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ТИББИЁТДА ЯНГИ КУН
НОВЫЙ ДЕНЬ В МЕДИЦИНЕ
NEW DAY IN MEDICINE

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BRASSICA OLERACEA VAR. ITALICA PLENCK OVERVIEW

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✓ ***Resume***

Broccoli is one of the oldest vegetables on earth. This review presents the latest data on the phytochemical composition, pharmacological properties of broccoli. There are robust epidemiological data on the beneficial effects of broccoli consumption on health, many of which are clearly mediated by the isothiocyanate sulforaphane. Present in the plant as its precursor, glucoraphanin, sulforaphane is formed by the action of myrosinase, a β-thioglucosidase found either in plant tissues or in the mammalian microbiome. The second important glucosinolate found in broccoli is glucobrassicin (3-indolylmethylglucosinolate), derived from tryptophan and releasing the biologically active indole-3-carbinol (I3C) upon hydrolysis. In addition, various parts of broccoli contain various biologically active substances, such as polysaccharides, phenolics, proteins and nitrogen-containing compounds, vitamins and minerals. These chemicals are known to have powerful antioxidant, anti-inflammatory, and anti-cancer effects.

Key words: Botanical characteristics of broccoli; significance of broccoli in folk and traditional medicine; phytochemical composition of broccoli; glycosinates; isothiocyanates; phenolic compounds.

BRASSICA OLERACEA VAR. ITALICA PLENCK XUSUSIY TURLARI

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✓ ***Rezyume***

Brokkoli Yerdagi eng qadimgi sabzavotlardan biridir. Ushbu sharhda brokkolining fitokimyoviy tarkibi va farmakologik xususiyatlari haqidagi so'nggi ma'lumotlarni taqdim etilgan. Brokkoli iste'mol qilishning sog'liq uchun foydali ta'siri haqida ishonchli epidemiologik dalillar mavjud, Bu foydali xususiyatlar tarkibidagi izotiosionat- sulfaranga bog’liq. O'simlikda uning kashshofi sifatida mavjud bo'lgan glyukorafanin, sulforafan o'simlik to'qimalarida yoki sutemizuvchilar mikrobiomasida joylashgan mirozinaza, b-tioglyukozidaza ta'sirida hosil bo'ladi. Brokkoli tarkibidagi ikkinchi muhim glyukozinolat glyukobrassisin (3-indolilmetilglyukozinolat) bo'lib, u triptofandan olinadi va gidroliz paytida biologik faol indol-3-karbinolni (I3C) chiqaradi. Bundan tashqari, brokkolining turli qismlarida polisaxaridlar, fenollar, oqsillar va azot o'z ichiga olgan birikmalar, vitaminlar va minerallar kabi turli xil biologik faol moddalar mavjud. Ushbu kimyoviy moddalar kuchli antioksidant, yallig'lanishga qarshi va saratonga qarshi ta'sirga ega ekanligi ma'lum.

Kalit so'zlar: Brokkolining botanik xususiyatlari; brokkolining xalq va an’anaviy tibbiyotdagi ahamiyati; brokkolining fitokimyoviy tarkibi; glikozinatlar; izotiosiyanatlar; fenolik birikmalar.

ОБЗОР РАЗНОВИДНОСТИ BRASSICA OLERACEA VAR. ITALICA PLENCK

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✓ ***Резюме***

Брокколи — один из древнейших овощей на Земле. В этом обзоре представлены новейшие данные о фитохимическом составе, фармакологических свойствах брокколи. Существуют надежные эпидемиологические данные о благотворном влиянии потребления брокколи на здоровье, многие из которых явно опосредованы изотиоцианатом сульфорафаном. Присутствующий в растении в качестве своего предшественника, глюкорафанина, сульфорафан образуется под действием мирозиназы, β-тиоглюкозидазы, обнаруженной либо в тканях растений, либо в микробиоме млекопитающих. Вторым важным глюкозинолатом, обнаруженным в брокколи, является глюкобрассицин (3-индолилметилглюкозинолат), полученный из триптофана и высвобождающий биологически активный индол-3-карбинол (I3C) при гидролизе. Кроме того, различные части брокколи содержат различные биологически активные вещества, такие как полисахариды, фенолы, белки и азотсодержащие соединения, витамины и минералы. Известно, что эти химические вещества обладают мощным антиоксидантным, противовоспалительным и противораковым действием.

Ключевые слова: Ботаническая характеристика брокколи; значение брокколи в народной и традиционной медицине; фитохимический состав брокколи; гликозинаты; изотиоцианаты; фенольные соединения.

