DOI:10.26104/IVK.2024.45.557



**ISSN 1694-7681 (Print)**
**ISSN 1694-8475 (Online)**
**DOI:10.26104/IVK.2024.45.557**

**ЖУРНАЛ «ИЗВЕСТИЯ ВУЗОВ»**
**ОСНОВАН 2001 ГОДУ, ПЕРЕИМЕНОВАН**
**В «ИЗВЕСТИЯ ВУЗОВ КЫРГЫЗСТАНА»**
**В 2015 ГОДУ, ВЫХОДИТ ЕЖЕМЕСЯЧНО**

Зарегистрирован
в Министерстве юстиции
Кыргызской Республики
Регистрационный № 673
от 19 декабря 2001 года

**Республиканский научно-теоретический журнал**

# ИЗВЕСТИЯ ВУЗОВ КЫРГЫЗСТАНА № 6, 2024

БИШКЕК – 2024

DOI:10.26104/IVK.2024.45.557



**ISSN 1694-7681 (Print)**
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# ИЗВЕСТИЯ ВУЗОВ КЫРГЫЗСТАНА
# 2024 № 6 (Декабрь)

**РЕСПУБЛИКАНСКИЙ НАУЧНО-ТЕОРЕТИЧЕСКИЙ ЖУРНАЛ**
Журнал зарегистрирован в Российском индексе научного цитирования **(РИНЦ)**
(Лицензионный договор №001-01/2015 от 12.01.2015).



Журнал зарегистрирован в Министерстве юстиции Кыргызской Республики (Регистрационный №673 от 19 декабря 2001 г.)

(Свидетельство о государственной перерегистрации серия ГПЮ №150408-3301-ОО код ОКПО 20224813 от 3 ноября 2015 г.).
Издается с 2001 года.

**Выходит:**
**6 выпусков в год.**

**Сдано в набор:**
**1.11.2024.**
**Подписано в печать:**
**30.12.2024.**

Формат 70x108/16
Бумага офсетная.
Гарнитура: «Таймс».
Печать офсетная.
Усл.печ.л. 19,5 п.л.
Тираж 100 экз.

**ИЗДАТЕЛЬСТВО:**
**ОсОО «Издательство научных журналов и детской художественной литературы».**
**г.Бишкек.**

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**sje.kg.2009@mail.ru, сайт: www.science-journal.kg**
**e-mail: sje.kg.2009@mail.ru**

DOI:10.26104/IVK.2024.45.557



***DOI:10.26104/IVK.2024.68.66.020***

***Сунакбаева Д.К.***

# ӨСҮМДҮКТӨРДӨГҮ ФЕНОЛДУК БИРИКМЕЛЕРДИН ЭКОЛОГИЯЛЫК МААНИСИ ЖАНА БИОЛОГИЯЛЫК АКТИВДҮҮЛҮГҮ

***Сунакбаева Д.К.***

# ЭКОЛОГИЧЕСКАЯ ВАЖНОСТЬ И БИОЛОГИЧЕСКАЯ АКТИВНОСТЬ ФЕНОЛЬНЫХ СОЕДИНЕНИЙ В РАСТЕНИЯХ

***D. Sunakbaeva***

# ECOLOGICAL IMPORTANCE AND BIOLOGICAL ACTIVITY OF PHENOLIC COMPOUNDS IN PLANTS

*УДК: 581.192.2:574.4:547.56*

*Бул маселелердин жана кызыкчылыктардын борборунда чөптөр жана табигый азыктар турат. Өсүмдүктөрдүн эң маанилүү заттары-өсүмдүктөрдө экинчи метаболит катары өндүрүлгөн фенолдук бирикмелер. Өсүмдүктөрдүн азыктарында полифенолдор деп аталган фенолдук бирикмелер бар. Фенолдорду эки ири компанияда эң пайдалуу классификациялоо: флавоноиддер жана флавоноид эмес полифенолдор. Антиоксидант кошулмаларына дүйнө жүзү боюнча кызыгуу өсүүдө, алар акыркы жылдары эркин радикалдарды нейтралдаштыруу менен окистенүү стрессин алдын алат. Азыркы учурда адамдардын ден соолугун коргоо, оорулардын алдын алуу жана дарылоо максатында альтернативдүү медицинаны издөө көбөйүүдө. Алардын коргоочу активдүүлүгү алгач антиоксидант, эркин радикалдарды тазалоочу жана металл хелаторлук касиеттерине, андан кийин ар кандай ферменттерди ингибациялоо же азайтуу жөндөмүнө байланыштуу болгон. Акырында, өсүмдүк фенолдук бирикмелеринин структуралык-эффекттик байланыштарын билүү, адамдын ден-соолугуна мүмкүн болгон пайдалуу таасирлерди жана/же жагымсыз таасирлерди аныктоо жана бирикмелердин ылайыктуу колдонулушун аныктоо үчүн кененирээк изилдөөлөр талап кылынарын белгилей кетүү керек.*

