MINISTRY OF HEALTHCARE OF THE REPUBLIC OF UZBEKISTAN

SAMARKAND STATE MEDICAL UNIVERSITY

URGENCH STATE MEDICAL INSTITUTE

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AMPELO-ENOTHERAPY AND MICRONUTRIENTS

MONOGRAPH

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(Monograph)

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This monograph summarizes and analyzes current scientific knowledge on the chemical composition of micronutrient-rich grape products and their role in maintaining and promoting human health. It presents the results of the authors' own research, with a focus on the trace element profile of grapes and their processed forms, including grape juice, wine, raisins, and must. Data on oenotherapy are provided, along with insights into its prospects and substantiated recommendations for the use of grape-based products in both clinical and traditional folk medicine.

This publication is intended for professionals in the fields of medicine, biology, dietetics, and nutrition science, and may also be of interest to a broader readership.

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INTRODUCTION

In recent years, there has been a notable improvement in living standards and health awareness among the population, including in rural areas. This trend contributes to the development of a conscious attitude toward personal health, which serves as a key factor in social fulfillment and sustained work productivity.

According to the World Health Organization (WHO), approximately 49–53% of all diseases are attributed to unhealthy lifestyles, 21–23% to genetic predisposition, 19–21% to adverse environmental conditions, and only 8–10% are linked to the healthcare system and the quality of medical care. Thus, individual lifestyle plays a decisive role in maintaining health.

At the same time, the rapid pace of industrialization, the widespread use of chemicals in agriculture, domestic life, and medicine, as well as anthropogenic disasters, have significantly worsened the ecological situation. These factors exert a negative impact on public health, particularly affecting vulnerable groups such as children. In this context, the increasing prevalence of environmentally induced diseases has become a pressing concern.

Ecological imbalance also affects the quality of food products. In the modern world, ensuring food security has become a strategic priority, requiring a high degree of responsibility from both society and individuals.

It is widely acknowledged that fruits, vegetables, and other food items available in the consumer market often contain residues of chemical substances. In the cultivation of *agricultural crops such as potatoes, carrots, onions, cabbage, and beets, synthetic fertilizers and pesticides are extensively used, yet their application is not always adequately controlled. For instance, beets are a primary raw material for sugar production, a product consumed daily. However, during processing, most biologically active components are removed, leaving behind a refined polysaccharide — sugar. In contrast, the consumption of raw beets and their derivatives, such as infusions, syrups, and other natural products, offers significantly greater physiological benefits.*

From this standpoint, replacing refined sugar with natural grape syrup — rich in vitamins, enzymes, and minerals — appears to be a rational and physiologically sound alternative.

It is also important to note that even wild-growing plants and fruits, despite their presumed ecological purity, cannot be considered entirely safe under conditions of global air pollution caused by industrial emissions. Pollutants can travel great distances through the atmosphere and settle even in remote and mountainous regions, highlighting the critical and global nature of environmental challenges.

Under such ecological pressures, horticulture and viticulture acquire particular importance as sources of health-promoting and ecologically clean products. Grapes, owing to their rich content of vitamins, organic acids, proteins, sugars, essential oils, microelements, pectin, tannins, and dietary fiber, have a beneficial effect on metabolic processes, the respiratory system, and the body's overall immune status.

Despite the existence of certain laboratory and clinical studies, the comprehensive therapeutic use of grapes in treating *various diseases remains underexplored. This monograph aims to summarize current scientific and practical knowledge on the physiological and therapeutic value of grapes and grape-derived products — including juice, wine, raisins, and must. It presents the authors' original research, details biochemical properties, and offers evidence-based recommendations for their application in both medical and traditional health practices.*

Ampelotherapy, or grape-based treatment, has long been considered a part of dietary and phytotherapy. Given that grapes contain more than 150 biologically active compounds that are easily assimilated by the human body, their incorporation into the diet may play a vital role in the prevention and supportive treatment of a wide range of diseases.

The objective of this work is to draw the attention of healthcare professionals and the wider public to the unique potential of grapes as a natural product that contributes to health promotion and disease prevention.

The authors gratefully welcome any comments, suggestions, and recommendations from readers and the scientific community.

CHAPTER I
MICRONUTRIENTS AND HEALTH

"Among fruits, the most suitable for nutrition are figs, fully ripened grapes, and — in typical urban conditions — persimmons"
Abu Ali Ibn Sina (Avicenna)

The Critical Role of Food Safety in Public Health

The 20th century was marked by rapid advancements in science and technology that encompassed virtually all areas of human activity. Remarkable progress was achieved particularly in the field of medicine, including the development of new diagnostic, therapeutic, and preventive strategies. Nevertheless, despite these scientific accomplishments, general morbidity and mortality rates remain consistently high, showing no significant trend toward decline.

According to analytical data, more than 500 new pharmacological agents are developed daily, and thousands of food products are introduced to the market. However, contrary to expectations, the prevalence of many diseases has not diminished. On the contrary, previously unknown pathological forms are increasingly being recorded, while formerly eradicated diseases are re-emerging in new variations.

This epidemiological situation is due in part to insufficient public awareness of strategies for maintaining health and prolonging life, resulting in the deterioration of general well-being and reduced life expectancy.

Statistical evidence indicates that approximately 10% of the global population dies from natural age-related changes, and another 20% due to external factors such as accidents or armed conflicts. However, the majority—around 70%—of deaths are attributable to various diseases.

It is important to note that while inevitable processes such as aging and accidental injuries are beyond human control, overall health and life expectancy are largely influenced by modifiable risk factors, including lifestyle and dietary behavior. Contemporary research indicates that only about 10% of an individual's health status is determined by the level of medical advancement and access to healthcare services.

One of the major contributors to population health decline is the excessive consumption of saturated fats, salt, and refined sugars. These dietary patterns promote the development of a wide range of chronic conditions, including cardiovascular diseases, cancer, obesity, metabolic syndrome, allergic reactions, and autoimmune disorders.

Plant-based foods enriched with biologically active compounds and natural micronutrient complexes constitute a vital component of a health-promoting diet. Micronutrients play a crucial role in sustaining the body's physiological functions. More than 70 micronutrients are currently known to be present in various tissues and organs, with their distribution determined by the functional roles of specific systems. Imbalances—whether deficiencies or excesses of micro- and macroelements—can provoke the development of numerous pathological conditions.

In addition to the traditional macronutrients—proteins, fats, carbohydrates, and vitamins—plants are a source of trace elements that retain their biological activity when consumed fresh or minimally processed. However, the therapeutic value of plant products largely depends on their storage conditions. Exposure to adverse temperature or humidity can compromise the chemical stability of these products. In high-temperature environments, it is preferable to store them in shaded or naturally ventilated cool spaces.

The degree of fruit maturity at the moment of intake is an important factor to consider. For instance, immature grapes are characterized by elevated concentrations of organic acids combined with reduced sugar content, while delayed harvesting in late autumn (November–December) is associated with a considerable depletion of vitamins and mineral elements.

Given their limited shelf life, fruits, vegetables, and melons are most effectively preserved through drying, a mild processing technique that safeguards both the nutritional value and the micronutrient profile of the product. Within this framework, raisins—dried grapes—are distinguished by their substantial content of carbohydrates, vitamins, and essential micronutrients, rendering them an important component of the human diet.

Hygienic quality control of food products is essential, as adverse environmental conditions can alter their properties and render them potentially hazardous to health. In an era of industrial pollution caused by factory emissions and vehicle exhaust, food contamination with heavy metals has become a pressing concern.

Selling food products near roadways is associated with the risk of accumulating toxic substances such as tetraethyl lead—a harmful component of vehicle emissions. This compound can settle on food located within a 50-meter radius of the road. For instance, meat sold near busy highways is often contaminated with soot and heavy metals, making its consumption unsafe. From a public health standpoint, selling food in such areas is inadmissible. Chronic lead exposure, though often unnoticed, can lead to serious conditions such as lead-induced anemia, which is challenging to treat.

Modern agriculture makes extensive use of chemical fertilizers, herbicides, insecticides, and other agrochemicals to boost crop yields and protect plants from pests and diseases. However, these substances may persist in plant-based products (vegetables, fruits, herbs) for extended periods. They can enter the human body not only through direct consumption of plant foods but also via animal products if livestock are fed with contaminated plants.

In recent decades, animal husbandry has shown a trend toward the use of synthetic feed additives, antibiotics, and hormonal agents to accelerate growth and increase productivity. Although these practices help meet the rising demand for protein-rich food, they pose numerous medical and sanitary risks. The medical community is aware of the potential danger posed by residual antibiotics and hormones in the human body—risks that are particularly acute for children and women of reproductive age.

Moreover, the widespread use of synthetic vitamins, preservatives, flavorings, and colorants in the food industry can have cumulative toxic effects, disrupting metabolic processes and increasing the risk of allergic, metabolic, and oncological diseases.

Soils and natural water sources originally contain a broad spectrum of essential macro- and micronutrients such as sodium, potassium, calcium, iron, zinc, copper, selenium, chromium, and iodine. However, due to intensive agricultural exploitation and land degradation, the concentration of these elements in the soil has been declining annually. This mineral depletion inevitably affects their presence in crops, and consequently, in animals that consume these plants.

Agricultural technologies aimed at enhancing yields and prolonging shelf life have indeed improved the visual and commercial qualities of food. Yet, they are often accompanied by a reduction in the nutritional and biological value of products. The agrochemicals used in plant cultivation act as "time bombs": accumulating in soil, plant tissues, water bodies, and animal organisms, they exert long-term toxic effects on human health.

Numerous studies confirm that prolonged storage of food leads to a gradual loss of vitamins, minerals, and other bioactive compounds. For instance, the nutrient content in stored potatoes may decrease to just 8% of the original level over time. This decline is due to natural biochemical degradation as well as external storage conditions (temperature, humidity, and light).

In the food industry, a range of additives—such as synthetic preservatives, colorants, and flavor enhancers—are employed to prolong shelf life and enhance organoleptic properties. Although these compounds serve important technological purposes by inhibiting spoilage and maintaining product flavor and appearance, their excessive or unregulated application may exert carcinogenic effects, thereby elevating the risk of malignant tumor development. This underscores the potential danger of consuming certain foods even within a seemingly normal diet.

