

Nutritional attributes of wheat

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Cereals are important crops since time immemorial. Indeed, their successful production, storage and use have contributed in no small measure to the development of modern civilisation. Wheat is the cereal of choice in most parts of the world and enjoys special status due to the following reasons:

- *It is grown on 240 million hectares, an area larger than that of any other crop.
- *It contributes more calories and more protein to world's diet than any other food.
- *World trade in wheat exceeds trades in all other grains combined.
- *The raised bread is possible because the wheat kernel contains gluten, an elastic form of protein.

WHEAT IN PAKISTANI DIET

Wheat grain and its products are important components of our daily diet. The average consumption of wheat is 318 gram/person/day, constituting 83 percent of the total cereals intake. The calories and nutrients supplied by wheat as percent of the Recommended Daily Allowance (RDA) for adult man is given as follows:

	Percent of RDA
Calories (Kcal)	42
Protein	79
Thiamine	168
Riboflavin	54
Niacin	95
Iron	56

Wheat contributes larger proportion of protein than energy to the nutritional requirements of an adult man. It can meet the daily need of thiamine and niacin alone. More than half of daily requirements of iron and riboflavin is met by the amount of wheat available to an adult man.

NUTRITIVE VALUE

Wheat is primarily regarded as a source of protein, calories, vitamins and minerals. It compares well with other cereals in nutrient values. Its protein content is higher than that of rice, maize and sorghum and about equal to that of other cereals. The protein content is influenced by its variety, environmental and cultural conditions such as temperature moisture, methods of cultivation, type of soil and availability of nitrogen. Protein percentage in wheat can be manipulated to some extent by the amount of

fertilizer applied and timing of applications. Applying nitrogen to the soil early in crop season (before flowering) will generally result in higher grain yield and applying nitrogen at flowering time or a little later will generally produce more protein in the grain but will have little effect upon yield.

The nutritional value of proteins is determined not only by the quantity of proteins but by the balance of amino acids within the proteins. During human digestion, the proteins are broken into their constituent parts, which are absorbed into the blood stream and then reassemble to form different kinds of proteins needed by the body for growth, maintenance and repair. Eight amino acids are essential for adults (10 for infants) because the human body cannot manufacture them and must obtain from food. The biological value of the wheat protein is set by the first limiting essential amino acid, that is, the amino acid that falls short of the body requirements to the greatest extent. In wheat, the first limiting amino acid is lysine.

There are two problems with lysine in wheat protein. First,

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when wheat is milled, one-third of the total protein and lysine in whole wheat is removed. The loss occurs because much of the protein and lysine are located in the bran and in the germ, which are separated from the flour during milling. Breeders have not been able to change the way protein and lysine are apportioned among the various parts of grain. Second, high protein wheats generally contain higher quantities of proteins that form gluten, which is low in lysine. There tends to be an inverse ratio between the amount of protein in the grain and the amount of lysine per gram of protein. Protein improvement has rarely been a major objective of wheat breeders because wheat protein has usually been considered adequate for human nutrition.

The nutritive value of some wheat varieties grown in Pakistan is given in Table 1.

The protein content ranged from 12.7 to 16.7 percent. Lysine per 100 g protein varied

between 2.46 and 2.90 percent. The protein of Chenab-70 and Barani-70 contained 16–18 percent more lysine than the SA-75 having highest content of protein. The true protein digestibility, biological value and net protein utilization varied between 91 and 94 percent, 58 and 69 percent, and 54 and 63 percent, respectively. Carbohydrate, lysine and biological value were lowered in varieties with a higher content of protein.

WHEAT QUALITY

Wheat quality involves two main aspects, the external quality and the internal quality. External quality includes freedom from weather damage and foreign material and purity of colour and type. These factors are used to segregate wheat into grades visually.

Internal characteristics include parameters such as density, which is determined by measuring test weight, chemical

composition including moisture and protein contents and processing potentials, which include enzyme activity, milling quality and end-use quality. End-use quality usually involves baking of breads or sweet goods. Milling quality is affected by the hardness of wheat, the size and shape, and density of kernels and other factors.