***Негизги сөздөр:*** *фенол бирикмелери, өсүмдүктөр, флавоноиддер, биологиялык активдүүлүк, экинчи метаболиттер, полифенолдор, антиоксиданттар.*

*Растительные и натуральные продукты находятся в центре внимания. Наиболее важными растительными веществами являются фенольные соединения, образующиеся в растениях в виде вторичных метаболитов. Фенольные соединения, называемые полифенолами, присутствуют в растительных продуктах. Наиболее полезна классификация фенольных соединений в двух крупных компаний: флавоноиды и неметаллическими флавоноиды, полифенолы. Во всем мире ширится интерес к антиоксидантные соединения, которые могут предотвратить окислительный стресс, нейтрализуя свободные радикалы в последние годы. В настоящее время усиливается поиск альтернативной медицины с целью защиты здоровья людей, профилактики и лечения заболеваний. Их защитная активность была сначала обусловлена их антиоксидантными свойствами, способностью улавливать свободные радикалы и хелатировать металлы, а затем способностью ингибировать или уменьшать количество различных ферментов. Наконец, стоит отметить, что необходимы более подробные исследования, чтобы узнать взаимосвязи между структурой и действием фенольных соединений растительного происхождения, выявить возможные полезные и/или нежелательные воздействия на здоровье человека и определить соответствующие способы применения соединений.*

***Ключевые слова:*** *фенольные соединения, растения, флавоноиды, биологическая активность, вторичные метаболиты, полифенолы, антиоксиданты.*

*Herbal and natural products are at the centre of these issues and interest. The most important of the herbal substances are phenolic compounds produced as secondary metabolites in plants. Phenolic compounds, named polyphenols, are present in plant foods. The most useful classification of phenolics in two major companies: flavonoids and non-flavonoid polyphenols. There is a growing worldwide interest in antioxidant compounds that can prevent oxidative stress by neutralizing free radicals in recent years. Nowadays, the search for alternative medicine has been increasing in order to protect the health of individuals, prevent and treatment of diseases. Their protective activity was firstly attributed to their antioxidant, free radical scavenger, and metal chelator properties, then to their ability to inhibit or reduce different enzymes. Finally, it is worth noting that more detailed studies are needed to know the structure-effect relationships of herbal phenolic compounds, to identify possible beneficial effects and/or undesirable effects on human health, and to determine the appropriate uses of the compounds.*

***Key words:*** *phenolic compounds, plants, flavonoids, biological activity, secondary metabolites, polyphenols, antioxidants.*

**Introduction.** The information on antioxidant potential and health benefits of plant phenolic compounds found by biotechnological applications will be presented in this study. Phenolic compounds play an important role in ecological processes and the functioning of plant organisms. These substances are a class of organic compounds containing one or more hydroxyl groups associated with an aromatic ring. They have a variety of biological and ecological functions. The main group of the secondary metabolites in plants are phenolic compounds with antioxidant properties. The secondary metabolites that are ubiquitous in plants have many practical applications. The roles of these metabolites have lately been accepted in an analytical context. Numbers of phenolic compounds present in natural foods may reduce the risk of serious health disorders because of their antioxidant activity [1]. Due to their antioxidant activities, the numbers of phenolic compounds found in natural foods can prevent many health disorders and reduce the risk. Biotechnology has been getting an increasing consideration towards cure of health problems due to their distinctive biomedical treatments to overcome the targeted drug delivery, designed drug solubility and drug toxicity.