Recent analytical investigations conducted across multiple countries indicate a twofold tendency in food products: a marked insufficiency of vital trace elements (including iron, selenium, zinc, and iodine) alongside an overabundance of toxic compounds (such as heavy metals and nitrates). This dual phenomenon poses serious challenges to food safety, particularly with regard to staple crops such as melons, onions, tomatoes, potatoes, and related produce.These foods are frequently sold without certified quality control—both at open markets and through private home-based agriculture—making it difficult to accurately assess their chemical safety.

Despite these challenges, certain food products are generally not subjected to intensive agrochemical treatment. These include apricots, mulberries, walnuts, almonds, pistachios, persimmons, pomegranates, peaches, plums, cherries, and others. They are valuable from both a nutritional and ecological standpoint. However, even these crops cannot be considered entirely safe if cultivated near industrial zones or major urban centers, where elevated levels of air, water, and soil pollution are observed.

In conclusion, the issue of ecological and chemical food safety has taken on a global dimension and requires an interdisciplinary approach involving experts in agrochemistry, medicine, ecology, and food technology.

Preventive Nutritional Measures Against Micronutrient Deficiency

Contemporary perspectives on rational nutrition encompass more than the assessment of caloric content and the balance of macronutrients (proteins, fats, and carbohydrates). A key component of a balanced diet is ensuring the sufficient intake of vital micronutrients—vitamins and trace elements. In medical science, the pathogenesis of hypo- and avitaminosis has been studied extensively, and the associated clinical syndromes are well described. However, the issue of micronutrient deficiencies has traditionally received significantly less attention, especially in clinical practice in developing countries.

Over recent decades, drawing on international experience, the Republic of Uzbekistan has also intensified scientific and practical research aimed at studying *microelementoses*—disorders caused by deficiency, excess, or metabolic dysfunction of essential micronutrients. These disturbances are increasingly being considered as independent nosological entities that significantly affect public health and are included among socially significant diseases.

Microelementoses constitute a widespread medico-social problem in Central Asian countries, including

Uzbekistan. The most common form is iron-deficiency anemia, particularly among women of reproductive age, pregnant and lactating mothers, and children.

In certain biogeochemical regions of the republic, the prevalence of iron deficiency reaches 70–80%, indicating its epidemiological significance. Chronic micronutrient deficiency in the diet exerts particularly pronounced negative effects on children, contributing to development of specific diseases, stunted growth, and impaired intellectual development. In clinical practice, two main types of microelementoses are identified: hypomicroelementoses (deficiency of micronutrients) and hypermicroelementoses (excessive accumulation in the body). Hypomicroelementoses have been studied much more deeply than conditions caused by excess micronutrients, highlighting the need for further clinical and epidemiological research.

Thus, prevention and correction of microelementoses have become an important objective of modern medicine, nutrition science, and public health policy—especially in countries with distinct geochemical characteristics of soil, water, and diet.

In Uzbekistan, interest in studying microelementoses is growing, fostering large-scale scientific research. Essential micronutrient deficiency—critical for health—is widespread among the population. According to A. V. Skalniy (1999), microelementoses occur in 40–50% of children and adolescents in Russia, whereas specialists in our republic report prevalence rates of 30–80% among schoolchildren in the Zarafshan oasis. Children especially frequently experience deficits of iron, iodine, zinc, copper, cobalt, calcium, and other macro- and microelements. Manifestations such as reduced immunity and adaptive capacity, slowed growth and development are all signs of micronutrient deficiency.

The causes include, on one hand, loss of micronutrients due to various diseases, poor intestinal absorption, and increased demand during periods of growth; and on the other hand, insufficient consumption of micronutrient-rich foods and their low content in certain biogeochemical zones. From this perspective, it is important to quantify micronutrient content in national dishes to prevent such deficiencies.

Statistics show that over 80% of modern diseases among humans are caused by micronutrient insufficiencies. Deficiency of micronutrients can lead to increased morbidity and mortality, especially among women and children. In addition, it adversely affects both the cognitive and physical development of adolescents, while also diminishing the productivity of women and other demographic groups.

Inadequate intake of vitamins and micronutrients represents a significant risk factor for maternal and child health. Among pregnant women, such deficiencies generate a "double burden," simultaneously endangering both fetal development and neonatal outcomes. Among women of reproductive age, such deficiencies can lead to pregnancy and birth complications. Poor fetal absorption of micronutrients during pregnancy and maternal deficiency during lactation adversely affect child development and may cause microelementosis. This increases the child's susceptibility to various illnesses and impairs growth and development.

Observations indicate a correlation between the breastfeeding mother's micronutrient adequacy and the duration of breastfeeding. Micronutrient deficiency is also common among children living in economically affluent large cities. It is important to note, however, that in rural areas the prevalence of micronutrient deficiencies among children is relatively higher. The negative impact of deficiencies on children's health is insufficiently studied, complicating the development of regionally tailored prevention programs.

International research has made significant advances in preventing micronutrient deficiency. These strategies include food fortification and micronutrient supplementation.

International documents adopted by the World Health Organization (WHO) and UNICEF recommend urgent measures to prevent micronutrient deficiencies in countries where they affect more than 30% of women and children. Our recent investigations demonstrate that among school-aged children in the Zarafshan oasis, deficiencies in key micronutrients (including iron, zinc, copper, cobalt, and manganese) are identified in 40–70% of cases. Analysis of 48 local food items revealed insufficient levels of copper, zinc, iron, and other micronutrients—reflecting their low concentration in the region's soil and water.

At present, food fortification is recognized as one of the most practical and safe approaches to preventing micronutrient deficiencies. This strategy involves enriching widely consumed staple foods with essential micronutrients. To date, more than 50 countries worldwide, including Uzbekistan, have adopted legislation on food fortification to address population-level micronutrient requirements. Fortification of flour with vitamins and micronutrients has been practiced for many years in Central and South American countries and in Canada. In recent years, this program has been implemented in CIS countries. In our republic—as well as in Moldova, Kazakhstan, Georgia, Azerbaijan, and Armenia—preventive measures under this program are actively underway. In Romania, Bulgaria, Turkey, and other countries, micronutrient fortification of foods has yielded significant results in deficiency prevention, improving health indicators among mothers and children in those regions.

In Uzbekistan, substantial attention is also devoted to preventing micronutrient deficiency. Scientific studies of food fortification among women and children have reduced anemia incidence by 5–7% over one year. These outcomes served as the basis for Presidential Decree No. PP-153 of 11 August 2005, establishing the National Flour Fortification Program for 2005–2009.

Flour fortification enabled developed countries to reduce anemia levels in their populations by 20–25%, substantially lowering morbidity and mortality among women and children. In Uzbekistan, implementation of this program reduced anemia prevalence from 60% to 33.5% in recent years, and enhanced women's reproductive health.

Based on initial achievements by the Ministry of Health of Uzbekistan and to ensure sustainable progress in micronutrient deficiency prevention, on 25 November 2009 an extended session of the Legislative Chamber of the Oliy Majlis drafted the Law "On Prevention of Micronutrient Deficiency Among the Population of the Republic of Uzbekistan." This legislative act was unanimously approved by the Senate on 7 May 2010. The law aimed to normatively regulate relations related to population-level prevention of micronutrient deficiency.

The law defines the following key concepts:

- **Micronutrients**: vital dietary components, encompassing vitamins and minerals, that are indispensable for normal growth, development, and physiological functioning. Since they cannot be synthesized endogenously in sufficient quantities, they must be supplied through the diet.;
- **Fundamental nutritional elements**, including vitamins and minerals, that are essential for proper growth, development, and the maintenance of physiological processes. As they are not produced endogenously in adequate amounts, their intake must be ensured through the diet;
- **Fortified food product**: foods into which micronutrients are artificially added at the production stage to enhance their nutritional value (fortification);
- **Micronutrient supplementation**: the deliberate preventive administration of vitamins and minerals in the form of pharmaceutical or dietary supplements to defined population groups at risk of deficiency;
- **Target population groups**: socio-demographic categories (children, pregnant women, elderly individuals, etc.) for whom preventive actions against micronutrient deficiency are implemented.

The legislation establishes legal regulation of micronutrient deficiency prevention measures in the population, recognizing it as a key direction of state policy, specifically:

- implementation of social, economic, legal, and organizational measures to ensure access to fortified food products;
- Regulatory oversight of the quality and safety of fortified food products and vitamin–mineral premixes designated for fortification;
- Expansion and advancement of fortified food production;
- Promotion and support of the manufacturing of vitamin–mineral premixes utilized in fortification.
- organization of micronutrient supplementation programs for the population;
- monitoring and evaluation of programs aimed at preventing micronutrient deficiency;
- facilitation of scientific research on modern technologies for detecting and preventing micronutrient deficiency;
- promotion of international cooperation in this domain.
- The Ministry of Health of the Republic of Uzbekistan is assigned the following functions in the area of micronutrient deficiency prevention:
- carrying out state sanitary oversight related to deficiency prevention;
- designing and implementing nationwide programs aimed at preventing micronutrient deficiencies.
- defining the list of food products subject to mandatory fortification;
- organizing technical regulation and ensuring compliance with mandatory safety standards for fortified

foods and vitamin-mineral premixes intended for fortification;

- identifying population groups to be supplemented with micronutrients;
- developing norms and recommended levels of micronutrient content for food fortification;
- organizing supplementation activities;
- conducting sanitary-hygienic and educational outreach on micronutrient deficiency prevention;
- monitoring and evaluating the implementation of prevention programs.

Under the law, the following measures are envisaged:

- assessment of demand for fortified food products and ensuring their consumption;
- implementation of micronutrient supplementation;
- conducting sanitary-hygiene and explanatory (educational) campaigns.

The legislation outlines the functions of government bodies, including the Cabinet of Ministers, relevant ministries, and regional authorities, in preventing micronutrient deficiencies. It defines specific tasks concerning the production, certification, distribution, and promotion of vitamin-mineral premixes, as well as procedures for resolving disputes arising in this area.