MILLING

Wheat is invariably subjected to some degree of milling. The extent to which the milling process removes the nutrients is important. For a proper understanding of the nutritive value of wheat grain and of the changes it undergoes in preparing food for man it is necessary to consider the structure of the grain and composition of its parts.

ANATOMY OF GRAIN

Wheat grains are ovoid in shape, rounded at both ends. The

Table 1 Nutritive value of some wheat varieties

Varieties	LU-26	PARI-73	SA-42	SA-75	Chenab-70	Barani-70
Protein (%)	13.3	16.2	12.7	16.7	13.6	12.9
Fat (%)	2.9	2.5	2.9	2.9	3.1	3.0
Carbohydrate (%)	70.2	68.5	71.6	66.1	70.0	68.9
Crude fibre (%)	2.6	2.8	2.9	2.9	2.8	2.9
Ash (%)	1.7	2.0	2.0	1.7	1.6	1.9
Calories (per 100g)	440	439	436	442	438	439
Calcium (mg/100g)	42.7	45.1	41.9	38.0	47.9	50.3
Phosphorus (mg/100g)	348.2	392.4	401.3	358.3	315.1	367.5
Iron (mg/100g)	5.2	6.7	6.0	5.9	3.9	4.9
Lysine (g/16gN)	2.77	2.56	2.78	2.46	2.85	2.90
True digestibility (%)	93.0	93.0	93.0	94.0	92.0	91.0
Biological value (%)	63.0	61.0	66.0	58.0	66.0	69.0
Net protein utilisation (%)	58.0	57.0	62.0	54.0	61.0	63.0

outer coverings are the pericarp and testa which are hard and contain much indigestible fibre. Beneath them is the aleurone layer, which is an envelope of cells rich in protein. The outer layers form about 12 percent of the weight of the grain. Inside is the endosperm, comprising about 85 percent of the weight of the grain. The germ is attached to the grain by a special structure the scutellum and both form about 3 percent of the total weight of the grain.

NUTRIENTS DISTRIBUTION

The distribution is not uniform. The germ is relatively rich in protein, fat and several of the B vitamins. So also is the scutellum, which contains about 50 times more thiamine than the whole grain. The outer layers of the endosperm and the aleurone layer contain a higher concentration of protein, vitamins and phytic acid than the inner endosperm. The inner endosperm contains most of the starch and protein in the grain.

DISTRIBUTION OF NUTRIENTS IN FLOUR

Wheat is usually ground into flour before being prepared as food. The flour containing the whole grain may be used but usually the germ and varying proportion of the outer layers are separated from the central portion of the grain and discarded as bran. The proportion of the whole grain that is utilised to make flour is known as the extraction rate. Thus an 85 percent extraction rate flour contains 85 percent by weight of the whole grain and 15 percent is discarded as bran. It is important to

Table 2. Nutritive value of wheat flour of different extraction rates

Extraction rate (%)	100	85	80	70/72
Protein (%)	12.2	12.1	11.7	11.3
Fat (%)	2.4	1.6	1.4	1.1
Carbohydrate (%)	64.1	69.8	70.2	72.0
Fibre (%)	2.0	0.40	0.21	0.10
Calories (per 100g)	327	342	341	343
Thiamine (mg/100g)	0.37	0.29	0.24	0.08
Riboflavin (mg/100g)	0.12	0.07	0.06	0.05
Nicotinic acid (mg/100g)	5.70	2.00	1.60	0.80
Iron (mg/100g)	3.50	2.10	1.65	1.25

Source: Aykroyd and Doughty (1970) *Nutritional Studies No. 23, FAO, Rome.*

remember that the extraction rate refers to the proportion of the original grain in the flour and not in the bran. The nutritive value of wheat flour of different extraction rates is given in Table 2.

Low extraction flours as compared with high extraction flours have the following advantages:—

*They are whiter. Bread made from them is more attractive to the eye.

