



UDC 616.329-006.6-084:615.89:635.3

**PREVENTION OF ESOPHAGEAL CANCER USING TRADITIONAL MEDICINE
APPROACHES AND THE MECHANISM OF ACTION OF CRUCIFEROUS
VEGETABLES**

Mamatova Iroda Yusupovna

Doctor of Medical Sciences, Head of the Department
of Biological Chemistry, Andijan State Medical Institute, Andijan, Uzbekistan

Fozilova Gavharoy Erkinjonovna

gavharoyfozilova223@gmail.com,

[Orcid.org/0009-0005-4103-480x](https://orcid.org/0009-0005-4103-480x)

Assistant of the Department of Biological Chemistry,
Andijan State Medical Institute, Andijan, Uzbekistan

Abstract. Esophageal cancer is one of the malignant neoplastic diseases characterized by a high mortality rate, late detection, and biologically aggressive course. Tobacco products, alcohol, very hot beverages, a diet rich in nitrosamines, chronic gastroesophageal reflux, Barrett's esophagus, obesity, micronutrient deficiency, and disturbances in the general culture of nutrition play an important role in its development. In traditional medicine, views on cancer prevention are often associated with the use of natural foods, vegetables, greens, spices, and plants. A modern scientific approach evaluates such remedies not as substitutes for treatment, but as an additional direction of a healthy lifestyle, rational nutrition, and reduction of risk factors. Cruciferous vegetables such as cabbage, broccoli, cauliflower, Brussels sprouts, turnip, radish, garden radish, and arugula are attracting particular attention because they are rich in glucosinolates, isothiocyanates, indole compounds, sulforaphane, phenolic substances, vitamin C, folates, and dietary fiber. This review-analytical article highlights the elements of traditional medicine in the prevention of esophageal cancer and the possible molecular mechanisms of action of cruciferous vegetables. The analysis of available literature shows that cruciferous vegetables should not be interpreted as agents that directly treat cancer; however, through carcinogen detoxification, reduction of oxidative stress, lowering of inflammatory mediators, apoptosis, and control of the cell cycle, they may occupy an important place in the model of primary preventive nutrition.

Keywords: Esophageal cancer, traditional medicine, cruciferous vegetables, broccoli, cabbage, sulforaphane, isothiocyanates, glucosinolates, prevention, nutrition, carcinogenesis.

**ПРОФИЛАКТИКА РАКА ПИЩЕВОДА СРЕДСТВАМИ НАРОДНОЙ МЕДИЦИНЫ
И МЕХАНИЗМ ДЕЙСТВИЯ ОВОЩЕЙ СЕМЕЙСТВА КРЕСТОЦВЕТНЫХ**

Аннотация. Рак пищевода относится к злокачественным опухолям с высокой смертностью, поздней диагностикой и агрессивным биологическим течением. В его развитии важную роль играют употребление табака, алкоголь, очень горячие напитки, пищевые продукты с высоким содержанием нитрозаминов, хронический гастроэзофагеальный рефлюкс, пищевод Барретта, ожирение, дефицит микронутриентов и нарушения культуры питания. Подходы народной медицины к профилактике рака часто связаны с использованием натуральных пищевых продуктов, овощей, зелени, пряностей и растительных компонентов. Современная доказательная медицина не рассматривает такие



средства как альтернативу лечению, однако оценивает их как вспомогательный элемент здорового образа жизни, рационального питания и снижения модифицируемых факторов риска. Овощи семейства крестоцветных, включая капусту, брокколи, цветную капусту, брюссельскую капусту, репу, редьку, редис и рукколу, богаты глюкозинолатами, изотиоцианатами, индольными соединениями, сульфорафаном, фенольными веществами, витамином С, фолатами и пищевыми волокнами. В данной обзорно-аналитической статье рассматриваются роль традиционных пищевых подходов и потенциальные молекулярные механизмы действия крестоцветных овощей в профилактике рака пищевода. Анализ литературы показывает, что крестоцветные овощи не следует рассматривать как средство лечения рака, однако они могут занимать важное место в первичной профилактике благодаря участию в детоксикации канцерогенов, снижении окислительного стресса, модуляции воспаления, активации апоптоза и регуляции клеточного цикла.

