UDK 633.88:581.522.4(575.1)

BIOECOLOGICAL CHARACTERISTICS AND MEDICINAL IMPORTANCE OF THE RAW MATERIALS OF TURMERIC (CURCUMA LONGA L.) INTRODUCED IN THE CONDITIONS OF UZBEKISTAN

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Abstract: *This study analyzes the morphological, bioecological, and chemical properties of Curcuma longa L. (Turmeric) introduced into the climatic conditions of Uzbekistan. The research results revealed that the content of curcuminoids in the plant rhizomes ranges from 3,0% to 6,5%, with curcumin being the dominant compound (55-75%). Furthermore, the total amino acid content (7,80-9,50%) and its significance for the human body were investigated. The article highlights the hepatoprotective, antioxidant, and immunomodulatory properties of turmeric rhizomes, as well as their strategic importance as an import-substituting raw material for the local pharmaceutical and food industries.*

Keywords: *Curcuma longa L., introduction, curcumin, amino acids, hepatoprotective, pharmaceuticals, antioxidant, raw materials.*

Introduction

The flora of Uzbekistan is rich in more than 4,400 plant species, among which essential oil-bearing and medicinal plants occupy a special place. To provide the national pharmaceutical industry with local raw materials, it is relevant to study introduced plants such as Turmeric (Curcuma longa L.) under introduction conditions. This species of turmeric is a perennial herb that grows mainly in tropical and subtropical climates.

Today, nearly 40% of the medicines used in modern medicine are derived from plants. Preparations made from turmeric raw materials are distinguished by their potent anti-inflammatory, antioxidant, and liver-restoring properties. In particular, the curcumin substance in its composition shows high efficiency in strengthening the immune system and preventing oncological diseases. Establishing scientifically-based technologies for growing turmeric in plantations within the Republic serves to preserve the reserves of wild medicinal plants. This plant is not only a source of valuable bioactive substances but also an economically effective introduced plant widely used in the food industry and traditional medicine. Its cultivation in a managed environment enriches the local flora with new species

and serves as an important solution for meeting the pharmaceutical industry's need for high-quality raw materials.

Research Objects and Methods. The perennial herb Turmeric (Curcuma longa L.), belonging to the Zingiberaceae Martynov family, was selected as the object of study. Biometric, bioecological, and statistical methods used in the experiments were processed based on the obtained indicators using MS-Excel. This plant originates from tropical and subtropical regions and is cultivated as an introduction object in South Asia, India, China, as well as under the climatic conditions of Uzbekistan. Due to the valuable curcuminoids and essential oils in its composition, it is widely planted and cultivated on a global scale.

Results and Discussion. Turmeric is a perennial herb reaching a height of 0,6 to 1 meter, sometimes exceeding these dimensions. The underground portion is well-developed, consisting of succulent, ovoid, or cylindrical rhizomes, which feature a bright orange or yellowish interior. The leaves are large and oblong-elliptical, emerging from the stem to form a sheath, and are light green in color. The flowers possess a complex structure, forming a cylindrical spike-like inflorescence at the tip of the stem. The bracts are aesthetically pleasing, with light green or whitish-pink hues. The fruit is a three-valved capsule; however, seed production is rarely observed in cultivation, and the plant is primarily propagated vegetatively through its rhizomes.

The fragrant, bright orange rhizomes are the primary product, harvested between December and January at the conclusion of the vegetation period once the aerial parts have yellowed and dried. This raw material is exceptionally rich in biologically active compounds, specifically curcuminoids and essential oils. Consequently, it is extensively utilized in medicine (for treating inflammation and liver/gallbladder diseases), food production (as a spice and natural dye), and the cosmetics industry.

Turmeric rhizomes are regarded as a vital medicinal and functional raw material across Asia and Europe. They are integral components of global "superfoods," bioactive supplements, and medicinal teas. Due to its potent antioxidant and immunomodulatory properties, turmeric has gained global popularity as the "golden spice". Historically, it has been used for blood purification, wound healing, and improving digestive functions.