By its essence, the enacted law plays a crucial role not only in guaranteeing sustained fortification of foods but also in meeting the population's micronutrient needs. This, in turn, contributes to reducing morbidity and mortality among mothers and children, improving their health, and fostering a healthier generation.

The law places significant responsibilities on scientific professionals in preventing micronutrient deficiencies among mothers and children. In line with its provisions, the faculty of the Samarkand Medical Institute developed a series of scientific initiatives to improve micronutrient deficiency prevention in the population. Based on the results obtained over many years, research has been conducted to determine micronutrient contents in food products, select and recommend micronutrient-rich foods for mothers and children, identify groups predisposed to deficiency, and develop prevention measures. More than 200 scientific research articles, 2 monographs, and over 15 methodological guides and brochures have been published on this topic.

In 2006, a practical project on “Diagnosis, Treatment, and Prevention of Microelementoses in School-Age Children” won first prize in the national scientific-practical research competition organized by the Committee for Science and Technology under the Cabinet of Ministers.

The presented book contains recommendations based on scientific study of the therapeutic properties and micronutrient composition of grapes and grape-derived products widely consumed locally.

Ampelotherapy, a distinct branch of medicine studying the healing properties of grapes and their derivatives, is now recognized as an effective method of wellness promotion and therapy.

In this work, an in-depth analysis was conducted of the micronutrient composition of grapes, grapevine, as well as a range of biologically active beverages produced from them, with a focus on evaluating their therapeutic potential.

Particular consideration was given not only to widely consumed products such as grapes, raisins, and grape juice, but also to lesser-studied and rarely used local items—*shinni*, *g'urobu*, and several other grapevine derivatives. The aim was to provide a scientific rationale for their biological significance and their role in maintaining and enhancing human health.

It should be noted that despite sufficient coverage in the scientific literature on the chemical composition of grapes, grape juice, and wine products, data on the composition and preventive-therapeutic properties of secondary and traditionally homemade grapevine-based products remain fragmentary. Given the contribution of viticultural products to food security objectives and their importance in maintaining public health, this work focused on determining macro- and micronutrient composition as a key factor influencing growth, development, immune status, and in the prevention and therapy of diet-related diseases.

Health-Promoting and Therapeutic Roles of Plant- and Fruit-Based Macro- and Micronutrients in the Human Body

The healing properties of plants have been known to humankind since ancient times and, over the centuries, have become the subject of study by scholars, physicians, and traditional healers. However, in many cases, phytotherapeutic approaches demonstrated low efficacy. This can primarily be attributed to the fact that the therapeutic properties of the plants recommended for public use have not been sufficiently studied to date, and the mechanisms of action of the biologically active compounds they contain remain poorly understood. As a result, their rational and scientifically grounded application in clinical practice has proved to be challenging.

Nevertheless, due to the specific physiological and pharmacological effects of certain bioactive compounds, pathological processes could in some cases undergo spontaneous regression, leading to disease remission and restoration of vital functions in patients.

It is important to note that, in addition to major biologically active compounds, plants contain a number of secondary metabolites that exhibit therapeutic effects. These compounds may potentiate the absorption and bioavailability of primary substances, exerting both beneficial and adverse effects on the human body. At the same time, plants also contain ballast substances that lack pharmacological activity.

Among the biologically active compounds of plant origin, pharmacologically significant groups of substances occupy a central role in phytotherapy. Among them are alkaloids, glycosides, essential and fatty oils, proteins, vitamins, tannins, flavonoids, enzymes, as well as macro- and microelements. In this regard, it is relevant to explore in greater detail the biological functions of macro- and microelements and their influence on physiological processes in the human body.

Mineral Substances

Mineral substances are integral components of every cell in the human body and play a critical role in sustaining vital functions. They constitute a significant part of the diet: approximately 4% of the dry matter of food is comprised of minerals. Insufficient intake of these elements leads to metabolic disturbances, growth retardation, and the development of pathological conditions.

Based on their content in the human body, chemical elements are classified into three groups:

- **Macroelements** (>0.01%),
- **Microelements** (0.001–0.00001%), and
- **Ultratrace elements** (<0.0000000000001%).

Despite the extremely low quantitative requirement of the body for these elements, their absence makes the proper functioning of the organism impossible. Macroelements account for approximately 99.6% of all essential elements, while microelements constitute no more than 0.04%. The latter are involved in the biosynthesis of hormones, vitamins, amino acids, and enzymatic complexes, ensuring the regulation of key biochemical reactions.

The mineral composition of grapevine is determined by a number of factors, among which the grape variety, plant maturity, climatic conditions, soil characteristics, and the use of agricultural techniques are particularly significant.

According to V.I. Nilov et al. (1967), the average content of mineral substances in 1 gram of grapevine is as follows (in mg):

- P_2O_5 — 80–160
- SO_3 — 40–100
- SiO_3 — 20–40
- Cl — 20–60
- BO_3 — trace amounts
- K_2O — 500–700
- CaO — 40–70
- MgO — 30–50
- Na_2O — 10–25
- Fe_2O_3 — 4–20

The content of mineral substances varies in different parts of the grapevine and its fruits, as shown in Table 1.

Table No. 1

Chemical Composition (%) of Mineral Substances in Different Parts of the Grapevine

Detected Source	K2O	Na2O	CaO	MgO	Fe2O3	PO4	SO4	CL	SiO3
Juice	65	1	6	4	1,5	13	5	1,0	3
Peel	48	3	16	4	1,5	20	5	0,5	2
Seeds	31	4	34	9	0,5	24	6	0,5	1
Grapevine	36	7	13	3	0	9	3	0	0

It is evident that in all analyzed ash samples, potassium and phosphoric acid are the predominant components.

The mass fraction of cations in the ash residue accounts for 48.15%, whereas anions constitute 51.66%.

Macroelements

Plant organisms accumulate virtually the entire spectrum of chemical elements and their nuclides present in the biosphere.

Macroelements—which collectively account for approximately 99% of plant biomass—include carbon, hydrogen, oxygen, potassium, calcium, magnesium, sulfur, phosphorus, and iron. It is worth noting that although iron is often quantitatively minor and predominantly localized within hemoproteins (e.g., hemoglobin), it is frequently classified as a microelement. The remaining chemical elements, whose combined proportion does not exceed 1–2%, belong to the group of micro- and ultramicroelements and perform catalytic and regulatory functions in biochemical processes.

Phytoproducts, including fruits and plant tissues, are characterized by a high content of potassium-organic compounds and, to a lesser extent, sodium.

The ash residue of fruits typically exhibits a pronounced alkaline reaction, which, when consumed in excess, may contribute to a shift in the body's acid-base balance toward alkalosis. This biochemical characteristic of fruits and plant-derived compounds is especially relevant in therapeutic nutrition and can be effectively applied for the correction of metabolic disorders associated with acidosis, particularly in diabetes mellitus and cardiovascular diseases.

Potassium (K)

Potassium represents the principal intracellular cation, essential for the regulation and preservation of physiological homeostasis in the human body. The total potassium content in an adult human body reaches approximately 170–180 grams, with plasma concentrations ranging between 3.8 and 5.4 mmol/L. Together with sodium, potassium is involved in regulating metabolic processes, facilitating the renal excretion of metabolites and toxic compounds, normalizing myocardial rhythmic activity, and mitigating the cardiotoxic effects of cardiac glycosides. Furthermore, this element contributes to the maintenance of acid-base balance, participates in the regulation of water-electrolyte equilibrium and arterial blood pressure, enhances tissue oxygenation—including in the brain—and promotes the elimination of metabolic waste products.

Due to its pronounced diuretic properties, potassium aids in the removal of excess fluid during edema, which is especially critical in cardiovascular and renal pathologies associated with fluid retention.

The physiological potassium requirement for adults ranges from 900 mg to 2–4 g per day.

According to A.V. Andryushchenko (1980), foods with high potassium content include dried apricots (8.4%), dried melon (7.69%), grapes (2.02%), and potatoes (0.4%). Other significant sources of potassium are leafy green vegetables, citrus fruits, bananas, dairy products, and herbs.

Research by V.I. Nilov et al. (1967) indicates a substantial increase in potassium content in grape berries during the vegetation period—from 825 mg/L at early ripening stages to 1400 mg/L at full maturity.

Our own experimental data also confirm a high potassium content in various food products. Among fruits, the richest sources of potassium are dried apricots (7.2%), grape pomace (6.6%), black grapes (5.7%), white kishmish grapes (0.6–1.1%), peaches (1.2–2.4%), black plums (1.2–1.8%), apples (0.6–0.8%), melons (2.4%), blackcurrants (1.2–1.6%), as well as jujube, mulberries, hawthorn, and pears (approximately 1%). Among vegetables, the highest potassium concentrations are found in tomatoes (3.1–5.5%), turnips (3%), beets (2.7%), pumpkins (2.63%), potatoes (1–2.1%), beans (1.8–2%), mung beans (1.6–1.7%), and peas (0.8–1.6%). Animal-derived products contain lower potassium levels: meat and eggs (1.4%), cream and cottage cheese (0.6% each), and honey (0.24%).

The physiological activity of potassium decreases with excessive consumption of alcohol, caffeine, sugar, and diuretics.

Hypokalemia is characterized by a serum potassium level falling below 4 mmol/L and may arise from insufficient dietary intake, enhanced renal elimination, or excessive loss of gastrointestinal secretions (vomiting and diarrhea), or administration of large volumes of potassium-free intravenous fluids. Clinically, hypokalemia manifests with a broad spectrum of disturbances: impaired neuromuscular conduction leading to intestinal atony and reduced muscle and vascular tone; electrocardiographic changes such as prolonged QT interval and decreased T-wave amplitude; central nervous system disorders including depressive states;

and cardiac dysfunctions such as bradycardia and arterial hypotension. Potassium deficiency is also accompanied by increased renal excretion of hydrogen ions, predisposing to metabolic alkalosis.