Ключевые слова: Рак пищевода, народная медицина, крестоцветные овощи, брокколи, капуста, сульфорафан, изотиоцианаты, глюкозинолаты, профилактика, питание, канцерогенез.

XALQ TABOBATI VOSITALARI YORDAMIDA QIZIL O'NGACH SARATONI PROFILAKTIKASI VA UNDA KRESTGULLILAR OILASIGA MANSUB SABZAVOTLARNING TA'SIR MEXANIZMI

Annotatsiya. Qizil o'ngach saratoni yuqori o'lim ko'rsatkichiga ega bo'lgan, kech aniqlanishi va biologik jihatdan agressiv kechishi bilan ajralib turadigan xavfli o'sma kasalliklaridan biridir. Uning shakllanishida tamaki mahsulotlari, alkogol, juda issiq ichimliklar, nitrozaminlarga boy ovqatlanish, surunkali gastroezofageal refluks, Barrett qizil o'ngachi, semizlik, mikroelementlar tanqisligi va umumiy ovqatlanish madaniyatining buzilishi muhim ahamiyatga ega. Xalq tabobatida saraton profilaktikasiga oid qarashlar ko'pincha tabiiy oziq-ovqat, sabzavot, ko'kat, ziravor va o'simliklardan foydalanish bilan bog'liq bo'lib, zamonaviy ilmiy yondashuv bunday vositalarni davolash o'rnini bosuvchi emas, balki sog'lom turmush tarzi, ratsional ovqatlanish va xavf omillarini kamaytirishning qo'shimcha yo'nalishi sifatida baholaydi. Krestgullilar oilasiga mansub karam, brokkoli, gulkaram, bryussel karami, sholg'om, turp, rediska va rukkola kabi sabzavotlar glyukozinolatlar, izotiosianatlar, indol birikmalari, sulforafan, fenolik moddalar, vitamin C, folatlar va oziq tolalariga boyligi bilan alohida e'tibor qozonmoqda. Ushbu sharhli-tahliliy maqolada qizil o'ngach saratoni profilaktikasida xalq tabobati elementlari va krestgullilar oilasiga mansub sabzavotlarning ehtimoliy molekulyar ta'sir mexanizmlari yoritildi. Mavjud adabiyotlar tahlili shuni ko'rsatadiki, krestgullilar saratonni bevosita davolovchi vosita sifatida talqin qilinmasligi kerak, biroq ular kanserogenlarni zararsizlantirish, oksidlovchi stressni kamaytirish, yallig'lanish mediatorlarini pasaytirish, apoptoz va hujayra siklini nazorat qilish orqali birlamchi profilaktik ovqatlanish modelida muhim o'rin tutishi mumkin.

Kalit so'zlar: Qizil o'ngach saratoni, xalq tabobati, krestgullilar, brokkoli, karam, sulforafan, izotiosianatlar, glyukozinolatlar, profilaktika, ovqatlanish, kanserogenez.

INTRODUCTION

Esophageal cancer remains one of the urgent oncological problems worldwide. According to GLOBOCAN data, in 2022 more than 511 thousand new cases of esophageal cancer and more than 445 thousand deaths were registered globally [1, 2]. Such a high mortality rate is explained by the fact that the disease is often detected at advanced stages, its initial clinical signs are weak



or nonspecific, the tumor develops considerably before dysphagia appears, and the disease may progress to a stage at which treatment options are limited.

Two main morphological types of esophageal cancer are distinguished. Squamous cell carcinoma occurs more often in the upper and middle parts of the esophagus and is closely associated with smoking, alcohol, very hot beverages, nitrosamines in food, and micronutrient deficiency. Adenocarcinoma develops more often in the distal esophagus and in the area of the esophagogastric junction; gastroesophageal reflux disease, Barrett's esophagus, and excess body weight occupy a special place among its main risk factors [3, 4].

The concept of traditional medicine in cancer prevention must be interpreted with caution. Attempts to treat cancer with folk remedies, especially delaying medical examination in a patient who has already been diagnosed, can lead to serious consequences. At the same time, the aspects of traditional medicine aimed at healthy nutrition, rational use of natural products, moderate physical activity, avoidance of harmful habits, and strengthening the general resistance of the organism may be harmonized with modern preventive medicine.