*They contain less fat. This makes them less likely to go rancid, so white flours are most easily preserved.

*They contain less phytic acid. Therefore, the minerals remaining in them are perhaps more readily absorbed.

*They have better, more uniform baking qualities. Bread from them has a finer texture.

Against these, low extraction flours have the disadvantages of containing less B vitamins,

iron, protein and trace minerals.

In addition, low extraction flour contains less fibre. As the fibre is indigestible this has been claimed to be an advantage. On the other hand, the extra fibre in high extraction flours adds bulk to the faeces and so has a mild laxative effect. The advantages and disadvantages of low- and high extraction flours are beyond dispute. There is however, a big difference of opinion among responsible and knowledgeable people as to whether the advantages of bread made from low extraction flour outweigh the disadvantages. Moreover, it is possible to overcome, at least in part, the disadvantages of low extraction flour by the addition of minerals and synthetic vitamins. The flour used for making bread in countries like Saudi Arabia, Iran, Turkey and whole of Europe is

70 percent. Patent grade flour used for making pastries etc. is 60 percent extraction. In Pakistan, flour that would meet the requirements of Pure Food Act, 1962, would be not more than 95 percent of extraction. However, the flour which is actually sold to public is usually 100 percent extraction. In fact, it may even be 115–120 percent extraction. The mill-owners take out fines, *maida* and *suji*, leaving proportionately higher percentage of bran in the flour.

A recent study on the effect of milling on the nutritive value of flour from wheat has indicated that the concentration of essential nutrients decreased when the extraction rate was lowered. The lysine content (g/16gN) e.g., was 2.52 in whole wheat but only 2.18 in the 66 percent extraction flour. However, only a slight reduction in biological value was found.

PROTEIN QUALITY OF WHEAT PRODUCTS

Moderate heat treatment may

improve the nutritional quality of wheat protein. On the other hand, excessive heat treatment decreases the nutritive value. The most important factors determining the loss in nutritive value are the duration and temperature level during heat treatment and the levels of moisture and reducing substances. The protein quality of some common dishes prepared from whole wheat is shown in Table 3.

LYSINE LEVELS

The levels of lysine, generally considered to be the most heat-sensitive amino acid, were slightly lower in *chapati*, *paratha*, *puri* and porridge and were significantly lower in bread, vermicelli and popped wheat than that of unprocessed sample. The processing of wheat into *chapati*, *paratha*, bread and porridge only decreases the protein quality to a minor extent. However, the protein quality of vermicelli and popped wheat

was the poorest indicating long duration and high temperature level during processing. In case of *puri*, the highest protein quality was due to short time with low cooking temperature.

To make a balanced diet, wheat should be supplemented by foods such as pulses, fresh green vegetables, milk, meat, eggs and fish. The optimum nutritional combination is provided by a diet composed of two parts of wheat and one part of pulse. The protein quality of this diet is as good as a diet containing wheat bread and meat. Similarly, the protein quality of diet having wheat bread and a glass of *lassi* is similar to milk protein.

Wheat will continue to remain as primary source of energy, protein, vitamins and minerals for rapidly increasing population of Pakistan. There is need to improve wheat production through strengthening agricultural research capabilities in the country.

Table 3. Protein quality of some wheat products prepared from whole wheat

	Whole flour	Chapati	Paratha	Puri	Bread	Porridge	Vermicelli	Popped wheat
Lysine (g/16g N)	2.66	2.52	2.49	2.48	2.37	2.5	1.5	1.13
True digestibility (%)	92.5	93.8	93.6	98.8	93.3	97.0	92.0	87.7
Biological value (%)	62.6	60.7	58.7	62.4	58.6	59.0	48.0	45.1
Net protein utilization (%)	57.9	56.9	54.9	61.4	54.7	57.0	44.0	39.6

Sources: Eggum, B.O. (1978) IAEA, Vienna.

Khan and Eggum, (1979) J. Sci. Fd. Agric. 30,369.