Hyperkalemia, characterized by serum potassium levels exceeding 5 mmol/L, can result from excessive potassium intake, impaired renal excretion, massive tissue breakdown, or other pathological processes. This condition is associated with blood acidosis (decreased pH) and may present with symptoms including bradycardia, muscle paresis and paralysis, paresthesias, lower limb muscle pain, digestive disturbances, renal failure, and in severe cases, cardiac arrest. Correction of hyperkalemia is achieved through administration of isoosmotic glucose solutions combined with insulin.

The potassium content in grape wines (expressed as K_2O) ranges from 0.45 to 1.35 g/L, with the highest concentrations observed in dessert wines, whereas aged wines exhibit somewhat reduced levels.

Sodium (Na)

The daily physiological requirement for sodium is approximately 4 grams. Functioning in close interplay with potassium, this element participates in maintaining acid-base balance through buffer system activity. The primary physiological role of sodium lies in regulating metabolic processes in the kidneys and ensuring the stability of osmotic pressure in blood plasma. This cation is essential for preserving the excitability of membranes in nerve and muscle cells, thereby facilitating normal generation and conduction of nerve impulses. In the human body, sodium is present in biological fluids (such as lymph and gastrointestinal secretions). It forms an essential component of the extracellular matrix, cartilage, and bone tissue, predominantly occurring as chlorides, phosphates, and bicarbonates, and fulfills important regulatory roles in maintaining water–electrolyte balance.

In extracellular fluid, sodium concentration averages around 140 mmol/L, whereas intracellular levels are considerably lower, at approximately 20 mmol/L; nearly one-third of the body's total sodium reserves are localized within the skeletal system. Disturbances in sodium metabolism are invariably associated with disruptions in water balance. Additionally, sodium modulates neuromuscular activity and plays an important role in preventing heat and solar injuries.

The total amount of sodium in the adult human body is roughly 250 grams. The main sources of sodium intake are table salt and salt-containing foods such as seafood, meat products, baked goods, and certain vegetables (e.g., beetroot, carrots).

According to V.I. Nilov et al. (1967), during the ripening process of grape berries, sodium content significantly increases from 34 mg/L to 158 mg/L. Data from P. Pietinen (1982) indicate that the highest contributions to daily sodium intake in humans come from baked goods (20%), meat products (12%), and various salads (40%). Disorders of sodium metabolism, caused by both deficiency and excess intake, exert a significant impact on water-electrolyte homeostasis. Excessive sodium intake, particularly in the form of NaCl, is one of the leading risk factors for the development of arterial hypertension. In patients with cardiovascular and renal diseases, sodium overload promotes fluid retention, edema formation, and exacerbates liver and kidney dysfunction. Consequently, increasing the proportion of fruits and vegetables with low sodium content in the diet appears justified.

Sodium deficiency, especially in infants, may lead to hyponatremia, defined as a plasma sodium concentration below 135 mmol/L. This condition can be triggered by increased sodium losses due to profuse sweating, vomiting, diarrhea, and administration of large volumes of potassium-containing solutions that inhibit sodium reabsorption in the renal tubules. Daily sodium loss during recurrent vomiting can reach up to 15% of the total body sodium content. Excessive water intake in such cases exacerbates hyponatremia. Clinical manifestations include muscle weakness, apathy, impaired consciousness, nausea, vomiting, arterial hypotension, and muscle tremors.

Hypernatremia, characterized by plasma sodium levels exceeding 145 mmol/L, develops due to excessive intake of sodium with food and fluids or its retention in the body. This pathological state is associated with neuromuscular hyperexcitability, increased body temperature, intense thirst, convulsive syndromes, and may lead to loss of consciousness.

The average sodium content in wine beverages (expressed as Na_2O) ranges from 0.02 to 0.15 mg/g; however, in grapes cultivated on saline soils, sodium concentrations can reach up to 2 g/L.

Calcium (Ca)

Calcium is a key macronutrient that, together with phosphorus, forms the primary mineral matrix of bone tissue, accounting for approximately 98% of the total calcium content in the human body. Ca^{2+} ions play a fundamental role in regulating cellular cytolysis processes and ensure the functional activity of the nervous system, integumentary system, skeletal and cardiac muscle tissues, as well as other organs and systems. Calcium enhances the body's protective functions, participates in the detoxification of heavy metals, and exhibits pronounced anti-stress and anti-allergic properties. In combination with phosphorus, calcium provides strength to bones and teeth, and together with magnesium, it is involved in the regulation of cardiovascular function and the maintenance of normal heart rhythm. Moreover, calcium plays an important role in iron metabolism and nerve impulse transmission. The physiological requirement for this macronutrient significantly increases during periods of rapid growth in children, as well as in pregnant and lactating women.

Calcium absorption in the intestine is influenced by several factors, including the calcium-to-phosphorus ratio in the diet, the acid-base balance (pH) of the intestinal contents, as well as the presence of fatty acids and vitamin D in the diet. Vitamin D is indispensable for normal calcium metabolism; its deficiency leads to the development of pathologies such as rickets and osteoporosis.

Primary sources of calcium include dairy products (milk, cheese, cottage cheese), fish, nuts, sunflower seeds, legumes, and green leafy vegetables.

The daily physiological requirement for calcium ranges from 0.8 to 1.2 grams. The high consumption level is associated with the ongoing renewal of cellular structures, which involves calcium expenditure over approximately five years. Disturbances in calcium–phosphorus metabolism may present as reduced absorption within the gastrointestinal tract, altered metabolic processes in osseous and dental tissues, abnormal deposition of calcium and phosphorus in soft tissues, and variations in serum calcium concentrations.

In circulation, calcium is distributed in two primary forms: about 50% as ionized, biologically active calcium, and the remaining 50% bound to proteins. Acidosis conditions (e.g., in diabetes mellitus or oncological diseases) are associated with an increased proportion of ionized calcium, whereas alkalosis (e.g., during hyperventilation) reduces the concentration of the active calcium form.

Calcium performs vital functions in the body: it is a structural component of cell membranes, participates in nerve conduction, muscle contraction, hormone secretion, and hemostasis. Recent studies have revealed its significant role in blood pressure regulation. Research demonstrates that increased dietary calcium intake exerts a more pronounced antihypertensive effect than sodium reduction. Large-scale clinical trials involving 5,000 patients showed normalization of blood pressure in 85% of participants within 1.5 months after doubling calcium intake.

The regulation of stable calcium and phosphorus levels in plasma is primarily mediated through the interplay between calcitonin and parathyroid hormone (PTH). Calcitonin, a hormone produced by the C-cells of the thyroid gland, exerts a hypocalcemic effect. A decrease in blood calcium levels stimulates the activity of the parathyroid glands and the secretion of PTH, which promotes the mobilization of calcium from the bone matrix into the bloodstream (resulting in hypercalcemia) and inhibits phosphorus reabsorption in the renal tubules (leading to hypophosphatemia and hyperphosphaturia). Conversely, an increase in blood calcium levels triggers the release of calcitonin, enhancing renal calcium excretion and reducing bone calcium mobilization, thereby causing hypocalcemia and hyperphosphatemia.

Disruptions in calcium-phosphorus homeostasis, accompanied by hypocalcemia (a reduction in blood calcium concentration), may occur due to hypofunction of the parathyroid glands, hypersecretion of thyrocalcitonin, or impaired calcium absorption in the small intestine. Prolonged hypocalcemia leads to increased neuromuscular excitability and the development of convulsive syndromes. This phenomenon is explained by the antagonistic interaction between calcium and potassium ions: hypocalcemia is often associated with hyperkalemia, which enhances synaptic nerve conduction.

A reduction in calcium concentration in the extracellular fluid increases the permeability of biological membranes to ions, causing a decrease in the normal electrokinetic potential and the onset of tetanic contractions and seizures. In severe cases, respiratory arrest and fatal outcomes may occur.

Calcium deficiency is associated with more than 150 diseases, including facial nerve neuritis, rickets, tetany, osteoporosis, arthritis, and urolithiasis.

Hypercalcemia (elevated blood calcium levels) may develop due to hyperfunction of the parathyroid glands, hyposecretion of calcitonin, vitamin D excess, and acidosis.

Calcium content in wine beverages varies depending on production technology, storage conditions and duration, as well as the material of the containers used for wine aging, averaging between 0.07 and 0.14 g/L.

Magnesium (Mg)

Magnesium is an essential macronutrient that regulates numerous biochemical and physiological processes. It functions as a cofactor in enzymatic reactions and participates in the operation of ion channels. Following potassium, magnesium is the second most abundant intracellular cation and is involved in energy metabolism, structural functions, and electrolyte balance. In recent decades, a decline in magnesium intake has been observed, attributed to dietary habits, environmental factors, and decreased magnesium content in ecosystems. The prevalence of magnesium deficiency (hypomagnesemia) ranges from 2.5% to 15% in the United States and approximately 14% in Germany. In Russia, magnesium deficiency ranks alongside insufficiencies of iodine, calcium, zinc, and selenium. The concentration of magnesium in blood serum ranges from 1.8 to 2.5 mmol/L, approximately 3.5 mmol/L in erythrocytes, and up to 16 mmol/L in tissue cells. The majority of magnesium is stored in the skeletal system. The total magnesium content in the human body is approximately 20 grams.

Functions of Magnesium:

 Serves as a cofactor for enzymes engaged in carbohydrate metabolism (such as phosphatases and phosphorylases), protein synthesis, and ATP-dependent energy processes.

 Decreases neuronal excitability and facilitates relaxation of cardiac muscle.

 Demonstrates anti-stress and antioxidant properties, contributes to DNA and RNA synthesis, and enhances vascular metabolic functions.

 Acts synergistically with calcium, phosphorus, potassium, and vitamins B, C, and E.

Daily Requirements:

- Adults: 300–400 mg per day (6–8 mg/kg body weight).
- Children aged 1–10 years: 80–170 mg per day.

Sources of Magnesium: whole grains, leafy greens, vegetables, fruits, meat, and fish (notably lemon, grapefruit, nuts, apples, and dark green vegetables).

Magnesium absorption is impaired by alcohol consumption and diuretic use. Deficiency manifests as decreased physical activity, fatigue, depression, impaired memory and sleep, tetany (convulsive contractions), muscle spasms, and increased pain sensitivity.