Today, many herbal products that are claimed to have antioxidant, anticancer, antimutagen, anti-inflammatory and antimicrobial properties are used in the treatment

DOI:10.26104/IVK.2024.45.557



of various diseases. Their consumption has been linked with reduced threat of a couple of chronic diseases such as cardiovascular and neurodegenerative illnesses, particular cancers, type II diabetes and osteoporosis, developed with theirs antioxidation, anti-inflammation, modulation of signal transduction, anti-microbial activity, and anti-proliferation activities. Phenolic compounds in our food regimen may just provide extra wellbeing advantages related to diminished chance of setting up illnesses. Most studies have shown the preventive and therapeutic effect of phenolic compounds in chronic diseases. Many studies on livings assume that the intake of phenolic compound rich vegetable food can reduce the risk of various acute and chronic diseases such as cardiovascular diseases, neurodegenerative diseases, type 2 diabetes. The epidemiological studies and related meta-analyzes in recent years have strongly suggested that long-term consumption of plant foods provides protection against diseases associated with oxidative stress, such as cancers, cardiovascular diseases, diabetes, osteoporosis and neurodegenerative diseases. The studies suggests that these mechanisms of action of phenolics are not only related to oxidative stress modulation, but also can be ascribed to their capacity of interact with cellular functions at different levels, such as affecting gene expression, protein synthesis and enzyme activities, binding to membrane or nuclear receptors as either an elective ligand or a ligand mimic. It has been also proclaimed the antibacterial activity of some phenolic compounds against multidrug-resistant bacteria lately [2-4].

This work offers plenty of substantial information on the origin, mode of action and health benefits of dietary plant secondary metabolites owing to their antioxidant properties. A great deal of fascinating knowledge about their biochemistry and metabolism are still waiting to be discovered.

**Dietary Plant Phenolic Compounds.** Ecologically, pharmacologically and biologically important secondary metabolites, synthesized in biochemical pathways, are not necessary for plant growth, although valuable [5]. Phenolics (such as phenolic acids, lignans, stilbenes, tannins, coumarins, flavonoids and lignin), terpenes (such as cardiac glycosides, carotenoids, sterols and plant volatiles) and nitrogen containing compounds (such as alkaloids and glucosinolates) are the three main groups of plant secondary metabolites in broad terms [3]. Plant secondary metabolites are important organic compounds that, despite their importance, are not involved in primary metabolic processes and are essential for the survival of plants against herbivores, pests and pathogens [4]. The main group of secondary metabolites are phenolic compounds with antioxidant properties. The roles of secondary metabolites in plants have recently come to be acknowledged in an analytical context. The primary function of natural products refers to support plant defense against predators and pathogens [6]. Besides, these phyto-compounds provide reproductive advantage in plants as attractants of pollinators and seed dispersers. There are also those that serve other important functions in plants such as acting as pigments, as for anthocyanins or providing structural support, as in the case of lignin. The secondary metabolites used in various medicines and food products due to their potential health benefits since ancient times are ubiquitous in plants and have many practical applications [1]. Additionally, they are still relevant and popular today. Due to their antioxidant activity, numbers of phenolic compounds present in natural foods may lessen the risk of serious health disorders [7-8].