In the conditions of Uzbekistan and Central Asia, the habit of drinking hot tea, consumption of fried and salted products, the level of use of seasonal vegetables, attitudes toward tobacco and alcohol, and insufficient attention among some people to symptoms of dyspepsia and reflux make the prevention of esophageal diseases even more relevant. From this point of view, harmonizing traditional dietary practices with scientifically grounded principles of prevention, especially the study of biologically active substances in cruciferous vegetables, has great practical importance.

LITERATURE REVIEW

In international studies, esophageal cancer is assessed as a multifactorial disease. The American Cancer Society lists tobacco products, alcohol, gastroesophageal reflux, Barrett's esophagus, excess body weight, certain dietary factors, and very hot beverages among the risk factors [4]. In the WCRF and AICR report, increased body fat is assessed as a convincing risk factor for esophageal adenocarcinoma, while alcohol consumption is evaluated as a convincing causal factor for squamous cell esophageal cancer [3]. The IARC classified very hot beverages consumed at temperatures above 65 degrees as a possible carcinogenic factor associated with the risk of esophageal cancer [5].

Regarding prevention related to nutrition, many observational studies suggest that a diet rich in fruits and vegetables may reduce the risk of esophageal cancer. At the same time, results in such studies are not always identical, because dietary habits, socioeconomic conditions, smoking, alcohol, infectious factors, and environmental factors are intermingled. Nevertheless, the WCRF/AICR noted that the evidence for the protective effect of vegetables and fruits is limited but has indicative significance [3, 6]. Meta-analyses conducted in the Asian region have also shown that groups with higher fruit and vegetable consumption may have a lower risk of esophageal cancer [15].

The issue of cruciferous vegetables attracts particular scientific interest. According to the National Cancer Institute, these vegetables contain glucosinolates, which are broken down during chewing, chopping, and digestion into indoles, nitriles, thiocyanates, and isothiocyanates. Indole-3-carbinol and sulforaphane are among the most studied bioactive compounds [7]. In animal models and cell cultures, these substances have been studied through mechanisms such as protection of DNA from damage, inactivation of carcinogens, reduction of inflammation, enhancement of apoptosis, and limitation of angiogenesis and cell migration [7, 9, 11].

The special handbook prepared by the IARC on cruciferous vegetables, isothiocyanates, and indoles indicates that these vegetables may reduce neoplastic and preneoplastic processes in



various experimental models; however, it emphasizes that the strength of the effect for a specific type of cancer in humans, dose, preparation method, and individual metabolic differences need to be studied separately [8]. Therefore, it is correct to interpret cruciferous vegetables not as agents for cancer treatment, but as a scientifically grounded food component of a multifactorial prevention model.

PURPOSE OF THE STUDY

The purpose of this article is to analyze the scientific foundations for the use of elements of traditional medicine in the prevention of esophageal cancer, particularly cruciferous vegetables; to elucidate their biologically active substances and possible molecular mechanisms of action; and to integrate them with the principles of practical preventive nutrition.

MATERIALS AND METHODS

The article was prepared in a review-analytical format. During the analysis, epidemiological, experimental, meta-analytical, and review literature presented in GLOBOCAN, IARC, WCRF/AICR, the American Cancer Society, the National Cancer Institute, PubMed, and open scientific databases was studied. In selecting sources, attention was focused on data related to the epidemiology of esophageal cancer, risk factors, nutrition-related prevention, cruciferous vegetables, glucosinolates, isothiocyanates, sulforaphane, indole-3-carbinol, oxidative stress, inflammation, detoxification, and apoptosis.

In the analysis, traditional medicine remedies were understood not as methods claiming to directly treat cancer, but as elements of traditional dietary culture, the use of natural vegetables, the inclusion of greens and plant products in the diet, the moderate and safe-temperature consumption of hot beverages, the reduction of harmful habits, and preventive healthy lifestyle practices. This approach made it possible to ensure the clinical safety of the article and to assess traditional medicine in harmony with evidence-based medicine.