Magnesium deficiency can be primary (hereditary, e.g., Gitelman syndrome) or secondary (due to prolonged fasting, diarrhea, infusion of magnesium-free fluids). Factors reducing absorption include excess fatty acids, phytic acid, phosphates, and vitamin D deficiency. Magnesium deficiency is frequently identified in conditions of chronic stress, chronic fatigue, and diabetes.

Elevated magnesium levels are observed in cases of hyperfunction of the thyroid and parathyroid glands, nephrocalcinosis, arthritis, psoriasis, and dyslexia in children; high magnesium concentrations exert a sedative effect and depress respiratory centers.

According to S. Heyde, the magnesium content in wine (expressed as MgO) ranges from 0.1 to 0.24 mg/L, occasionally reaching up to 0.51 mg/L.

Microelements

Iron (Fe)

Iron is an essential trace element with anti-anemic properties, constituting a critical component of the hemoglobin molecule and participating in tissue oxygenation processes. The bioavailability of iron for the human body is enhanced by the synergistic action of vitamins C and E. This element not only imparts the characteristic rosy hue to the skin but also performs numerous vital functions: it is involved in the synthesis of B vitamins, supports organismal growth, and plays a key role in immune system development. Iron, as a fundamental bioelement, is actively engaged in the regulation of metabolic processes. Its primary biological function is oxygen transport and participation in redox reactions, both directly and indirectly.

Iron deficiency anemia manifests clinically with symptoms such as increased fatigue, general weakness, reduced work capacity, dyspnea, and dizziness. Iron is essential for maintaining proper immune system function, particularly enhancing antiviral defenses. Studies have shown that iron deficiency in childhood triples the risk of viral infections compared to healthy peers, doubles the incidence of viral hepatitis, and contributes to increased prevalence of purulent-inflammatory diseases.

Scientific evidence demonstrates that iron deficiency during early childhood significantly disrupts biochemical processes, resulting in impaired brain activity and the development of psychoemotional disturbances. Besides its presence in hemoglobin and myoglobin in blood and muscle tissues, significant iron amounts are found in cells of the central nervous system. Iron deficiency may cause delayed neuropsychological development, decreased cognitive abilities, and slowed speech and thought development, which subsequently complicates learning. Iron deficiency primarily disrupts four functional systems: hematopoietic, nervous, immune, and adaptive. These disturbances are most pronounced in children, while adults mainly experience hematopoietic dysfunction.

The total iron content in the adult human body is approximately 5 grams, of which 70% is incorporated in hemoglobin, with additional amounts in muscles as myoglobin, and in redox enzymes such as peroxidase and cytochromes. Iron is predominantly stored as the protein complex ferritin and, in smaller quantities, in tissues (myoglobin).

Daily iron requirements for adults are about 15 mg. In children, iron absorption from food typically exceeds losses, allowing positive balance and storage formation. In adults, iron intake and expenditure are generally balanced. A distinctive feature of iron metabolism in childhood is a greater dependency on dietary intake. In adults, about 95% of iron needed for hemoglobin and other iron-containing enzymes is recycled from senescent erythrocytes, with only 5% absorbed from the gastrointestinal tract. In children under one year, this balance shifts: approximately 70% is supplied by recycling, and 30% from dietary absorption [A.A. Buglanov et al., 2002].

Physiological iron requirements vary: 1–1.65 mg/day for men, 2–3 mg/day for women and girls, 4–5 mg/day during puberty and adolescence, and about 0.9 mg/day for infants under one year. To meet these needs, the diet should provide 15–20 mg of iron daily, though only 10–15% (2.5–3 mg) is typically absorbed. This balance may be disrupted by blood loss or impaired intestinal absorption [L.G. Kovaleva, 2001].

Iron absorption is influenced by multiple factors. The bioavailability of iron from meat products averages 20–30%, while from plant-based sources (such as vegetables, fruits, dairy products, and cereals) it does not exceed 2–7%. The simultaneous consumption of fresh vegetables, fruits, leafy greens, or their juices together with meat dishes enhances iron absorption. Conversely, excessive intake of sugar, confectionery, tea, and coffee inhibits absorption. Primary iron absorption occurs in the proximal duodenum and small intestine. Iron transport to tissues is mediated by transferrin, and storage primarily occurs as ferritin in the liver, spleen, macrophages, and to a lesser extent, the brain [P.A. Vorobyov, 2000].

As previously noted, iron deficiency primarily impairs the hematopoietic, nervous, immune, and adaptive systems, which is especially evident in childhood [A.A. Buglanov et al., 1991].

Women's iron requirements exceed those of men by 30–60% due to physiological losses. During menstruation, women expend approximately twice as much iron as men, with increased needs during pregnancy and lactation.

Iron deficiency may develop from low dietary intake or impaired absorption (e.g., due to excess inorganic phosphorus, frequent consumption of tea, confectionery, etc.). In children experiencing rapid growth, iron demand significantly increases.

Major dietary sources of iron include beef liver, kidneys, heart, whole-grain bread, mollusks, dried apricots, red wine, egg yolk, oysters, nuts, legumes, asparagus, grapes, mulberries, and oats.

Iron content varies within grape plant parts: 5.2–7.6 mg/kg in pulp, 5.2–7.2 mg/kg in skin, and 1.0–1.4 mg/kg in seeds. Total iron content in grape berries reaches 11.4–16.8 mg/kg [J. Robrero-Gayon et al., 1960]. Iron concentration in wine ranges from 4 to 10 mg/L.

Copper (Cu)

Copper is an essential trace element that plays a critical role in human physiological functions (Kopytko M.V. et al., 2000; Netrebenko O.K., 2005). According to D. Emsley (1993), the total copper reserve in an adult human body with an average weight of 75 kg is approximately 72 mg; the blood concentration reaches 1.01 mg/L, while its content in muscle tissue is about 0.001%. The toxic dose of copper exceeds 250 mg, whereas the daily dietary intake ranges between 0.5 and 6 mg.

In adults, total body copper content is estimated at 1.57–3.14 mmol, with roughly 50% deposited in muscle and bone tissues and around 10% retained in the liver. Considerable amounts are also distributed across the lungs, gastrointestinal tract, spleen, skin, and hair, reflecting its involvement in enzymatic systems and diverse metabolic processes. The average copper content in the circulatory system is around 100 µg, of which about 60 µg is associated with erythrocytes and leukocytes. The major copper pool in plasma is represented by ceruloplasmin, a copper-binding protein.

During childhood and adolescence, the satisfaction of the body's copper needs largely depends on the intake of mineral-rich foods. The daily dietary intake of copper ranges from 2 to 5 mg (0.031–0.039 µmol). Insufficient intake (<2 mg/day or <0.031 µmol) may trigger deficiency states. Children’s physiological copper requirement substantially exceeds that of adults, especially during periods of active growth, when the element’s expenditure reaches 3–7 mg/day. Diagnostic markers of copper deficiency include decreased serum copper concentration (<0.5 mg/L or <7.9 µmol) and hair copper levels (10–19 mg/g) (Shabalov N.P., 2001; Kopytko M.V. et al., 2000).

Copper absorption occurs primarily in the duodenum and proximal sections of the small intestine, where approximately 30% of dietary copper is assimilated. Inadequate copper intake from breast milk or infant formula necessitates timely introduction of complementary foods and the use of mineral-fortified juices to prevent deficiency. Clinically, copper is essential for a wide spectrum of physiological processes, including metabolic regulation, hematopoiesis, and hemoglobin synthesis. It also contributes to tissue respiration, skin and hair pigmentation, neurotransmitter-mediated conduction of nerve impulses, thyroid hormone (thyroxine) production, and connective tissue development, which is fundamental for the integrity of the musculoskeletal system. Deficiency during infancy may therefore result in anemia, impaired growth, neurological disturbances, and skeletal abnormalities.

Copper plays a critical role as a component of essential enzymatic systems—oxidases such as cytochrome oxidase and tyrosinase—and ceruloplasmin. The latter binds up to 90% of plasma copper and exhibits increased activity during stress and endocrine disorders. Copper directly influences growth, development, immunogenesis, and hematopoiesis.

Copper deficiency in humans and animals is associated with anemic conditions. Adequate copper intake is necessary for hemoglobin synthesis and normal erythrocyte formation, as well as for the organic transport of iron to the bone marrow.

Major manifestations of copper deficiency include reduced blood copper levels, depletion of tissue stores, and suppression of copper-dependent oxidases' activity, including ceruloplasmin (Nasolodin V.V., 1984). Severe deficiency in neonates is characterized by neutropenia, hypochromic anemia, delayed physical development, depigmentation of skin and hair, osteogenesis abnormalities, myocardial fibrosis, and erythema of the skin (Burch R.E., 1976; Davies I., 1977).

Copper deficiency may lead to destructive vascular wall changes, pathological bone formation, and connective tissue structure disorders. In elderly individuals, insufficient copper correlates with increased cancer risk. In children, copper deficiency frequently provokes severe nervous system damage (Menkes syndrome) due to inadequate cytochrome oxidase activity in brain tissue.

Inherited hypo- and dyscupremia include Wilson–Konovalov disease, Marfan syndrome, and Menkes syndrome. These disorders involve disrupted copper metabolism, changes in hair pigmentation, vascular and skeletal anomalies, and degenerative brain alterations (Avtsyn A.P., 1990, 1991; Maharaj N.R. et al., 1986). According to Skalny A.V. (1999), copper deficiency was detected in 50–90% of examined individuals in Moscow, with a 45–48% prevalence among children with various diseases. Koganova T.I. et al. (2004) reported a 7.4% copper deficiency incidence in gastrointestinal diseases. Own research indicates a 48.2% prevalence of copper deficiency among schoolchildren and 70.4% among rural children (Rasulov S.K., 2007).

Preventive measures aimed at averting copper deficiency depend on the copper content in locally consumed foods. Studies identified high copper content in whole-grain bread, black raisins, dried apricots, sumalak (fermented wheat dish), peas, egg whites, beef, nuts, mulberries, apricot kernels, apples, rice, vegetables, and dried fruits.