Flavonoids that present ubiquitously in plants as a member of polyphenolic molecules have been used in various medicines and food products since ancient times [9]. Recently, the numbers of the studies administered for the use of flavonoids in various fields of industry are expanding. The family members of flavonoids contain flavones, flavonol, isoflavones, flavanones, flavanonol, flavanol and anthocyanidin. Quercetin, kaempferol, and myricetin are the main representatives of flavonels, and quercetin is most ubiquitous of all. Cyclized diphenylpropane is the form commonly occurring in plants and especially in plant foods [10]. The use of these compounds is becoming common in the area of food, medicine and agriculture because of their antioxidant properties [11]. Phenolic antioxidants with many biological and pharmacological activities are widely distributed in nature. These compounds, characterized by having at least one aromatic ring linked by one or more hydroxyl groups, can range from a structurally simple phenolic molecule to high molecular weight polymers with complex structures. Simple phenols (C6) contain catechols and hydroxybenzoic acid derivatives. Stilbens (C6-C2-C6) and flavonoids (C6-C3-C6) are in phenolic compounds with intermediate molecular weight. The compounds such as catechol melanins (C6)6, lignins (C6-C3)n and condensed tannins (C6-C3-C6)n come in the category of long chain polymers with high molecular weight [12-15]. These phenolic compounds have become an indispensable group of food additives added to foods to control rancidity, to extend shelf life, and to maintain nutritional quality by delaying the formation of toxic oxidation products. Concerns over the use of synthetic antioxidants raise interest in obtaining these antioxidants from natural sources such as plants and edible by-products [16]. In phytotherapy, the plants rich in phenolic compounds, terpenoids and polysaccharides are generally us. These biologically active compounds are specific to the specific regions in cells they target. The cells that function as receptors, enzymes, transcriptional factors, ion channels, transporters, or cytoskeletal elements such as tubulin or microtubules target proteins as the major target molecules. They modify the binding or catalytic sites of enzymes, hence they no longer can bind their required substrate. Proteins are modified by secondary metabolites with reactive functional groups, phenols

DOI:10.26104/IVK.2024.45.557



and polyphenols. Phenolic compounds carry one or more hydroxyl groups and these groups can be bonded to electronegative atoms (O, N) in peptides and proteins by hydrogen bonding. [17]. These OH groups can partially dissociate into negatively charged phenolate ions under suitable physiological conditions. These negatively charged groups form ionic bonds with ease with positively charged amino groups of amino acid residues. When the polyphenols form several hydrogen and ionic bonds with the binding or catalytic site of a protein, the structural and functional flexibility of that protein get reduced, just as the situation with secondary metabolites with reactive functional groups that form covalent bonds with protein.

Isoflavones, called "phytoestrogens", exhibit estrogenic, antitumor and antioxidant activity. Tannins, highly effective antioxidants used in traditional medicine, have known as anti-diarrhea, cytotoxic and antiparasitic properties, today. Tannins, highly effective antioxidants used in traditional medicine, are now known for their anti-diarrhea, cytotoxic and antiparasitic properties. The plant extracts show synergistic effect as they contain more than one secondary metabolite, and the properties of these components may not be distinguished when evaluated separately. Such plant extracts are generally used for the treatment of broad spectrum health disorders [18]. Flavonoids, a broad and diverse group of phenolic compounds obtained from higher plants, are powerful bioactive compounds with anticarcinogenic effects. These effects are due to their ability to interfere with the initiation, development and progression of cancer through modulation of cellular proliferation, apoptosis, and metastasis. In natural products containing compounds such as flavonoids, phenolic acids and their esters, such as plants and their extracts; can be used as a mild antioxidant and preservative after the positive physiological effects of the these products and the non-toxicity are proven. Epidemiological studies have implied the ability of bioactive natural compounds such as flavonoids in plant products to reduce oxidative damage and have protective effects against a wide variety of cancers [19].

Recently, oncologists and other specialist physicians have turned their attention to the use of dietary supplements in patients undergoing chemotherapy in that they fear that antioxidant agents may reduce or increase the therapeutic effectiveness of chemotherapeutic treatment. *In vitro* and *in vivo* tests have shown that flavonoids are effective for the prevention and treatment of many health problems. Flavonoid-rich foods have been shown to reduce the risk of developing cancer due to their protective activities. The nvestigations have been concerned on how various natural products, used in folk medicine due to their some biotechnological and pharmacological activities, prevent or treat human and animal diseases due to their antioxidant potential. By the reason of the presence of different effective compounds such as flavonoids, phenolic acids and their esters in natural dietary products can be used as a mild antioxidant and preservative if their positive physiological effects and non-toxicity are proven [20].

**Plant Phenolic Compounds in The Human Health.** Phenolic compounds, called polyphenols, are present in plant foods. Phenolics are possess outlined as compounds that possess an aromatic ring with at the least one hydroxyl workforce, and their structure can vary from easy molecule to elaborate polymer with excessive molecular weight. Their consumption has been linked with reduced threat of most of chronic diseases such as cardiovascular and neurodegenerative illnesses, particular cancers, type II diabetes and osteoporosis, developed with theirs antioxidation, anti-inflammation, modulation of signal transduction, anti-microbial activity, and anti-proliferation activitie. There is discordance involving the best way wherein to classify them. Regularly probably the most adopted classification implies the subdivision of phenolics in two major companies: flavonoids and non-flavonoid polyphenols, and this classification have been ordinarily used inside the literature. Phenolic compounds play a main position as antioxidants with a high potential to scavenge free radicals, which is stylish on their structure [16].

