. The attention has been given to improve the protein content of wheat varieties. The protein and amino acid composition of the older varieties of wheat have been studied by many workers but no efforts has been made to establish some relationship between the protein and amino acid contents in the high yielding varieties of wheat grown in Pakistan. The present study was, therefore undertaken to determine the amino acid composition of wheat varieties grown in KP and to correlate the protein content with its amino acids. It is anticipated that this study will be helpful to the breeders in screening better wheat varieties from nutritional point of view.

Materials and methods

Six important varieties of wheat commonly grown in KP were collected from Agricultural Research Institute, Tarnab. The grains of wheat sample were screened to remove different kinds of impurities (stones, straw). The samples were then ground and kept in dried clean bottles for analysis.

Proximate composition

Moisture, crude protein, ash, crude fat and crude fiber in six varieties of wheat were determined by the standard methods of A.O.A.C. (1990) Nitrogen free extract was calculated by difference. Each determination was triplicate and the average results were presented.

Amino acids composition

Protein hydrolysate was prepared by treating 9 mg. wheat flour samples with 6 N HCl in sealed test tube for 24 hours at temperature of 105-110^{o}C. The amino acid composition was determined by paper chromatography. Buffered phenol solvent was used for the resolution of aspartic acid, glutamic acid, serine, glycine, threonine and alanine. Butanol acetic acid water (4:1:5) was used for the separation of lysine histidine and arginine. Butanol-acetic, acid water (4:1:1) was used for separation of other amino acids, except tryptophan. Tryptophan was determined after alkali hydrolysis by the method described by Blauth (1980) *et al*. the amino acid spots were detected by spraying ninhydrin reagent. Proline was located by using isatin reagent. The evaluated alcohol and their absorption was measured in a unicam spectrophotometer at 500mu.Each sample was replicated thrice (Three times) for the determination of each amino acid.

Relationships of Protein and Amino Acids

The co-efficient of correlation and co-efficient of determination were computed by the method of Waugh to study the protein and amino acid relation.

Results and discussion

The proximate composition of six varieties of wheat (Table I) indicates that the protein content ranged from 7.83 to 12.80%. The highest value was recorded for Pirsabak and the lowest for the Fakhre-e-sarhad. The ash and nitrogen free extract were found maximum in khattakwal. Ghaznavi contained the least amount of NFE. These observations are fair agreement to those of Rehman and Iqtidar who reported that the protein content of wheat varieties ranged from 10.17 to 14.64%. Sejian *et al* (2009). Recorded lower value (7.4 to 12.4%) for the protein content in various wheat varieties grown in Peshawar.

Table I. Protein and Amino acids correlations in six wheat varieties

Amino acids	Amino acid range (% of protein)	Correlation Coefficient of Co-efficient(r) determination $(r)^2$	Esse -ntial
Lysine	2.52-3.25	-0.92b	0.86
Tryptophan	1.01-1.50	-0.96b	0.93
Methionine	0.75-1.13	+0.38	0.14
Histidine	1.56-1.65	+0.28	0.08
Threonine	2.00-2.68	-0.81	0.64
Arginine	4.63-5.02	-0.74	0.55
Valine	3.65-4.03	+0.46	0.21
Leucine	7.18-7.56	-0.74	0.55
Iso-leucine	3.21-4.50	-0.88a	0.77
Phenylalanine	4.71-5.10	+0.86a	0.74
Non-Essential			
Aspartic acid	05.56-06.05	+0.49	0.24
Glutamic acid	26.81-28.35	+0.93a	0.87
Serine	03.76-04.15	+0.87a	0.76
Glycine	03.42-03.78	+0.41	0.16
Alanine	03.05-03.80	+0.87a	0.76
Tryosine	02.15-02.60	-0.86a	0.74
Proline	09.82-11.21	+0.98a	0.96

Protein content ranged from 7.83 to12.80%

"a" Significant at 5% level of probability.