Copper concentration in grape juice varies from 1.00 to 9.00 mg% (Markh A.T. et al., 1957), while in grape wine it reaches 1.3 mg/L. Notably, the use of copper cookware and plumbing fixtures may contribute to increased copper content in prepared products.

Iodine (I)

Iodine daily requirement for humans is approximately 0.2 mg. This trace element plays a critical role in thyroid gland function as it is an essential component of thyroid hormones that regulate overall metabolism, lipid and carbohydrate catabolism, and energy production. Iodine is also necessary for the normal development of the central nervous system, skin, hair, and teeth.

Clinically, iodine deficiency is expressed through thyroid enlargement (endemic goiter), reduced overall reactivity of the body, and delayed physical as well as mental development (manifesting as cretinism in childhood). It is also associated with suppressed metabolic activity, decreased body temperature, dry skin, and impaired cognitive performance.

Excessive iodine intake typically provokes allergic reactions. Prolonged use of iodine-containing medications or hypersensitivity to iodine may lead to iodism, characterized by symptoms such as rhinitis, allergic exanthema, Quincke's edema (angioedema), and lacrimation.

Iodine content in food products varies: in grapes it ranges from 0.25 to 0.30 mg/L, in dessert wines — 0.10 to 0.20 mg/L, and in semi-sweet wines — 0.4 to 0.6 mg/L.

Zinc (Zn)

Zinc is one of the most important trace elements involved in the synthesis of amino acids and proteins. It is present in all body cells and is a component of numerous enzymatic systems. Zinc regulates blood glucose levels by prolonging the action of insulin, maintains acid-base balance, participates in tissue regeneration, insulin synthesis, and muscle contractions, and ensures the proper functioning of the prostate and reproductive system. This trace element enhances male sexual function and exhibits pronounced anti-inflammatory properties. Clinically, zinc is used in the treatment of schizophrenia, accelerates wound healing, eliminates white spots on nails, and plays a role in the restoration of taste and smell perception.

In men, the highest concentrations of zinc are found in the prostate gland and its secretions. Major dietary sources of zinc include meat, eggs, dairy products, pumpkin seeds, brewer's yeast, grapes, and grape-based products. Zinc exhibits synergistic effects when combined with vitamin A, calcium, and phosphorus.

Zinc is a component of more than 20 metalloenzymes, including DNA and RNA polymerases, phosphatase, carbonic anhydrase, and others (Sheyback M.P. et al., 2000). Approximately 98% of the body's zinc is located intracellularly, with total body stores estimated at 1.4–2.3 g. The main depots are muscle and bone tissue, the liver, prostate gland, and the eyeball. About 2% of zinc is present in blood serum: 80% of that is bound to albumin, 15% to α2-macroglobulin, and the remaining fraction to transferrin and low-molecular-weight proteins.

According to the World Health Organization (WHO), the recommended daily intake of zinc is 15–20 mg. For children under 11 years of age, the requirement is approximately 10 mg per day, for adults — 15 mg, and for pregnant and lactating women — 20–25 mg. In newborns, the requirement is estimated at 0.1 mg/kg of body weight, and for premature infants — 0.3 mg/kg (Shabalov N.P., 2001). Zinc levels in the human body correlate with its availability in the biosphere.

Zinc is involved in numerous physiological processes, including the regulation of cell division, tissue growth and development, activation of T-cell immunity, synthesis of digestive enzymes and insulin, protein synthesis, hair growth, and skin regeneration. Zinc deficiency leads to dysfunctions of the nervous and reproductive systems and is frequently associated with iron-deficiency anemia (Droke E.A. et al., 2006; Rico J.A. et al., 2006).

Recent studies have shown that zinc deficiency during pregnancy increases the risk of preterm birth and congenital anomalies in the fetus (Lavrova A.E., 2000; Legonkova T.I., 2002; Pikusa O.I., 2005; Lachat S.K. et al., 2006).

As noted by Skalny A.V. (1999), zinc deficiency can result from protein–energy malnutrition, impaired intestinal absorption, renal pathologies, or the use of glucocorticoids and cytostatic agents. It may also arise during pregnancy, in chronic inflammatory bowel conditions such as enteritis, colitis, and Crohn’s disease, as well as in chronic hepatitis, cirrhosis, psoriasis, and following radiation therapy. Additionally, excessive intake of calcium, copper, phytates, tetracycline, or isoniazid may contribute to the development of zinc deficiency. Additional risk factors include postoperative states, burns, stress, and alcohol abuse. Zinc deficiency is more common in children than in adults. Zinc levels are determined in blood, erythrocytes, hair, and urine. In healthy children, serum zinc levels range from 6.5 to 7.5 µg/mL.

A reduction in zinc levels in hair can also serve as a diagnostic marker of deficiency: in newborns it averages about 204 μg/g, decreasing to 112 μg/g by the first year of life. Breastfed infants generally have higher zinc levels than those fed with formula.

The total amount of zinc in the human body may reach 2 g; however, significant losses occur through intense sweating. In pediatric populations, zinc deficiency manifests through a wide range of clinical symptoms, including dermatitis, eczema, recurrent furunculosis, and trophic skin ulcers. It is also associated with impaired somatic growth and body mass (hypostature), alopecia, inflammatory lesions of the oral mucosa such as stomatitis, gingivitis, and cheilitis, as well as anorexia accompanied by disturbances in taste and olfactory perception. Additional features include iron-deficiency anemia, hepatosplenomegaly, delayed cognitive and sexual maturation, and, in boys, hypogonadism. (Skalny A.V., 2000; Mazariegos M. et al., 2006; Rasulov S.K., 2009).

In the postnatal period, zinc deficiency can be caused by endogenous (congenital or genetic), exogenous (dietary), or iatrogenic factors. This condition is diagnosed when blood zinc levels fall below 86 μg/100 mL, with serum levels below 53.7 ± 0.6 μg/100 mL being associated with a high risk of adverse outcomes.

According to Heide S. and Henning K. (1967), zinc content in grapes ranges from 9 to 19 mg/L. In Czech wines, the concentration of this trace element is 0.2–0.8 mg/kg, while in other wines it ranges from 0.45 to 5.6 mg/kg.

Manganese (Mn)

The recommended daily intake of manganese for humans is approximately 3–5 mg. This trace element possesses strong antioxidant activity, contributes to amino acid catabolism and energy generation, and is essential for the metabolism of vitamins B1 and E. Manganese serves as an activator of multiple enzymatic systems regulating digestion and energy metabolism, facilitates lipid and cholesterol degradation, supports proper skeletal development, and promotes the synthesis of sex hormones. The total manganese reserves in the adult human body are estimated at approximately 10–20 grams.

Experimental data indicate that manganese is involved in the biosynthesis of enzymes, stimulates the activity of the hypothalamic-pituitary-adrenal axis, enhances cellular glucose utilization, and modulates the functions of the central nervous system and reproductive organs. Moreover, it potentiates the effects of B-group vitamins and vitamin C. Manganese is also implicated in the synthesis of thyroxine, the principal hormone of the thyroid gland. It is hypothesized that manganese can penetrate systemic circulation transdermally, stimulate endogenous hormone production, and contribute to improved skin condition and general rejuvenation of the body. Furthermore, manganese has been shown to positively influence muscle reflexes and cognitive functions, including memory.

Epidemiological studies have reported manganese deficiency in 57% of school-aged children and 61% of children living in rural areas. The primary dietary sources of manganese include leafy vegetables, beets, legumes, nuts, and egg yolks.

Clinical manifestations of manganese deficiency may present as paralysis, convulsive syndromes, dizziness, and impaired auditory function. In children, congenital deafness and blindness, gastrointestinal disturbances, reduced blood cholesterol levels, and, in severe cases, the onset of insulin-dependent diabetes mellitus have been documented.

Conversely, excessive manganese accumulation in the body can result in neurotoxicity, including the development of parkinsonian syndromes, impaired iron absorption, and subsequent iron-deficiency anemia.

To prevent hypomanganesemia, the manganese content in local food products has been analyzed. The highest concentrations were found in grape-based products, rose hips, and dried apricots. Among animal-derived sources, liver, beef, egg yolks, and milk showed notable levels (Rasulov S.K., 2007). According to published data, manganese concentrations in anatomical parts of grapes vary: in the pulp – 0.68–0.84 mg/kg, in the skin – 0.50–0.60 mg/kg, and in the seeds – 1.78–2.04 mg/kg (J. Robere-Gayon & E. Peynaud, 1960). The manganese content in wine ranges from 0.61 to 7 mg/L, depending on its type and origin (S. Heide, A.M. Frolov, 1967).

Cobalt (Co)

Cobalt is an essential trace element that forms part of the structure of vitamin B_{12}. It plays a significant role in mobilizing stored iron for incorporation into the hemoglobin molecule, stimulates erythropoiesis, and promotes the release of mature erythrocytes into the peripheral bloodstream.

The average daily dietary intake of cobalt ranges from 0.005 to 1.5 mg (14–78 μg). However, it is noteworthy that in high doses, cobalt may exhibit carcinogenic properties; the toxic dose for humans is approximately 500 mg. In a healthy adult weighing 70 kg, the total body cobalt content is estimated to be around 14 mg.

Cobalt deficiency has been documented in 26 countries worldwide, including Uzbekistan. According to A.V. Skalny, 45% of children in the Russian Federation exhibit cobalt deficiency. Based on our own data, 61% of school-aged children in Uzbekistan present with cobalt deficiency, with this figure rising to 82% among children residing in rural areas.

Cobalt exerts critical effects on hematopoiesis and metabolism due to its high physiological activity. It belongs to the second group of toxic substances and is characterized by pronounced sensitizing properties. Chronic cobalt exposure, particularly in occupational settings, can lead to allergic reactions, cardiomyopathies, and respiratory tract disorders. Its primary biological function is related to its incorporation into the structure of cyanocobalamin (vitamin B_{12}), and thus, cobalt deficiency manifests clinically with a symptom complex indistinguishable from that of vitamin B_{12} hypovitaminosis (Orjonikidze E.K. et al., 1989; Popova I.Yu. et al., 1996).