RESULTS

The literature analysis shows the priority of several directions in the prevention of esophageal cancer. The first direction is related to reducing harmful habits. Smoking and alcohol are among the most important modifiable risk factors for squamous cell esophageal cancer. They increase the risk separately, and when acting together they produce synergistic damage [4]. Since moderation, restraint, and a natural way of life are also valued in traditional views of healthy living, reducing these factors is consistent with the useful preventive aspects of traditional medicine.

The second direction is prevention of thermal injury. Regular consumption of very hot tea, coffee, or other beverages may be associated with repeated microinjury to the esophageal mucosa, increased epithelial regeneration, and increased sensitivity to carcinogens. The IARC has assessed very hot beverages as a possible carcinogenic factor [5]. Therefore, it is important not to completely deny the widespread habit of tea drinking, but to lower the temperature of beverages, drink tea after it has cooled slightly, and avoid hot drinks at a temperature that burns the mouth and throat; these measures are important preventive steps.

The third direction is associated with increasing the proportion of vegetables and fruits in the diet. Plant products are sources of dietary fiber, vitamins, minerals, polyphenols, and antioxidants, and they support the physiological protection of the digestive tract mucosa. Observational studies indicate that a diet rich in vegetables may reduce the risk of esophageal cancer, although the results are not always absolute [6, 15]. Therefore, the main approach should not be to present one product as a miraculous remedy, but to enrich the overall diet with vegetables, fruits, grains, legumes, and minimally processed natural foods.



The fourth direction is related to the specific bioactive composition of cruciferous vegetables. Cabbage, broccoli, cauliflower, Brussels sprouts, turnip, radish, garden radish, mustard greens, and arugula contain glucosinolates. When vegetables are chopped or chewed, plant cells are damaged and the enzyme myrosinase converts glucosinolates into biologically active substances, including isothiocyanates and indole compounds [7, 11]. Sulforaphane, which occurs in broccoli and broccoli sprouts, is considered one of the most studied compounds of this group.

Sulforaphane and other isothiocyanates may affect several stages of carcinogenesis. On the one hand, they may weaken the effect of certain phase I enzymes that activate carcinogenic substances; on the other hand, they may activate phase II enzymes involved in detoxification [9, 10]. In this process, the Nrf2-related antioxidant response pathway is of particular importance. When Nrf2 is activated, synthesis of glutathione-S-transferase, NAD(P)H quinone oxidoreductase, heme oxygenase, and other protective enzymes increases. As a result, the cell can respond better to carcinogens, free radicals, and oxidative stress [11, 12].

The esophageal mucosa is constantly exposed to food, beverages, reflux, microtrauma, and chemical substances. Under such conditions, oxidative stress and chronic inflammation constitute an important pathogenetic chain. Experimental studies and reviews have noted that isothiocyanates contained in cruciferous vegetables may modulate inflammatory signaling pathways such as NF- κ B and reduce inflammatory mediators and indicators of oxidative stress [11, 12]. Although this effect is theoretically important in the prevention of esophageal cancer, it cannot be interpreted as a clinically fully proven therapeutic effect.

The fifth important mechanism is apoptosis and cell-cycle control. In cancer development, uncontrolled proliferation of damaged cells and evasion of natural cell death are among the main processes. In certain tumor cell models, isothiocyanates have been studied for their properties of activating the caspase system, enhancing apoptosis through the mitochondrial pathway, arresting the cell cycle, and reducing proliferation [11, 13]. Experimental data exist on the effect of sulforaphane on apoptosis through NRF2-related pathways in a model of esophageal squamous cell carcinoma [13]. Recent experimental studies have also shown that sulforaphane may suppress the growth of esophageal cancer through the MSK2 signaling pathway [14].

The sixth direction is related to epigenetic control. Carcinogenesis develops not only through DNA mutations, but also through epigenetic changes that regulate gene activity. In some studies, sulforaphane has been discussed as a compound that may affect histone deacetylase activity, support the expression of tumor-suppressor genes, and influence processes related to cell differentiation [11, 12]. Although these mechanisms are also theoretically and experimentally relevant in esophageal cancer, the main emphasis in practical prevention recommendations should be placed on the moderate consumption of whole vegetables.

