

Yeremko Liudmyla, Dr. of Agricultural Sciences
ORCID ID (0000-0001-5641-7436)

Hanhur Volodymyr, Dr. Hab.
ORCID ID (0000-0002-5619-492X)

Department of Crop Production
Poltava State Agrarian University, Ukraine

Staniak Mariola, Prof. Dr. Hab.
ORCID ID (0000-0003-1962-9469)

Czopek Katarzyna, Dr. of Agricultural Sciences
ORCID ID (0000-0002-7711-6998)

Stępień-Warda Ann, Dr. of Agricultural Sciences
ORCID ID (0000-0002-2039-0419)

Department of Crops and Yield Quality

Institute of Soil Science and Plant Cultivation - State Research Institute, Poland
DOI

THE ROLE OF LEGUMES IN COMBATING PLANT PROTEIN SHORTAGE

The rise in population growth, the worsening of climate change, and environmental degradation have exacerbated the problems facing the global food system. According to projections, the world's population will reach 10 billion people over the next 25 years, which will require an increase in food production of approximately 70% [1]. The intensive use of arable land to provide feed for livestock is a major destructive factor for the biosphere. These activities lead to the destruction of natural ecosystems, a decline in biodiversity, soil erosion, pollution of the hydrosphere, and the degradation of pastures due to overgrazing, which ultimately contributes to desertification and global climate change. Currently, the meat industry accounts for about 14.5% of all anthropogenic greenhouse gas emissions. Although livestock farming accounts for about 77% of the world's total agricultural land, it provides only 18% of overall human caloric needs and 37% of nutritional protein needs. In this context, the transition to plant-based protein sources is seen as a key strategy for achieving sustainable development goals and ensuring food security [1,2].

Protein is a fundamental macronutrient that ensures the structural integrity and functioning of all cellular systems in the human body. This component is critical for growth and biosynthesis in a youthful human body. Proteins perform the function of selective membrane transport and also act as catalysts for key metabolic and chemical reactions.

Peptides formed during the digestion of dietary proteins in the gastrointestinal tract are capable of regulating the secretory and transport functions of the digestive system and modulating nutrient absorption. In addition, amino acids derived from proteins serve as precursors in the synthesis of many hormones and neurotransmitters, including thyroxine, triiodothyronine, adrenaline, noradrenaline, histamine, and serotonin. A chronic protein deficiency in the diet leads to sarcopenia (loss of muscle mass), decreased physical strength, and destructive changes in the epidermis and hair [3]. Animal-based proteins play a significant role in the protein sources consumed by

the population. However, as scientific studies have shown, consuming large amounts of meat leads to obesity, overweight, and cardiovascular disorders. On the other hand, hidden hunger, caused by a lack of micronutrients in the daily diet, is a root cause of many health problems, including stunted growth, low weight, and cognitive impairments.

One of the components that can ensure a healthy diet for the populations of both developed and developing countries is highly nutritious plant-based products made from legume seeds [4]. Legumes are one of the largest groups of seed plants, comprising about 600 tribes and 13,000 species. Nearly 60 of these, including soybeans, chickpeas, lentils, mung beans, and lupins, have been domesticated by humans.

These crops have been part of the human diet for thousands of years, and in traditional medicine, they are valued for their universal healing properties. The edible part is the pod, which is consumed whole or in part, depending on the species and degree of ripeness [5].

Legumes have high nutritional value, serving as a complete source of high-quality protein with a well-balanced amino acid profile. In particular, soy and pea protein isolates exhibit amino acid digestibility coefficients of 1.0 and 0.89, respectively, which, in terms of biological value, practically place them on par with animal-derived proteins—egg albumin and milk casein. For other representatives of this taxon, this indicator ranges from 0.5 to 0.7 [6].

Biologically active compounds in legumes (enzyme inhibitors, lectins, phytoestrogens, oligosaccharides, saponins, and phenolic compounds) are characterized by antithrombotic, antioxidant, opioid-like activity, exert cytomodulatory or immunomodulatory effects, and help improve mineral absorption/bioavailability. They have a positive effect on energy balance, blood glucose and lipid levels, blood pressure, and peristalsis. Pharmaceuticals made from legume-based raw materials are widely used in the prevention and treatment of cardiovascular diseases, diabetes, cancer, and obesity [7].

Proteins with an optimal amino acid composition and high biological value are of significant scientific and practical interest.

The wide range of possibilities for integrating them into food systems stems from their distinct technological properties, including solubility, hydrophilicity, and lipophilicity, as well as their foaming ability. Given the limited environmental and production sustainability of the meat industry, there is a growing global trend toward replacing traditional meat products with plant-based alternatives.

The primary raw material for their production is plant protein, primarily legume isolates and concentrates, due to their affordability and high processability. At the same time, there has been dynamic growth in consumer demand for alternative dairy products. Although they currently fall short of traditional dairy ingredients in terms of nutritional composition, their key advantage resides in their hypoallergenic properties—the absence of lactose, cholesterol, and casein [8]. Legume shoots (particularly soybeans, alfalfa, and mung beans) are of particular scientific and practical value and are increasingly classified as functional foods.

They are rich in amino acids, fiber, essential trace elements (copper, manganese, selenium), vitamins C and E, as well as a wide range of phenolic compounds and flavonoids, including quercetin, rutin, daidzein, and genistein. Given their rich nutritional profile, leading organizations in the field recommend incorporating legumes into the daily diet. In particular, the FAO highlights their significant role in supporting human health and preserving the planet's ecosystems. It has been proven that including as little as 50 g of legumes in one's daily diet helps reduce the overall risk of mortality [6].

Thus, systematic support for the production and promotion of the consumption of legumes is a strategic step toward achieving sustainable development goals and safeguarding the health of future generations.

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