Compared to other biominerals, cobalt demonstrates a relatively high absorption rate, with a bioavailability ranging from 20% to 95% (Avtsyn A.P. et al., 1991). Dietary intake provides approximately 0.25–0.69 mg/kg of cobalt, while drinking water contributes up to 10 µg. About 90% of total cobalt intake is derived from plant-based sources.

In children, the mean serum cobalt concentration is reported at 0.07 mg/L, with levels in blood cells averaging 0.019 ± 0.002 mg/L (Nasolodin V.V., 1987). According to our investigations, serum cobalt levels in children are 0.08 ± 0.03 mg/L, and salivary concentrations reach 2.7 ± 1.2 mg/L.

According to Skalny A.V. (1999), dietary sources particularly rich in cobalt comprise liver, legumes, garlic, meat, dairy products, and fish, as well as beets, green vegetables, parsley, raspberries, blackcurrants, buckwheat, and eggs. Our own findings show that the highest concentrations of cobalt are present in grape-derived products, dried apricots, and hawthorn berries.

Selenium (Se)

In recent decades, selenium has become a focal point of scientific research due to its critical role in human physiology. This trace element is an integral component of glutathione peroxidase and several other enzymes involved in cellular antioxidant defense and metabolic regulation. Selenium exhibits pronounced biological activity and is recognized as one of the most important natural antioxidants.

The selenium content in food products is largely determined by its concentration in the soil, which leads to significant regional differences in population selenium status. Selenium-deficient regions include certain areas of the Russian Federation, as well as several countries in East and Southeast Asia (e.g., China, Korea), which are regarded as endemic zones for selenium deficiency.

The physiological requirement for selenium in adults averages between 20 and 100 μg per day. Selenium contributes to the maintenance of cardiovascular function, reduces the risk of cardiomyopathy and malignant neoplasms, and promotes microcirculatory health in skin tissues. In combination with vitamin E and β-carotene, selenium exerts a potent synergistic antioxidant effect, protecting cellular membranes from oxidative damage and maintaining the elasticity of connective tissues. Additionally, it plays an essential role in hair health and the prevention of dermatological disorders such as seborrhea.

Primary dietary sources of selenium include vegetables (such as onions and tomatoes), wheat bran, as well as seafood and fish. To prevent and correct selenium deficiency, it is recommended to use selenium in combination with biologically active substances and B-group vitamins.

Selenium deficiency may manifest in the form of characteristic dermatological symptoms, such as erythematous rashes on the face and upper limbs. Systemic manifestations of deficiency encompass weakened immune reactivity, higher susceptibility to respiratory infections, impaired hepatic function, cardiovascular disorders, pathological alterations of the skin, hair, and nails, cataract formation, delayed somatic growth, and insufficient synthesis of pulmonary surfactant. An association has also been established between selenium deficiency and sudden infant death syndrome (SIDS). Furthermore, insufficient selenium intake contributes to the accumulation of toxic elements such as arsenic, cadmium, and mercury in the body.

Excessive selenium intake—exceeding 5 mg/kg of body weight—may lead to toxic effects. Nonetheless, selenium exhibits antagonistic properties toward arsenic and mercury, mitigating their toxic effects on the human body.

Biologically Active Compounds of Vegetables, Fruits, and Aromatic Plants

The chemical composition of vegetables, fruits, and aromatic herbs is characterized by a high degree of complexity and diversity, which is typical of plant-based materials in general.

These products constitute valuable sources of readily bioavailable carbohydrates, a broad spectrum of vitamins and enzymes, organic acids, phenolic compounds and their derivatives, as well as essential oils, glycosides, alkaloids, and tannins. In addition, they provide mineral elements, aromatic constituents, and other pharmacologically active compounds of therapeutic significance. T

hese compounds are predominantly obtained through the consumption of fruits and vegetables and play a vital role in maintaining human health. They play an important role in the prevention and management of diseases affecting the cardiovascular and nervous systems, the gastrointestinal tract, liver, kidneys, and respiratory organs, as well as in the correction of metabolic disturbances and various other pathological conditions.

Vitamins

Vitamins are indispensable micronutrients that govern the metabolism of carbohydrates, proteins, and lipids, while also sustaining the functional activity and secretory processes of the endocrine system. Although the daily requirement for vitamins is significantly lower than that for macronutrients, their biological role in metabolic processes is critically important.

Plant-derived foods provide a wide array of vitamins that differ in chemical structure and physiological function. These compounds fulfill a variety of biological roles in both humans and animals. Insufficient intake or complete lack of certain vitamins in the diet results in metabolic disturbances and impaired organ function, which clinically present as vitamin deficiency states, including hypovitaminosis and avitaminosis.

Vitamin deficiency is a general term encompassing pathological conditions resulting from the lack of one or more vitamins. It is classified into avitaminosis, hypovitaminosis, and subclinical or marginal vitamin insufficiency. Avitaminosis is characterized by the total absence of a particular vitamin and presents with pronounced clinical symptoms (e.g., scurvy, pellagra).

Hypovitaminosis refers to a partial deficiency and may manifest with both specific and non-specific symptoms such as reduced appetite, fatigue, weakness, and decreased performance. The simultaneous deficiency of multiple vitamins is termed polyhypovitaminosis.

In adults, dietary intake is the main source of vitamins. Some water-soluble vitamins are synthesized by the intestinal microbiota and absorbed into the bloodstream, partially compensating for dietary deficits. However, excessive cooking, frying, preserving, and adherence to traditional culinary practices may substantially reduce the vitamin content of food. Most vitamins are prone to rapid degradation and have limited storage capacity in the body, making their regular intake from food essential.

Although vitamins are required only in trace amounts in foods (10–100 mg per 100 g), they remain critical components of the human diet, albeit not serving as sources of energy. Depending on their solubility, vitamins are classified as fat-soluble or water-soluble, and a separate category is reserved for vitamin-like compounds.

Modern nutritional science has identified numerous vitamins, but for public health purposes, priority is given to those with the highest biological significance. To prevent vitamin deficiency, key strategies include biofortification, consumption of vitamin-enriched products, and the regular intake of natural sources of these compounds.

In the vitamin classification presented below, the biological functions and disease-preventive roles of each compound are indicated in parentheses. The prefix “anti-” in the name denotes the disease the vitamin counteracts, emphasizing its preventive or therapeutic value.

1. Fat-Soluble Vitamins

- **Vitamin A** – retinol, also known as the *anti-xerophthalmic factor*

- **Vitamin D** – calciferols, referred to as the *anti-rachitic factor*
- **Vitamin E** – tocopherols, often termed the *reproductive vitamin*
- **Vitamin K** – phylloquinones and menaquinones, the *antihemorrhagic factor*

2. Water-Soluble Vitamins

- **Vitamin B1 (Thiamine)** – recognized as the *antineuritic factor*
- **Vitamin B2 (Riboflavin)**
- **Vitamin PP (Niacin, Nicotinic acid)** – known as the *antipellagric factor*
- **Vitamin B6 (Pyridoxine)** – regarded as the *antidermatitic factor*
- **Pantothenic acid** – also associated with *anti-dermatitic effects*
- **Biotin (Vitamin H)** – a *growth factor* active against fungi, yeasts, and bacteria
- **Inositol and Para-aminobenzoic acid (PABA)** – contribute as *factors for bacterial growth and pigmentation*
- **Folic acid** – considered an *anti-anemic vitamin* and a *growth factor* for chicks and bacteria
- **Vitamin B12 (Cobalamin)** – the *anti-anemic vitamin*
- **Vitamin B15 (Pangamic acid)**
- **Vitamin C (Ascorbic acid)** – recognized as the *antiscorbutic factor*
- **Vitamin P (Bioflavonoids)** – regulate *capillary permeability*

Vegetables and fruits contain a wide spectrum of biologically active compounds, with vitamins occupying a central position. The vitamin profile of these products includes:

- **B-complex vitamins** — B1 (thiamine), B2 (riboflavin), B3 (pantothenic acid), B5/PP (nicotinic acid), B6 (pyridoxine), and B9 (folic acid);
- **Vitamin C (ascorbic acid);**
- **Vitamin F** — a collective designation for high-molecular-weight polyunsaturated fatty acids;
- **Vitamin P** — represented by citrin and various flavonoids;
- **Vitamin E (tocopherols);**
- **Vitamin K (phylloquinones);**
- **Vitamin H (biotin);**
- **Vitamin U;**
- **Carotene (provitamin A);**
- **Ergosterol (provitamin D);**
- as well as several other vitamin-like compounds.

Vitamin B1 (thiamine) is synthesized by higher plants and certain microorganisms (particularly yeasts), but cannot be produced by animals, and therefore must be supplied through the diet. Thiamine plays a pivotal role in carbohydrate metabolism, most notably in the decarboxylation of pyruvic acid. Its deficiency may lead to nutritional polyneuritis, growth retardation, impaired gastrointestinal peristalsis, and reduced gastric acid secretion. Severe deficiency leads to beriberi, a condition characterized by neurological dysfunction, insomnia, irritability, and, in advanced stages, lower limb paralysis. In regions where polished rice is a staple, thiamine deficiency is more prevalent. In Central Asia and Europe, hypovitaminosis B1 is rare due to widespread consumption of thiamine-rich foods (e.g., rye bread, vegetables). The highest concentrations are found in green peas, beans, onions, sorrel, lettuce, cabbage, pepper, cereal husks and germ (wheat, oats, buckwheat), peanuts, and more.

Grapes contain approximately 30–60 μg of vitamin B1 per 100 grams. However, during industrial processing, thiamine levels may decline by 77–97%. The vitamin is preserved in wines if they are not subjected to intensive treatment.

Vitamin B2 (Riboflavin) is synthesized in nature primarily by plant leaves and numerous microorganisms, including yeast during fermentation. It plays an essential role in protein, lipid, and carbohydrate metabolism and regulates the function of the central nervous system, microvasculature, liver, skin, and endocrine glands. Riboflavin is a structural component of flavoproteins—enzymes that catalyze oxidation-reduction reactions at the cellular level.