Secondary metabolites are more diverse structurally and chemically than primary metabolites. These metabolites are compounds that aren't directly required for photosynthesis or respiratory metabolism. However, these compounds are thought to be essential for plants to survive from environment and they are found in special cells. For this reason, secondary metabolite levels in plants are both induced by the influence of the environment and genetically controlled. Secondary metabolites provide defence against herbivores, microorganisms, viruses, or rival plants. These compounds act as signal compounds to attract pollination or seed dispersing animals. It also provides protection of the plant from oxidants and ultraviolet radiation. Thousands of high plant species in the world synthesize many compounds in various structures and classes. These compounds are primary and secondary metabolites. The compounds such as sugars, fatty acids, amino acids and nucleic acids are primary metabolites. Also, primary metabolites include chemicals synthesized by all plants for growth and development. These compounds can vary in a tissue and organ-specific manner, and may differ between different developmental stages, among individuals, or among populations. Secondary metabolites are divided into several groups based on their structural features and biosynthetic pathways.

In recent years, interest in plant phenolics and their positive effects on human health has been increasing. This interest ranges from academics to healthcare professionals, from food producers to food processing and dieticians. The benefits of plant phenolics, which include diets rich in fruits and vegetables, are supported by in vitro

DOI:10.26104/IVK.2024.45.557



research. There is evidence that diets rich in phenolics reduce the risk of developing diseases such as cancer, cardiovascular diseases, osteoporosis, cataracts, brain and immune dysfunction. In addition, phenolic compounds that make up the active substances in commonly used medicinal plant extracts modulate the activity of a wide variety of enzymes and cell receptors. The peculiarity of this protection against diseases is due to the strong antioxidant and free radical scavenging properties of phenolic compounds. As studies have been conducted, more specific benefits of phenolics have also been identified. Phenolics have a protective effect by inhibiting the oxidation of molecules of low-density lipoproteins and DNA bases by free radicals. Isoflavones, stilbens and lignans are phenolics that occur naturally and are structurally similar to mammalian estrogen estradiol-17β. They interact with the estrogen receptor, causing growth of hormone-dependent cancers to deteriorate. In addition, phenolics can inhibit xanthine oxidase and other enzymes associated with the production of harmful reactive oxygen species. Flavonoids have positive effects on controlling type 2 diabetes through glucose absorption and inhibition of haemoglobin glycosylation. It also shows benefits to stimulate insulin secretion and / or effect and to improve insulin binding.

**Conclusion.** This review study presented a current understanding on the bioactivities of natural polyphenols and the benefits to human health. Their protective activity was firstly attributed to their antioxidant, free radical scavenger, and metal chelator properties, then to their ability to inhibit or reduce different enzymes. Bioactivities of natural polyphenols and their benefits to human health are discussed.

Currently, chronic diseases are becoming more common due to environmental pollution, stressful living conditions, nutrition, etc. The prevention of these diseases and inadequate treatment methods or causing unwanted side effects increase the importance of treatment with herbal active substances rather than synthetic substances. Due to the benefits mentioned in this work, the use of phenolic vegetable origin compounds is becoming widespread. However, more detailed investigation is needed to know the structure-effect relationships of plant phenolic compounds, to present possible beneficial effects or undesirable effects on human health, and to ontain the appropriate uses of these compounds.