"b" Significant at 1% level of probability

The amino acid composition of six prominent varieties of wheat grown in KPK is presented in Table II. These results suggest that wheat protein is deficient in certain essential amino acids, such as lysine, tryptophan, threonine, methionine and histidine. Wheat protein is rich in glutamic acid and proline, which are the dominating non essential amino acids. Paterson (1990) also reported the deficiency of lysine, tryptophan and methionine in wheat protein. Likewise Jones and Nadeem *et al* (1965) reported that lysine is the limiting essential amino acid in wheat grain protein.

The results (Table III) showed highly significant negative relations between the protein and the two essential amino acids, lysine and tryptophan. In contrast glutamic acid and praline had highly significant positive correlations with protein. Except, tyrosine all non essential amino acids were positively correlated with the protein content. While tyrosine, phenylalanine had a significant positive correlation with the protein. However, threonine, arginine, leusine and iso-leucine were inversely related to the protein. The co-efficient of determination for lysine, tryptophan, glutamic acid and praline being 3.85, 0.90, 0.87 and 0.96, respectively, shows that these amino acids were affected up to the extent of 85, 92, 87, and 96% respectively by an increase or decrease in the protein content. The association of protein with these amino acids was maximum as compared to all other amino acids. These observations suggest that the increase in the protein content of wheat grain is due to an increase in the synthesis of glutamic acid and proline.

Ahmad & Hussain (1986) and Jensen (1976) also reported negative relation between the protein and lysine content of wheat. Likewise Sejian *et al* (2009) found that increase in the protein content of wheat grain due to applied nitrogen caused a decrease in concentration of basic amino acids. In high protein grains the amount of non-essential amino acids, such as aspartic acid glutamic acid and praline was more.

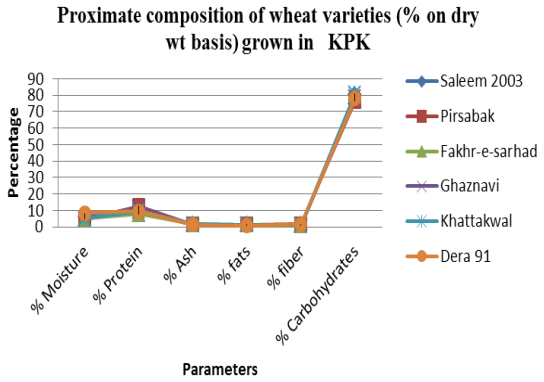

Fig. 1. Proximate composition of wheat varieties grown in KP

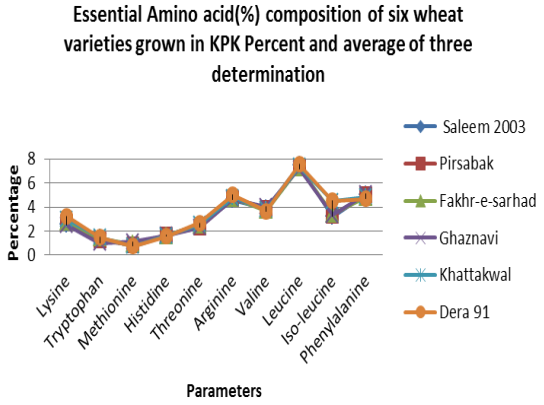

Fig. 2. Essential amino acids composition of wheat varieties grown in KP

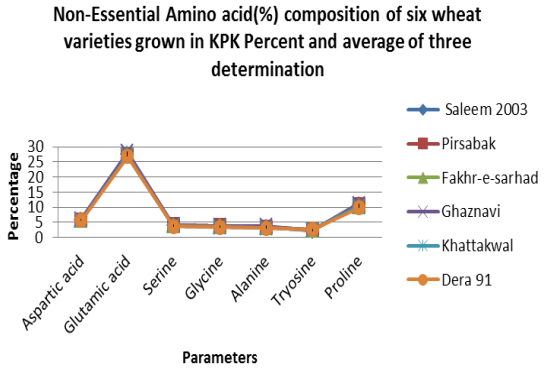

Fig. 3. Non-essential amino acid composition of wheat varieties grown in KP

Conclusions and Recommendations

The breeders should exploit these correlations in their breeding programmes and should produced wheat cultivars rich in lysine and other essential amino acids. Mutation breeding can play an important role in the evolution of such cultivars.

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