Chemical Composition. The composition of Curcuma longa L. is remarkably diverse, contributing to its medicinal, dietary, and pharmaceutical value. The primary components include:

Curcuminoids (Curcumin). The most significant bioactive component, possessing strong antioxidant, anti-inflammatory, and anti-tumor properties that protect cells from free radicals;

Essential Oils. Contains compounds such as turmerone, zingiberene, and phellandren, which provide its characteristic aroma and antimicrobial activity;

Vitamins. Rich in Vitamins C, E, K, and the B-complex group (B1, B2, B3, B6).

Minerals and Microelements. Contains high levels of essential elements including iron, manganese, potassium, calcium, copper, and zinc.

Polysaccharides and Fiber. Complex carbohydrates that enhance digestive functions and regulate intestinal microflora.

Organic Compounds. Substances that accelerate metabolism and facilitate the regeneration of liver cells.

Due to its active composition, turmeric provides immunomodulatory, choleretic (bile-stimulating), and blood-thinning effects. It is highly valued in treating liver, joint (arthritis), cardiovascular, and gastrointestinal diseases. Its specific medicinal benefits are summarized below:

Anti-inflammatory and Antiseptic. Curcumin blocks inflammatory mediators at the cellular level and acts as a natural antibiotic against various infections.

Antioxidant and Oncoprotective. Neutralizes free radicals, protecting cells from oxidative stress and slowing the aging process.

Hepatoprotective and Choleretic. Protects hepatocytes from toxins, stimulates regeneration, and improves bile secretion to prevent gallbladder stones.

Digestive Regulation. Strengthens gastrointestinal mucous membranes, eliminates flatulence, and relieves chronic digestive pain.

Immunomodulatory. Increases overall resistance, particularly aiding recovery after viral and bacterial illnesses.

Cardiotropic and Blood Purification. Reduces "bad" cholesterol, prevents arterial plaque, and cleanses the blood of toxins.

Experimental Results and Analysis. Modern and classical methodologies were employed to study Curcuma longa L., including High-Performance Liquid Chromatography (HPLC) to quantify curcuminoids (curcumin, demethoxycurcumin, and bisdemethoxycurcumin) and Spectrophotometric methods to analyze total polyphenols and antioxidant activity.

Research findings indicate that the total curcuminoid content in the rhizomes ranges between 3,0% and 6,5%. Curcumin is the dominant substance (55-75%), providing the plant's bright orange color and its potent anti-inflammatory activity. Additionally, the essential oil content (2,5-5,0%) includes turmerone (20-30%), zingiberene, and atlantone, which collectively provide antioxidant and antiseptic effects (Table 1).

Table 1

Turmeric (Curcuma longa L.) the composition of biologically active substances and basic components of rhizomes

№	Components name	Amount (%)	Main feature
1.	Common curcuminoides	3,0 - 6,5	Antioxidant, anti-inflammatory

2.	*including: curcumin*	55,0 - 75,0*	Dominant active ingredient
3.	Essential oils	2,5 - 5,0	Antiseptic, fragrance
4.	Turmeron	20,0 - 30,0*	Immunomodulator
5.	Additives	1,5 - 3,0	Adstringent (binding)

* - share in the total group.

As you can see from the table above, the amount of the bioactive substance curcumin (55-75%) in the composition of a long zarchava is an absolute dominant, which determines the specific bright color and healing (anti-inflammatory, antioxidant) properties of the plant. Turmerone and essential oil compounds enhance the plant's immunomodulatory and antiseptic effects. The main biological activity of turmeric is due to the complex of curcuminoids and essential oils it contains.

Table 2

Turmeric (Curcuma longa L.) amino acid composition of rhizomes

№	**Amino acid content (on dry matter basis)**	**Curcuma longa L. (%)**
1.	Asparaginic acid	0,45 - 0,52
2.	Glutamic acid	0,38 - 0,44
3.	Leysin	0,25 - 0,30
4.	Valin	0,20 - 0,26
5.	Phenylalanine	0,18 - 0,22
6.	Lysine	0,15 - 0,19
7.	Arginine	0,12 - 0,16
8.	Histidine	0,08 - 0,11

As shown in the table above, aspartic and glutamic acid levels in the plant are remarkably high. These amino acids play a vital role in plant metabolism and protein synthesis. Furthermore, the presence of essential amino acids such as leucine, valine, and lysine increases the biological value of turmeric raw materials and explains its use for both medicinal and dietary purposes.