Relevance

The plant world is one of the most necessary factors that ensure life on earth. All over the world preference is given to natural plant products, as medicines and vegetables for the prevention and treatment of various diseases due to their less painful effects.

Although modern chemistry has allowed the creation of the most advanced synthetic drugs, the drugs obtained in this way have not lost their side effects and toxicity. One of the main reasons for this is that it is often not possible to completely separate the chemicals used in the process. For this reason, the need for natural medicines has not decreased, but their value has increased. For this reason, almost 40% of drugs and drugs used in scientific medicine are drugs derived from medicinal plants or drugs derived from them. After all, medicinal preparations obtained from medicinal plants differ from synthetic ones in softness of action, low toxicity and a small number of side effects.

Abu Ali ibn Sina and Abu Raykhan Beruniy, one of our world famous ancestors, left an indelible mark on the search for medicinal plants in nature and the treatment of diseases.

Epidemiological studies have shown that natural foods strengthen the immune system and act as anti-inflammatory, antioxidant, anti-mutagenic and anti-cancer agents, one such agent is the miracle vegetable broccoli from the Brassicaceae family [1].

The anti-cancer properties of cruciferous vegetables are primarily documented by the Roman statesman Cato and the Elder (234-149 BC), who in his study of medicines wrote: “If a cancerous ulcer appears on the chest, apply a crushed cabbage leaf to it, and he will recover."

The genus Brassica of the cabbage family Brassicaceae is of ancient origin. Its homeland is the coast of the Mediterranean Sea and the Atlantic Ocean with a moderately warm and humid climate. Chinese and Beijing cabbage came to us from the east. White cabbage was appreciated long before our era. Science has proven that they began to grow cabbage at the end of the Stone Age. The domestication of cabbage coincides with the development of human culture and civilization in Ancient Egypt and the Roman Empire; ancient writings report many distinct but still headless types (Charlemagne's Capitulare de villis, written 792–800 AD) that were first primarily used as medicinal plants and later as vegetables [1,2]. Over the course of millennia, through selection from wild cabbage, a person has managed to obtain a wide variety of forms, from a simple leafy type (leaf cabbage, var. viridis L.) to various highly valuable modifications associated with developmental delay, enlargement and morphological changes in above-ground organs, stems or buds) of inflorescences in broccoli (var. italica L.) and cauliflower (var. botrytis L.), folding leaves into “heads” in cabbage (var. capitata L.), an increase in the basal stem in kohlrabi (var. gongylodes L.), thickened stems in bone-stem cabbage (var. medullosa Thell.), proliferation of head buds in Brussels sprouts (var. gemmifera (DC.) Zenker) and others [3,4,5].

Broccoli is one of the oldest vegetables on earth. It did not exist in the wild: scientists have found that this type of cabbage was bred in the 6th-5th centuries BC. In the 1st century BC, the ancient Roman scientist Pliny wrote a description of broccoli, where he called it a "blessed plant." Despite the fact that

broccoli was very loved in ancient Rome, the rest of the world did not suspect its existence. After Rome, broccoli was recognized in ancient Greece - more than 2,000 years ago. Then, centuries later, broccoli came to Byzantium (modern Turkey), and from there it spread throughout the world. The name "broccoli" was popular only in Rome. In the rest of the world, it was called "Italian asparagus" - everywhere except in Germany. There, the cabbage was called "brown kopf" - brown head [6].

Broccoli (Brassica oleracea var. italica Plenck) is an annual, herbaceous crop belonging to the Brassicaceae family, which is a relative of Brussels sprouts, white cabbage, cauliflower and leaf cabbage. The name 'broccoli' comes from the Italian 'broccolo' meaning the flowering top of a cabbage [16,23,81], and has more divided and petiolate leaves. The main head consists of clumps of fully differentiated flower buds arranged less densely on longer stems. Germinating forms of broccoli bear many small flower heads. It grows reaching 400 mm in the vegetative phase and 1–2 m at the end of the flowering period [102]. The development of the head of broccoli is an important factor determining their phytochemical composition, since significant changes occur at this stage [7].

Broccoli can grow in a variety of climates and geographies; this suggests a significant impact not only on the yield potential, but also on various qualitative characteristics of broccoli (aroma, texture, taste, etc.) and on the levels of healthy compounds in them [8].