**References:**


1. Kennedy D.O., Wightman E.L. (2011). Herbal extracts and phytochemicals: plant secondary metabolites and the enhancement of human brain function. Advances in Nutrition, 2(1), 32-50.
2. Shahidi F., Ambigaipalan P. (2015). Phenolics and polyphenolics in foods, beverages and spices: Antioxidant activity and health effects–A review. Journal of functional foods, 18, 820-897.
3. Hartmann T. (2007). From waste products to ecochemicals: fifty years research of plant secondary metabolism. Phytochemistry, 68(22-24), 2831-2846.
4. Ahmed E., Arshad M., Khan M.Z., Amjad H.S., Sadaf H.M., Riaz I., Ahmad N. (2017). Secondary metabolites and their multidimensional prospective in plant life. J. Pharmacogn. Phytochem, 6, 205-214.
5. Kabera J.N., Semana E., Mussa A.R., He X. (2014). Plant secondary metabolites: biosynthesis, classification, function and pharmacological properties. J Pharm Pharmacol, 2, 377-392.
6. Bennett R.N., Wallsgrove R.M. (1994). Secondary metabolites in plant defence mechanisms. New phytologist, 127(4), 617-633.
7. Sevindik M., Akgul H., Pehlivan M., Selamoglu Z. (2017). Determination of therapeutic potential of Mentha longifolia ssp. longifolia. Fresen Environ Bull, 26(7), 4757-4763.
8. Mohammed F.S., Akgul H., Sevindik M., Khaled B.M. T. (2018). Phenolic content and biological activities of Rhus coriaria var. zebaria. Fresenius Environmental Bulletin, 27(8), 5694-5702.
9. Pietta P.G. (2000). Flavonoids as antioxidants. Journal of natural products, 63(7), 1035-1042.
10. Pietta P.G. (2000). Flavonoids as antioxidants. Journal of natural products, 63(7), 1035-1042.
11. Cushnie T.T., Lamb A.J. (2005). Antimicrobial activity of flavonoids. International journal of antimicrobial agents, 26(5), 343-356.
12. Panche A.N., Diwan A.D., Chandra S.R. (2016). Flavonoids: an overview. Journal of nutritional science, 5.
13. Shahidi F., Janitha P.K., Wanasundara P. D. (1992). Phenolic antioxidants. Critical reviews in food science & nutrition, 32(1), 67-103.
14. Dimitrios B. (2006). Sources of natural phenolic antioxidants. Trends in food science & technology, 17(9), 505-512.
15. Surveswaran S., Cai Y.Z., Corke H., Sun M. (2007). Systematic evaluation of natural phenolic antioxidants from 133 Indian medicinal plants. Food chemistry, 102(3), 938-953.
16. Sevindik M. (2019). Wild Edible Mushroom Cantharellus cibarius as a Natural Antioxidant Food. Turkish Journal of Agriculture-Food Science and Technology, 7(9), 1377-1381.
17. Abdirashit kyzy A., Beysheev T. Extractıon of phenol from aqueous solutıons wıth polymer-ınclusıon membranes наука, новые технологии и инновации кыргызстана №7, 2023, http://science-journal.kg/media/Papers/nntiik/2023/7/%D0%9D%D0%9D%D0%A2_7-2023_81-86.pdf
18. Mamashukurov A., Karabaev N.Influence of sıderates on the bıologıcal productıvıty of cotton and soıl fertılıty. / Известия вузов Кыргызстана, №6, 2022, http://science-journal.kg/media/Papers/ivk/2022/6/%D0%9F%D0%94%D0%A4_%D0%98%D0%92%D0%9A_6-2022_160-164.pdf
19. Myrzabekova U., Tashibekova Z. Features of maıntenance of separate mıcroelements ın plants and soıls of pastures of talas valley. / Наука, новые технологии и инновации Кыргызстана, №11, 2020, http://science-journal.kg/media/Papers/_nntiik/2020/11/%D0%9D%D0%9D%D0%A2_-_11_2020%D0%B3._110-113.pdf
20. Myrzabekova U. features of maıntenance of separate mıcroelements ın plants and soıls of pastures of talas valley. / Наука, новые технологии и инновации Кыргызстана, № 6, 2020, http://science-journal.kg/media/Papers/nntiik/2020/6/%D0%9D%D0%9D%D0%A2_-_6_2020%D0%B3_26-29.pdf
21. Muminova N., Abdimalikova A., Hegay S. Applıcatıon of bıotechnology methods ın studyıng the genetıc dıversıty of the flora of Kyrgyzstan. / Известия вузов кыргызстана, №6, 2019 http://science-journal.kg/media/Papers/ivk/2019/6/27-30.pdf