The results also show that the safest and scientifically closest form of traditional medicine remedies is the rational use of natural food. For cancer prevention, decoctions with unknown composition, high-dose plant extracts, or methods that delay medical treatment are not recommended. Conversely, regularly including everyday foods such as cabbage and broccoli in the diet, avoiding excessive boiling, consuming them in combination with various vegetables, quitting smoking and alcohol, allowing very hot beverages to cool before drinking, and consulting a physician in the presence of reflux symptoms represent a scientifically grounded form of preventive approach.

DISCUSSION

In esophageal cancer, prevention is a more effective direction than treatment, because the disease is often detected late and the signs in early stages are not sufficiently clear. Therefore,



reducing risk factors among the population, improving dietary culture, and protecting the mucosa from chronic damaging factors are of great importance.

Traditional medicine is often associated with experience passed down from generation to generation, local food products, and the use of natural remedies. However, in the field of oncology, this concept must be used very cautiously. In a patient diagnosed with cancer, relying on folk remedies and delaying endoscopy, biopsy, surgery, chemotherapy, or radiation therapy may be life-threatening. Therefore, elements of traditional medicine should be discussed only within the framework of primary prevention, general healthy nutrition, and reduction of risk factors.

The advantage of cruciferous vegetables is that they are ordinary food products and can be included in the diet by a large part of the population. Cabbage and radish have long been used in Central Asian cuisine, while broccoli and cauliflower have become more widespread in recent years. The preventive value of these products is manifested when they are viewed not as separate medicinal remedies, but as part of an overall diet rich in vegetables.

From a practical point of view, the method of preparing cruciferous vegetables is also important. Very prolonged boiling may reduce the amount of glucosinolates and water-soluble vitamins. Light steaming, short-term stewing, eating them as salad, or combining them with other vegetables helps preserve bioactive substances. However, consuming large amounts raw is not suitable for everyone, because it may cause flatulence, abdominal bloating, or discomfort in some people. In individuals with thyroid disease, those taking anticoagulant medications, or people with severe gastrointestinal diseases, abrupt dietary changes should preferably be made after consultation with a physician or dietitian.

Scientific caution is necessary when linking cruciferous vegetables to the prevention of esophageal cancer. Although experimental studies have associated sulforaphane and isothiocyanates with many beneficial mechanisms, the exact amount in humans, duration of consumption, genetic polymorphisms, gut microbiota, and the role of cooking methods have not yet been fully determined. In addition, in observational studies, people with high vegetable consumption may usually have other healthy habits as well. Therefore, it is not scientifically correct to explain the results solely as the direct effect of a single vegetable group.

Nevertheless, there is a sufficient biological basis for including cruciferous vegetables in a preventive diet. These vegetables are rich in dietary fiber, vitamins, minerals, and phytochemical substances. They are among low-calorie products that reduce the risk of obesity. Since excess body weight is an important risk factor for esophageal adenocarcinoma, including cruciferous vegetables in a diet that controls overall energy balance also acquires indirect preventive significance [3].

The most rational model for preventing esophageal cancer combines several directions. In this model, quitting smoking and alcohol, avoiding very hot drinks, timely treatment of reflux symptoms, controlling body weight, following a diet rich in vegetables and fruits, limiting processed meat and excessively salted products, increasing physical activity, and not delaying endoscopic examinations in high-risk individuals are important. Cruciferous vegetables serve as one of the natural and useful food components of this model.

CONCLUSION

Esophageal cancer is an urgent oncological problem with a high mortality rate, and reducing risk factors is of primary importance in its prevention. In this field, traditional medicine remedies should be assessed not as an independent method of cancer treatment, but within the framework of preventive approaches such as healthy nutrition, rational use of natural products, and avoidance of harmful habits.



Cruciferous vegetables are a source of bioactive substances such as glucosinolates, isothiocyanates, indole compounds, and sulforaphane. These compounds have been studied through mechanisms such as carcinogen detoxification, reduction of oxidative stress, modulation of inflammation, activation of apoptosis, control of the cell cycle, and limitation of angiogenesis and cell migration. These effects create a biological basis for the prevention of esophageal cancer; however, existing evidence requires that they be interpreted not as treatment agents, but as an important component of evidence-based preventive nutrition.