Broccoli is a herbaceous plant with a branched root, erect, cylindrical, branched, thick, green stem with leathery, oblong, glaucous or green basal leaves. Plants in the vegetative phase are short, medium to tall, branched or unbranched, with horizontal or upward directed leaves. The leaves are lyre-pinnately divided, lyre-pinnate-lobed or lyre-shaped, rarely indistinctly lyre-shaped, large, on long petioles of a dark gray-green color. The leaf blade is smooth and shiny or slightly corrugated, the edges are varied, wavy to slightly curly. Unlike cauliflower, broccoli is tall and branchy. The main stem ends with a broccoli head inflorescence, which is a commonly consumed organ [66,102]. When the apical inflorescence is removed, lateral heads develop in the axils of the leaves, which increases the yield. At the ends of the central axis and branches (stems) of broccoli are dense, green, edible clusters of flower buds (flowers), which, if not picked, bloom with four-petalled yellow flowers and produce silky fruits. Flower brushes are long. Flowers with yellow, rarely white petals, collected in a multi-flowered raceme, 1.5-2.0 cm in diameter, with a limb from round to narrow oval, blister-like or corrugated wrinkled, suddenly tapering into a nail. The fruit of broccoli is a two-nest thin pod, 6.0-8.5 cm long, which ends with a short spout. In shape, the pods are predominantly cylindrical, tuberculate and implicitly tuberculate. Seeds are round, dark brown to black, small. Blooms in September-October. This plant is cultivated [9,10,11].

Chemical composition of representatives of the genus Brassica

Polysaccharides. Complex carbohydrates (polysaccharides), in particular, a group of pectin substances that can remove heavy metal salts from the body, are recognized as a highly valuable component of broccoli. The carbohydrate composition of cabbage is varied. It is represented by sugars, starch, fiber, hemicellulose and pectin. Sugars are mainly represented by monosaccharides (glucose and fructose), but in cabbage stalks up to 40-50% can be sucrose. According to the content of high-molecular carbohydrates, types and subspecies of cabbage differ significantly. A high fiber content (for raw raw materials) is characterized by leafy cabbage (1.4-2.5%) and kohlrabi (1.0-1.4%), it is less significant for Brussels sprouts and broccoli (1.2-1.3 %), even less for head (about 0.5-1.1%).

Cabbage hemicelluloses are mainly represented by pentosans, which include arabinose and galactose. The highest content of pentosans in leafy cabbage is 2.2% (per crude substance), in broccoli it is about 1.0%, and the lowest in white cabbage is 0.55% [12,13].

Sulfur compounds. The most important biologically active compounds of plants of the cabbage family are isothiocyanates, which can affect liver enzymes, stop inflammatory processes, increase immunity and slow down the development of cancer cells. Among the isothiocyanates in broccoli, sulforaphane predominates, which prevents the development of cancer at the molecular level, in particular, reducing oxidative stress [8,14].

Sulforaphane was described in the middle of the last century as an antibiotic, and was isolated from red cabbage, as well as from the western US pasture weed watercress. It has since been synthesized by various groups, but Talalay and Zhang were the first to isolate it from broccoli and demonstrate its anti-cancer properties. Its biogenic precursor, glucoraphanin, has been found abundantly in broccoli sprouts, and sulforaphane has been confirmed to be active in animal models of carcinogenesis [15].

Sulforaphane has the chemical structure 4-methylsulfinylbutylisothiocyanate or 1-isothiocyanate-4-methylsulfinylbutane, isothiocyanate, the main bioactive component of broccoli, is an unstable isothiocyanate stored in the plant as glucoraphanin [16].

Glucosinolates are a naturally occurring class of organic compounds that contain sulfur and nitrogen and are derivatives of glucose and the amino acid. They are water-soluble anions and belong to glucosides. Each glucosinolate contains a central carbon atom that is bonded to the sulfur atom of the thioglucose group and through the nitrogen atom to the sulfate group (forming sulfated aldoxime). In addition, the central carbon is linked to the side group; different glucosinolates have different side groups, and it is variations in the side group that are responsible for changing the biological activity of these plant compounds. The essence of the chemistry of glucosinolates lies in their ability to convert isothiocyanate ("mustard oil") upon hydrolysis of the thioglucoside bond by the enzyme myrosinase [12,17].

Glucosinolates (GSL) constitute a well-defined group of specialized plant metabolites with characteristic structures and biochemistry. Structurally, they are anions consisting of thiohydroxymates bearing an S-linked β-glucopyranosyl residue and an O-linked sulfate residue, as well as an amino acid-derived variable side chain. Sometimes additional substituents are attached to the O, S or N atoms of the side chain or the glucosyl moiety.

Glucosinolates are sulfur-containing secondary plant metabolites derived from amino acids. The basic structure of glucosinolate consists of a β-d-thioglucose group linked to a sulfonated aldoxime group and a variable side chain derived from amino acids. Depending on the amino acid precursor, glucosinolates are classified as follows:

1) Aliphatic glucosinolates derived from leucine, isoleucine, methionine or valine;

2) Aromatic glucosinolates derived from tyrosine and phenylalanine.