Total Amount and Biological Value. Research results indicate that turmeric rhizomes are rich in amino acids, with their total amount ranging from 7,80% to 9,50% relative to absolute dry raw material. This indicator demonstrates that the plant is not only a source of curcuminoids but also a source of high-nutritional protein compounds.

In this context, the sum of 8 essential amino acids required for the human body constitutes approximately 35-38% of the total amount, which signifies the plant's high-quality protein composition. Additionally, the highest concentrations found in turmeric rhizomes are aspartic acid (0,52%), glutamic acid (0,44%), and leucine (0,30%).

Aspartic and glutamic acids play a decisive role in nitrogen metabolism processes in the body and provide energy for immune system cells. Adequate levels of leucine and lysine are important for muscle tissue regeneration and enzyme synthesis. Although methionine content is low compared to other components, it acts synergistically with curcumin to protect liver function.

In conclusion, with its balanced amino acid composition, Curcuma longa L. rhizomes are significantly important not only for pharmaceutical preparations (anti-inflammatory, hepatoprotective) but also for dietetics, functional foods, and the production of immune-strengthening agents

Conclusion

The conducted research demonstrates that Turmeric (Curcuma longa L.) is a highly promising introduced plant for enriching the flora of Uzbekistan and providing the pharmaceutical industry with high-quality raw materials. The main findings of the study are summarized as follows:

The introduction of Curcuma longa L. (Turmeric) into the climatic conditions of Uzbekistan holds strategic importance in supplying the local pharmaceutical sector with quality and affordable raw materials. Based on their morphological and bioecological characteristics, the plant's rhizomes serve as a source of raw materials with high biological activity.

Research results indicated that the total curcuminoid content in turmeric rhizomes ranges from 3,0% to 6,5%, with curcumin (55-75%) being the absolute dominant compound. This dominant constituent is the primary factor determining the plant's potent anti-inflammatory, antioxidant, and oncoprotective properties.

Amino acid analysis revealed that turmeric rhizomes possess high dietary value in addition to their medicinal properties. The total amino acid content constitutes 7,80-9,50% of the absolute dry raw material, with nearly 40% consisting of essential amino acids vital for the human body. The high levels of aspartic and glutamic acids confirm the plant's activity in metabolic processes.

Turmeric raw material is a versatile product for modern medicine, dietetics, and the food industry, owing to its hepatoprotective (liver-protecting), cardiotropic, and immunomodulatory effects. Its industrial-scale cultivation in local conditions enables the production of natural preparations that serve as local substitutes for imported medicines.

The wide-scale cultivation of Curcuma longa L. through plantation methods in the Republic, while enriching the local flora, contributes to creating a stable raw material base for the pharmaceutical, perfumery, and food industries.

Furthermore, the synergy between curcuminoids and amino acids in the plant rhizomes enhances its adaptogenic and protective properties. Specifically, the potent anti-inflammatory effect of curcumin, combined with the immune-supporting properties of aspartic and glutamic

acids, allows for the production of complex medications that ensure body resistance to various infections and oxidative stress.

The significant proportion of essential amino acids (35-38%) enables the use of turmeric raw material not only as a spice but also in the functional food and phytopharmaceutical industries as a source of highly bioavailable proteins. This elevates the plant's nutritional and pharmaceutical value to a new level.

In final conclusion, the chemical composition of Curcuma longa L. confirms that it is not merely a traditional spice but a strategic raw material for modern phytopreparations that regulate metabolic processes, restore liver function, and strengthen the immune system. Expanding the cultivation of this plant under the soil and climatic conditions of the Republic serves as an important source of raw materials for increasing the volume of local import-substituting products in the pharmaceutical and culinary sectors.

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