From a practical point of view, regular, moderate, and varied consumption of vegetables such as cabbage, broccoli, cauliflower, turnip, radish, garden radish, and arugula; preparing them without excessively long thermal processing; increasing the proportion of vegetables in the overall diet; avoiding very hot beverages; quitting smoking and alcohol; and consulting a physician in the presence of reflux symptoms may be regarded as important directions in the prevention of esophageal cancer.

References

1. Bray, F., Laversanne, M., Sung, H., Ferlay, J., Siegel, R. L., Soerjomataram, I., & Jemal, A. (2024). Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA: A Cancer Journal for Clinicians*, 74, 229–263.
2. Qi, L., et al. (2024). Global esophageal cancer epidemiology in 2022 and predictions for 2050: A comprehensive analysis and projections based on GLOBOCAN data. *Chinese Medical Journal*.
3. World Cancer Research Fund International, & American Institute for Cancer Research. (2016). Diet, nutrition, physical activity and oesophageal cancer. Continuous Update Project Expert Report.
4. American Cancer Society. (2025). Risk factors for esophageal cancer.
5. International Agency for Research on Cancer. (2016). IARC Monographs evaluate drinking coffee, maté, and very hot beverages. IARC Press Release No. 244.
6. Vingeliene, S., Chan, D. S. M., Vieira, A. R., Polemiti, E., Stevens, C., Abar, L., Rosenblatt, D. N., Greenwood, D. C., & Norat, T. (2017). An update of the WCRF/AICR systematic literature review and meta-analysis on dietary and anthropometric factors and esophageal cancer risk. *Annals of Oncology*, 28(10), 2409–2419.
7. National Cancer Institute. (2012). Cruciferous vegetables and cancer prevention.
8. International Agency for Research on Cancer. (2004). Cruciferous vegetables, isothiocyanates and indoles. IARC Handbooks of Cancer Prevention.
9. Hecht, S. S. (2000). Inhibition of carcinogenesis by isothiocyanates. *Drug Metabolism Reviews*, 32(3–4), 395–411.
10. Keum, Y. S., Jeong, W. S., & Kong, A. N. T. (2004). Chemoprevention by isothiocyanates and their underlying molecular signaling mechanisms. *Mutation Research*, 555, 191–202.
11. Navarro, S. L., Li, F., & Lampe, J. W. (2011). Mechanisms of action of isothiocyanates in cancer chemoprevention: An update. *Food & Function*, 2, 579–587.
12. Mitsiogianni, M., Koutsidis, G., Mavroudis, N. E., Trafalis, D. T., Botaitis, S., Franco, R., Zoumpourlis, V., & Pappa, A. (2019). The role of isothiocyanates as cancer chemo-preventive, chemo-therapeutic and anti-inflammatory agents. *Antioxidants*, 8(4), 106.
13. Lu, Z., et al. (2021). Inhibiting autophagy enhances sulforaphane-induced apoptosis via targeting NRF2 in esophageal squamous cell carcinoma. *Acta Pharmaceutica Sinica B*, 11(5), 1246–1260.
14. Zhang, C., et al. (2023). Sulforaphane suppresses oesophageal cancer growth by inhibiting MSK2 expression. *Cellular and Molecular Biology Letters*.



15. Sakai, M., et al. (2022). Fruit and vegetable consumption and risk of esophageal cancer in the Asian region: A systematic review and meta-analysis. *Esophagus*, 19(1), 27–38.
16. Tang, L., et al. (2014). Fruit and vegetable consumption and risk of esophageal cancer: A case-control study in north-west China. *Diseases of the Esophagus*.
17. Qin, X., et al. (2022). Diet and esophageal cancer risk: An umbrella review of systematic reviews and meta-analyses. *Frontiers in Nutrition*.
18. Ren, H. G., et al. (2024). High intake of cruciferous vegetables reduces the risk of digestive system cancers: Evidence from updated meta-analysis. *Nutrients*.