# Amino Acid Profile

Amino acids are the building blocks of proteins and approximately 22 amino acids are commonly distributed among the proteins of all biological materials. Of these, 18 can be found in cereal grain proteins. Amino acids are organic compounds containing basic amine (-NH2) and acidic carboxyl (-COOH) functional groups, in addition to a side chain (R group) specific to each amino acid.

Amino acids are considered crucial to good health, contributing considerably to the health of the human nervous system, hormone production as well as muscular structure and are needed by vital organs and for cellular structure. A new study supports the idea that children with a high risk of stunting may not be receiving an adequate dietary intake of essential amino acids.

The classification of amino acids is based on different features, one being whether the amino acid can be acquired through the diet. According to this, three types are identified: essential, conditionally essential and non-essential amino acids. Classification as essential or non-essential, does however not reflect their actual importance, since all of them are necessary for human health. Essential amino acids are considered "essential" as they cannot be synthesized by the body and must be obtained from the diet. The nine amino acids that cannot be synthesized by humas are phenylalanine, valine, threonine, tryptophan, methionine, leucine, isoleucine, lysine and histidine. Arginine, cysteine, glycine, glutamine, proline and tyrosine, are considered conditionally essential in the human diet, meaning their synthesis can be limited under special pathophysiological conditions. Alanine, aspartic acid, asparagine, glutamic acid and serine are non-essential amino acids, meaning they can be synthesized by the body. [1,2]

Whole meal and white flours from different classes and varieties of wheat grown in three different countries (USA, USSR and Australia) show generally similar amino acid compositions, with high contents of glutamic acid (including glutamine) and proline, with very low tryptophan, and relatively low contents of lysine and threonine. Compared with the range of variation in the protein contents of the samples, the variation in their amino acid compositions resulting either from genetic differences or growing conditions such as fertilizer level is rather limited. The reason being that the amino acid compositions of the major endosperm proteins, representing close to 80% of the total wheat proteins, are very similar. Differences in the expression of levels of individual protein genes therefore do not usually result in significant differences in the amino acid compositions of the samples.

Significant variation in amino acid composition may however occur in extreme cases. Research showed that lysine and threonine were for example higher in yellow-berry kernels compared to normal kernels, while glutamic acid (including glutamine) was significantly lower. Extreme differences in fertilization conditions may also result in significant variation in the compositions of whole grain flour or specific protein fractions. It has been found that the proportions of glutamine, proline and phenylalanine in wheat grain and flour all increased with increased levels of nitrogen fertilization, whereas threonine, serine, glycine, alanine, valine and sulphur amino acids decreased.

In a study where wheat was grown under even more extreme fertilization conditions, with variation in nitrogen and sulphur, the grain amino acid composition changed significantly. Less than half of the amounts of cysteine and methionine were present in grain grown with no sulphur and high nitrogen levels compared to grain grown with adequate levels of sulphur.

Proteins are not distributed uniformly throughout a wheat kernel with variation occurring in both the protein content and composition. Even though the starchy endosperm's protein concentration is only a third of that in the germ and less than half of that in the aleurone layer, the starchy endosperm proteins still represent close to three quarters of the total grain protein. The starchy endosperm is characterized by high levels of glutamine and proline and low levels of basic amino acids, while the aleurone and germ contain significantly less proline and glutamine, with high levels of arginine and asparagine in the aleurone layer and germ, respectively. Since the various morphological parts of the wheat kernel differ in protein content and composition, milling extraction rates affect the content and composition of flour.

A large number of flour fractions or mill streams are produced during commercial flour milling which are recombined to provide flours with specific processing characteristics. As a result of the irregular distribution of components within the wheat kernel, these flour streams also vary in their composition and functional properties.

The amino acid compositions of flours differ from those of the grains from which they were milled in containing less lysine, arginine, aspartate (+ asparagine), glycine and alanine but more glutamate (+ glutamine) and proline. Analyses of manually dissected pericarp, testa, aleurone, starchy endosperm and germ suggest that these differences in composition result from differences in the distribution of protein classes throughout the wheat kernel, for example the proportions of basic amino acids increase and the nitrogen content decreases from the outside towards the centre of the endosperm.[3]

Due to the fact that cystine consists of two cysteine molecules, joined by a disulfide (S-S) bond, cysteine and cystine are interchangeable in wheat. The ratio of cysteine to cystine is dependent on the degree of oxidation in a dough. Addition of an oxidizing agent, such as ascorbic acid, will increase the amount of cystine at the expense of cysteine. This has a "strengthening" effect on the gluten by increasing its elasticity.[2]

Each of the 40 samples analysed for this survey, was hydrolysed in duplicate and the average value of the duplicate results, reported as g amino acid/100 g sample, are provided in Table 7. The results show that the wheat samples tested are deficient in certain essential amino acids, such as tryptophan, lysine, threonine, methionine and histidine. Tryptophan values ranged from 0.13 – 0.19 g/100 g and comprise ± 1.0 – 1.3 % of the total amino acid content. Tryptophan is nutritionally important since it is a precursor for important metabolites such as serotonin and nicotinamide. The World Health Organisation's (WHO) recommended daily dose for tryptohan is 4 mg/kg/day.[4]

The values for lysine ranged from 0.31 – 0.49 g/100 g. Lysine is the precursor for carnitine and is required for the structural modification of collagen together with the amino acids glycine and proline.[1] The WHO recommended daily dose for lysine is 30 mg/kg/day. Threonine values ranged from 0.32 – 0.54 g/100 g and the WHO recommended daily dose is 15 mg/kg/day.[4] Threonine supports digestive function, the immune system, liver and cardiovascular function as well as the central nervous system.[5]

Values for methionine ranged between 0.18 and 0.26 g/100 g. The daily recommendation by the WHO is 15 mg/kg/day for the sulphur containing amino acids in total.[4] The main functions of methionine include building of various protein molecules and the synthesis of the equally important sulphurous amino acid, cysteine.[5]

The values for histidine were between 0.23 and 0.44 g/100 g. This amino acid is involved in the formation of proteins, influences several of the metabolic reactions in the body and assists in regulating pH values of blood. The results also showed that the samples were high in the essential amino acid leucine, with values ranging from 0.70 – 1.32 g/100 g. This amino acid helps to sustain nitrogen balance and energy supply during times of stress. These qualities make this amino acid particularly important for body builders and other athletes that require strength and stamina.

The results showed that the samples were rich in glutamic acid and proline, together contributing ± 42% of the total amino acid content. Glutamic acid contributes to the health of the immune and digestive systems, as well as energy production. Proline is a non-essential amino acid manufactured mainly from ornithine, glutamine and glutamate in the liver and is one of the principal amino acids required by the body for building collagen.[5]

**References:**


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