

## THE ROLE OF TRYPTOPHAN IN ENSURING THE WELL-BEING OF HUMAN BODY

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**Abstract.** *Tryptophan is very useful for the human body, because it helps to secrete very important hormones and possesses multiple physiological functions in the metabolic transformations of nutrients. In this article we explain the characteristics of tryptophan and its importance in nutrition and health being. Therefore, was argued the correlation between the physiological need in tryptophan and the person's age. In the technological practice of food processing the level of tryptophan amino acid is also important, serving in the last time as an indicator of quality meat. The main foods and food proteins that have a high tryptophan potential were highlighted. Hydrolyzed protein products and transgenic seeds are presented as useful in strengthening the diet with accessible tryptophan.*

**Keywords:** *proteins, free and protein-bound tryptophan, tryptophan metabolites, fortified foods, absorption, nutrition, health benefits*

### Introduction

Tryptophan was discovered in 1901 by Frederick Hopkins in the milk casein composition [1, 2]. This amino acid is known to be essential in the biosynthesis of enzymes, the maintenance of nitrogen balance, the synthesis of haemoglobin and serum proteins, the synthesis of nicotinic acid, the prophylaxis of pellagra [6]. Tryptophan can be obtained from the following food sources: milk, shrimp, cheese, fish, turkey, chicken, eggs, soybeans, hazelnuts, bananas, dates (Table 1). Corn protein contains a relatively small amount of tryptophan. Because of this, the ration with the predominant use of corn can cause pellagra. Tryptophan is one of the 9 essential amino acids that the human body cannot produce on its own, but without which it cannot survive. Amino acids are organic compounds that act as structural elements in the body. They are basically the foundation on which the muscles, tissues and cells of the human body are built. Amino acids also help the body secrete certain important hormones.

Tryptophan has two very important functions in the human body. Specifically, it contributes to the secretion of serotonin and melatonin, both very important hormones [14]. Serotonin helps regulate mood, appetite and sleep patterns. Melatonin transmits to the body when it needs to feel tired and when it needs to be alert. So that's why it's so hard not to change our sleep schedule. When we try to do this, the hormones need a period of adaptation. If for various reasons you do not get enough tryptophan, there is a risk that your body may no longer be able to secrete these two hormones. For human well-being tryptophan must be obtained from dietary proteins. Its free form is easily absorbed in the presence of carbohydrate-rich food with high-glycaemic index and could increase the availability of this amino acid to the brain [7].

### The structure of tryptophan

Tryptophan has a molecular formula  $C_{11}H_{12}N_2O_2$ . From a biological point of view, tryptophan is an indispensable proteinogenic amino acid, which has an aromatic side chain. Like all amino acids, L-tryptophan has a  $\alpha$  carbon atom attached to an amino group ( $NH_2$ ), a hydrogen atom (H), a carboxyl group (COOH) and a side chain (R) formed by a heterocyclic structure, the indole group. Its chemical name  $\beta$  is 2-amino-3-indolyl propionic acid, it has a molecular weight of 204,23 g / mol. Its solubility at 20 ° C is 1,06 g in 100 g of water and has a density of 1,34 g / cm<sup>3</sup>. Being a hydrophobic amino acid, tryptophan is located inside of the native dietary protein molecule ( $\alpha$ -lactalbumin,  $\beta$  – lactoglobulin, ovalbumin, gluten) [4].

**Tryptophan content in food [15]**

The food product	The amount of tryptophan (mg%)	The food product	The amount of tryptophan (mg%)	The food product	The amount of tryptophan (mg%)
Red caviar	960	Pork	190	Carrot	42
Black caviar	910	Low-fat cottage cheese	180	Milk	40
Butch cheese	780	Buckwheat	180	Tomatoes	33
Peanut	750	Sea bass	170	Apricots	27
Almond	630	Oatmeal	160	Oranges	27
Cashew	600	Dried apricots	150	Pomegranate	27
Pine nuts	420	Mushrooms	130	Peaches	27
Rabbit meat, turkey meat	330	Pasta	130	Raspberries	24
Squid	320	Wheat bread	100	Honey	24
Pistachios	300	Dates	75	Watermelon	21
Chicken	290	Boiled rice	72	Melon	18