3) Indole glucosinolates derived from tryptophan [16,17].

Most isothiocyanates are metabolized in vivo via the mercapturic acid pathway. Indole compounds can react with ascorbic acid to form ascorbigen, and in the case of low gastric Ph, a number of condensed products that can act as additional biologically active compounds [18].

The glucosinolates found in the extract were neoglucobrassicin, glucobrassicin, 4-methoxy-glucobrassicin and 5-methoxy-glucobrassicin. These are the main glucosinolates found in broccoli, followed by 4-hydroxyglucobrassicin, gluconasturthiin, glucoerucin, and progoitrin, which were not detected by the LC-MS analysis method used [19].

Proteins and nitrogen-containing compound. Broccoli differs from other species in its increased content of nutrients, especially in its specific taste and higher biological activity. According to experimental data, a high protein content is known, which includes the anti-sclerotic substances choline and methionine, as well as such essential amino acids as lysine, methionine, valine, isoleucine, leucine, threonine, phenylalanine; interchangeable - tyrosine, histidine, alanine, arginine, aspartic acid, glycine, glutamic acid, proline, serine. In terms of protein, broccoli is superior to sweet potato, sweet corn, asparagus, and spinach.

As you know, the protein of all types of cabbage contains purine substances, which, turning into uric acid, can be deposited in the kidneys in the form of stones.

There are few purine substances in the protein of broccoli - almost 4 times less than that of cauliflower, which gives it an advantage over the latter. In terms of the content of most essential amino acids in the protein, broccoli is not inferior to beef, and in terms of the presence of isoleucine, lysine and tryptophan, it is not inferior to chicken egg protein. Young broccoli leaves are nutritionally equal to spinach and kale [20].

Qualitatively and quantitatively determined the content of total protein in broccoli. A qualitative reaction (biuret reaction) with an alkaline solution of copper (II) salts with the formation of a violet color confirmed the presence of protein in the raw material. Broccoli protein isolate was prepared for protein quantitation.

Quantitative determination of protein in raw materials was carried out according to the Bradford method with Coomasi reagent and found 6.09 g of protein per 100 g of dry raw materials. For the quantitative determination of protein in raw materials, the microbiuret method with Benedict's reagent was used and 18.6 g of protein per 100 g of dry raw materials were found. The protein content in broccoli is not inferior to protein of animal origin, for example, a chicken egg contains 13 g of protein per 100 g of the product [18].

One of the more labile proteins in the plant body are enzymes. Cabbage is characterized by high activity of iron- and copper-containing enzymes: cytochrome oxidase, peroxidase, ascorbate oxidase, etc. Cabbage tissues are also characterized by high activity of carbohydrases, namely amylase, hemicellulose, sucrase. Proteolytic enzymes (leucyl peptidase, transaminase) have also been found, an increased amount of which is found in tissues with a large amount of protein [6,14].

The composition of non-protein nitrogen-containing substances, in addition to amino acids, includes some biologically active substances: choline, betaines, etc. The choline content of broccoli is 90 mg/100 g, cauliflower 73 mg/100 g and Brussels sprouts 77 mg/100 g (raw). The content of the same substance in white cabbage is much less - on average 17-25 mg / 100 g. The largest amount of betaine is found in red cabbage (240-702 mg / 100 g) and the smallest - in cauliflower (87-149 mg / 100 g) [6,12].

Vitamins and minerals. Both macro and micronutrients are not the last among the most important phytochemicals in broccoli. The content of macro- and microelements in food is very small - milligrams or micrograms, but their amount in the body must correspond to the physiological needs of a person. They are not sources of energy, but are involved in the assimilation of food, the regulation of functions, the implementation of the processes of growth, adaptation and development of the body [6].

In plants, minerals are either in the cell sap in a dissolved state, or they are associated with organic compounds. In medicine, plants containing macro- and microelements are used as medicines, because a number of diseases are associated with a lack of one or another element in the body. Minerals perform a plastic function in the processes of human life, participating in the metabolism of almost any human tissue, but their role is especially great in building bone tissue, where elements such as phosphorus and calcium predominate. Mineral substances are involved in the most important metabolic processes of the body - water-salt, acid-base. Many enzymatic processes in the body are impossible without the participation of certain minerals, because. they are part of enzymes, active organometallic compounds.

Among the mineral salts, macro- and microelements in the composition of broccoli, potassium should be noted, which removes excess salts and water from the body; calcium and phosphorus, which ensure the functioning of bone and brain tissues; iron, copper, cobalt, which take part in hematopoiesis; iodine prevents thyroid disease. This plant also contains a large amount of macronutrients (sodium, potassium, calcium, magnesium, phosphorus) and microelements (iron, aluminum, manganese, copper, molybdenum, nickel, zinc, silicon). Especially a lot of carotene in broccoli (provitamin A), which is not found in cauliflower. By the amount of carotene, it is second only to carrots. In the human body, carotene turns into retinol, which promotes the growth and development of the body, normalizes metabolism, increases the protective properties of the body against infectious diseases, improves the condition of the skin and mucous membranes, and the retina of the eye. Broccoli also contains vitamins B1, B2, C, PP, B6, E. According to the content of vitamin C, broccoli is inferior only to lemon, although it is much sweeter than the latter. In addition, vitamin C is contained in cabbage not in the form of ascorbic acid, but in the form of its predecessor, ascorbigen, which is not destroyed during storage. B vitamins have a beneficial effect on the nervous system [16,23].

The study of the accumulation of vitamins in various organs (head, stems, stalks) and shoots (main, axillary) of cabbage showed that the content of vitamins E and PP in both the main and axillary heads exceeds all types of cabbage by 2-3 times, accumulating them even in the edible part of the stalk. The amount of vitamin P in broccoli is negligible [24]

Carotenoids (carotenes and xanthophylls) are yellow, orange and red pigments found in many fruits and vegetables. Some of them are vitamin A precursors (i.e. β-carotene, γ-carotene and β-cryptoxanthin), and due to conjugated double bonds they are both radical scavengers and singlet oxygen quenchers. Lower serum levels of β-carotene have been associated with higher rates of cancer and cardiovascular disease [25].

Among the vitamins in broccoli, a special place is occupied by vitamin K (about 140-150 mcg / 100 g, which is 15-20% higher than the daily norm for an adult) and vitamin C, according to the content of which per 100 g asparagus cabbage, even boiled and frozen easily outperforms almost all citrus fruits. Moreover, in broccoli, vitamin C is presented in the form of ascorbigen, a precursor of ascorbic acid, which is almost not lost during storage. A lot in broccoli and the precursor of vitamin A - carotene. According to this indicator, asparagus cabbage "loses" only carrots, and favorably stands out against the background of cauliflower, where there is very little carotene. There is also a certain amount of Omega-3 (about 0.12 g/100 g) and Omega-6 (0.05 g/100 g) in this vegetable [11,19].

One of the vital substances is vitamin U. This vitamin is found in cabbage juice, has a specific effect: it is a donor of methyl groups, which have a beneficial effect on the regeneration of the lining of the gastric mucosa. A valuable property of vitamin U is the presence of labile methyl groups that can easily be included in the exchange, due to which fat-mobilizing and lipolytic effects are achieved. The main pharmacological action of vitamin U is the healing of the mucous membranes of internal organs. Due to this property, the vitamin was called the anti-ulcer factor [20].

Vitamin U is methylated methionine S-methylmethionine (SMM) - vitamin U - was obtained as a result of research by American scientists G. Cheney (1940–1950) and G. Cummings et al. (1946). The first reports on the effectiveness of cabbage juice (SMM) appeared in the 40-50s of the last century. The isolated substance with an antiulcer effect was called vitamin U (from the Latin ulcus - ulcer).

In 1942, G. Cheney first identified the role of vitamin U in the treatment of peptic ulcers, based on the results of 5 years of research showing that the addition of this factor to the diet can prevent ulcers and/or treat ulcers [9,21].

The purpose of this retrospective study is aimed at familiarizing and comprehensively studying the botanical characteristics, phytochemical composition and the role of bioactive metabolites of cruciferous broccoli in the prevention and treatment of various diseases.

Conclusion

In recent years, broccoli has been one of the most consumed vegetable foods. It has gained acceptance as a functional food, or nutraceutical, due to the growing consumer interest in diets that support health and longevity. Consequently, health-promoting compounds from broccoli have been extracted and isolated for inclusion in food and pharmaceutical formulations. Over the past ten years, the extraction, isolation and characterization of the functional properties of these broccoli products have been demonstrated in many scientific publications. A critical review and retrospective analysis of domestic and foreign literature of recent years on the subject of research has been carried out. From scientific domestic and foreign literature sources available to us, it was found that representatives of the genus Brassica have long been used in folk and official medicine, due to the rich phytochemical composition, in addition, broccoli is cultivated on the territory of the Republic of Uzbekistan. They have been proven to be a rich source of important natural compounds, including glucosinolates, phenolic compounds, flavonoids, vitamins, minerals and pigments.

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