### **Tryptophan Requirement**

As a generator of plastics and energy compounds, tryptophan is especially necessary for children and pregnant women. The estimated average requirement (EAR) of tryptophan for school-age children was estimated to be 4.7 and 6.1 mg.kg<sup>-1</sup>.d<sup>-1</sup>. In the same time in the ideal protein the amount of tryptophan is 10 mg.g<sup>-1</sup> protein [1]. The mean tryptophan requirement is 4.01 mg.kg<sup>-1</sup>.d<sup>-1</sup>., with a safe intake at 5.02 mg.kg<sup>-1</sup>.d<sup>-1</sup> [9]., In the elderly, the intensity of metabolic processes decreases, which leads to a decrease in the need for tryptophan. The mean minimum tryptophan requirement of healthy, elderly people approximates 2 mg.kg<sup>-1</sup>.d<sup>-1</sup> body weights [12].

### **Tryptophan in Nutrition: Availability, Sources**

The nutritional value of tryptophan is determined by the conditions of its absorption in the digestive tract. In the study of Fernstrom et al [3] was analysed the effect of the vegetable juice that contain 40 g of  $\alpha$ -lactalbumin (a protein rich in tryptophan) on dynamics of plasma tryptophan increasing. In the same study, a gluten-containing beverage raised the plasma tryptophan level by 25% within 90 minutes, whereas a zein-containing drink lowered the level to about 50% of the fasting value. The authors suggest that negative effect of the corn protein zein probably reflects its poor digestibility, which cause a slower absorption of the amino acids from the gut [3].

Brain serotonin, derived from tryptophan, is known to influence affective events, such as mood disorders. In a study by Markus et al [11] was found that consumption of a tryptophan-rich egg protein hydrolysate by 35 participants with chronic stress resulted in an increase in plasma tryptophan uptake into the brain. The therapeutic value of the egg hydrolysate in improving mood and performance under acute stress exposure probably is due to the high accessibility of the tryptophan in this case.

In order to investigate the effects of different forms of dietary tryptophan, Markus et al [10] tested whether hydrolysed protein had greater effects on the plasma tryptophan/large neutral amino acid ratio and mood than intact protein in healthy volunteers. They observed significant faster increases and longer-lasting improvement in the ratio with the hydrolysed tryptophan source versus the intact or pure tryptophan. These results suggest that the food hydrolysates are useful ingredients that can increase tryptophan availability.

In technological practice, tryptophan is used as an indicator of quality meat, because it is massively contained in the proteins of the muscle tissue of the meat, in myogen and myalbumin [14].

### **Nutrition value of high-tryptophan transgenic seeds**

In several studies, the amount of protein-bound and free tryptophan present in some varieties of transgenic seeds of maize, rice, and soybeans was determinate. Kita et al [8] discovered that transgenic soybean plants were found to accumulate free tryptophan to levels as high as 3,8 to 4,8 mg/g dry weight of seed flour, up to a 12-fold increase compared with tryptophan levels in no transgenic seeds. For analysis, free tryptophan and other amino acids were extracted with sulfosalicylic acid and analyzed by the ninhydrin method using an automated amino acid analyser. The high-tryptophan soybeans can be used to increase the tryptophan content of mixed diets.

In an analysis of rice, Wakasa et al [13] found the amount of free tryptophan in a transgenic rice variety was about twice that in seeds in wild-type plants. The protein-bound tryptophan level was also enhanced. This observation led the authors to suggest that the tryptophan content of rice seeds could be increased trans genetically to improve the nutritional value of the human diet.

### **Conclusions**

1. The richest sources of free and protein bound tryptophan are meat, dairy products, and seeds. The richest sources of free tryptophan are dietary protein hydrolysates and transgenic seeds.
2. The dietary essential amino acid tryptophan contributes to protein synthesis and the regulation of numerous physiological mechanisms. These include serving as a precursor for the hormone serotonin and the vitamin niacin. It is therefore important to be able to analyze tryptophan levels accurately. The problem is that protein-bound tryptophan is degraded in the acid hydrolysis used for analysis of all amino acids.
3. Because tryptophan and its metabolites have potential health benefits, a major challenge is to foster the further development via plant molecular genetic methods, of high-tryptophan foods. Moreover, after consumption, tryptophan is reported to mitigate the course of multiple chronic diseases. Therefore it is an urgent need to facilitate studies that include the evaluation of the functions of tryptophan metabolites on the causes and prevention of human diseases.

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