Riboflavin deficiency is associated with impaired protein synthesis, anemia, angular stomatitis (cracks at the corners of the mouth), glossitis, stomatitis, growth retardation, and ocular disorders. Hypovitaminosis is more commonly observed in populations with limited dairy intake and in patients with chronic gastrointestinal diseases that impair nutrient absorption.

Elevated levels of riboflavin (vitamin B2) are characteristic of a variety of plant products, including cabbage, parsley, parsnip, green bell pepper, peas, beans, onions, lettuce, sorrel, tomatoes, horseradish, as well as cereal bran, germ, buckwheat, and related food sources. Grapes provide 14–40 µg of riboflavin per 100 g of fresh weight. Processing of berries leads to a reduction in its concentration by approximately 30–35%, whereas in wine, riboflavin levels remain largely unaffected.

Pantothenic acid (Vitamin B3) is synthesized by green plants and a range of microorganisms, including yeasts during fermentation processes. It is broadly distributed across both plant- and animal-derived tissues.

Pantothenic acid (vitamin B5) is a key constituent of coenzyme A, indispensable for carbohydrate, lipid, and amino acid metabolism. Clinically, insufficient intake can impair energy production and disrupt endocrine and nervous system function, potentially leading to fatigue, irritability, sleep disturbances, and neurological symptoms.

Major dietary sources include yeast, liver, egg yolks, green peas, cauliflower, celery, parsnip, black currants, raspberries, and others.

In grapes, pantothenic acid is found in concentrations of 68 µg/100 g in light-colored varieties and 85 µg/100 g in red varieties. In wine, its concentration ranges from 0.2 to 1.2 mg/L.

Vitamin B6 (Pyridoxine) is synthesized by higher plants and a wide range of microorganisms. It is a constituent of enzymes with biocatalytic functions and regulates nervous system activity.

As a coenzyme, pyridoxine participates in the operation of various enzymatic systems, particularly in the metabolism of amino acids, carbohydrates, and lipids.

Vitamin B6 deficiency is most pronounced in children and may present with convulsions (polyneuritis), dermatitis, stomatitis, conjunctivitis, a weakened immune response, and the development of microcytic hypochromic anemia.

High levels of pyridoxine are found in beans, peas, onions, garlic, hot and sweet peppers, cabbage, horseradish, parsley, black currants, apples, plums, and other foods. In grapes, pyridoxine content ranges from 0.16 to 0.53 mg/L (average: 0.32 mg/L), second only to nicotinic acid in concentration.

Folic acid (Folate, Vitamin B9) deficiency is prevalent worldwide, particularly among adults. Folic acid is particularly important for pregnant and lactating women as well as patients with certain medical conditions. Its biochemical roles are diverse, encompassing nucleic acid synthesis, methylation reactions, and amino acid metabolism. As a result, folic acid is essential for growth and development and exhibits lipotropic effects. It is also beneficial in the management of anemia and radiation-induced disorders. The recommended daily intake for adults is approximately 50 μg, whereas consumption below 5 μg/day can lead to deficiency symptoms.

Folate is abundantly present in plant foods such as parsley, beans, peas, horseradish root, onions, cabbage, sorrel, celery, strawberries, raspberries, cherries, currants, and other fruits and vegetables. According to A. Hall (1967), white grape varieties contain 4.2–5.3 μg per 100 g, while red grape varieties contain 5.8–10.2 μg per 100 g (mean value: 7.9 μg/100 g).

Vitamin C (Ascorbic Acid) is synthesized in the bodies of plants and most animals; however, humans lack this ability, and therefore must obtain it from food or in its ready-made form.

Ascorbic acid enhances the body's resistance to infectious diseases, increases the liver's detoxifying capacity, slows the progression of atherosclerosis, and participates in metabolic processes and various essential biochemical reactions.

Vitamin C deficiency results in reduced physical performance, heightened fatigue, compromised immune function, and increased capillary fragility and permeability, which may manifest as subcutaneous hemorrhages and bleeding gums, as well as loosening and eventual loss of teeth.

Vitamin C is widely distributed in vegetables, fruits, and aromatic plants, with concentrations reaching 15–18% in some species. Particularly rich sources include rose hips, black currants, sweet bell peppers, the green parts of parsley and celery, onions, cabbage, spinach, unripe walnuts, horseradish root, and turnips.

Grapes contain a relatively low amount of vitamin C—ranging from 1 to 15 mg per 100 g, most commonly between 3 and 9 mg/100 g (V.I. Nilov, 1967). In grape leaves, however, the concentration is significantly higher, reaching 206–259 mg/100 g during the vegetation period.

Vitamin E (Tocopherol) prevents the oxidation of high-molecular-weight unsaturated fatty acids and the formation of toxic metabolites with cytotoxic properties.

It also supports metabolic processes in the myocardium and improves the functional state of the cardiovascular system.

Tocopherol deficiency in pregnant women is associated with an increased risk of spontaneous abortion and fetal death; in men, it leads to reduced reproductive function, nervous system damage, and the development of fatty liver infiltration.

Tocopherols (Vitamin E) are abundant in dietary sources such as rose hips, hawthorn, chokeberry, and black currants, as well as in green peas, beans, onions, parsley, cabbage, spinach, rhubarb, and numerous other fruits and vegetables.

Vitamin F facilitates the transformation of cholesterol into water-soluble compounds and accelerates its elimination from the body, thereby preventing the development of atherosclerosis.

It also plays an important role in the prevention and treatment of eczema, ulcerative skin lesions, and diseases of the kidneys and reproductive organs.

Primary sources of vitamin F include vegetable oils—particularly sunflower, cottonseed, corn, rose hip, and linseed oils.

Vitamin K plays a crucial role in accelerating blood coagulation and promoting hemostasis, while also alleviating pain and supporting wound healing and tissue regeneration. It enhances cellular oxygen utilization and participates in the metabolism of proteins, nucleic acids, steroids, and other biologically significant molecules.

Deficiency of vitamin K is often observed in individuals with liver disorders, cardiovascular diseases, or inflammatory conditions of the stomach. Key dietary sources include cabbage, fresh tomatoes, rose hips, spinach, corn silk, chokeberry, cranberries, cherries, plums, and a wide variety of other fruits and vegetables.

Vitamin P designates a group of plant-derived flavonoids, including hesperidin, eriodictyol, rutin, quercetin, catechins, and others, which reinforce capillary walls and decrease their permeability and fragility. It plays a significant role in the prevention of hemorrhages, including those affecting the brain and myocardium.

Vitamin P is found in the aerial parts of buckwheat, chokeberry, rose hips, black currants, hawthorn, cranberries, citrus peels (orange, lemon, mandarin), grapes, cherries, barberries, green tea, and many other plant species.

Vitamin PP (nicotinic acid and nicotinamide) functions as a provitamin that is converted into nicotinamide in the human and animal body.

It protects against pellagra—a condition that, in severe cases, affects the central nervous system.

Nicotinic acid (niacin, vitamin B3) is present in substantial amounts in a variety of plant-based foods, including cabbage, parsley, onions, garlic, green peas, beans, lettuce, rhubarb, pumpkin, eggplant, tomatoes, celery, parsnip, carrots, as well as in fruits such as apples, plums, cherries, raspberries, strawberries, black currants, chokeberry, and numerous other vegetables and fruits.

Grapes are particularly rich in nicotinic acid: white varieties contain about 220 μg/100 g, while red varieties contain up to 309 μg/100 g.

In white wine, the concentration of free-form nicotinic acid is approximately 0.82 mg/L, and total nicotinic acid is about 1.57 mg/L; in red wine, these values are 1.31 mg/L and 1.89 mg/L, respectively.

Vitamin U exhibits anti-ulcer properties and is effective in the treatment of gastritis, gastric and duodenal ulcers, cardiovascular diseases, and dermatological conditions. The highest concentrations of vitamin U are found in certain vegetables, particularly cabbage.

Carotene (provitamin A) is metabolically converted into active vitamin A in the human body. Insufficient dietary intake or absence of carotene can result in impaired physical development, including growth retardation in children, diminished visual acuity—potentially leading to night blindness—and weakened immune defenses against infections and other diseases. Vitamin A is also essential for the biosynthesis of hormones in the adrenal cortex and gonads, and it plays a pivotal role in maintaining normal visual function.

Carotene is predominantly concentrated in yellow, orange, and red fruits and vegetables, such as rose hips, chokeberries, aronia, pumpkins, tomatoes, red bell peppers, black currants, raspberries, apricots, cherries, carrots, parsley greens, lettuce, sorrel, spinach, rhubarb, celery, cabbage, and the green portions of onions and garlic, as well as in watermelon, melon, and other plant-derived products.

Biotin (vitamin H, also known as the anti-seborrheic vitamin) is found in significant amounts in plant pollen, seeds, and underground plant organs. It is a key component of bios, a complex that promotes yeast growth. Biotin is part of active enzyme systems involved in carboxylation and decarboxylation reactions and serves a regulatory role in metabolic processes. Biotin deficiency in the diet can lead to inflammatory skin conditions in children (such as scaling and dermatitis), as well as anemia and increased blood cholesterol levels.

Notable concentrations of biotin are found in cabbage, lettuce, onions, cucumbers, tomatoes, green peas, beans, apples, cherries, strawberries, black currants, raspberries, and various other fruits and vegetables.

In mature grapes, biotin content ranges from 1.5 to 4.2 μg/L (average: 2.63 μg/L). In red wine, its concentration varies between 0.6 and 4.6 μg/L (average: 1.96 μg/L). During traditional winemaking, the biotin content generally remains stable in the final product.

Enzymes

Enzymes constitute a major class of protein compounds and play a central role in the physiological processes of all living organisms as well as in the processing of raw animal and plant materials. To date, more than 850 enzymes have been identified, with over 20% of them obtained in purified crystalline or ultrapure forms. According to international classification, enzymes are divided into six major classes:

oxidoreductases, transferases, hydrolases, lyases, isomerases, and ligases, which are further subdivided into smaller groups.

The existence of life is impossible without enzymes. They typically act on specific substrates, accelerating their chemical transformations. Enzymes are involved in all metabolic processes within the body. They can be classified as simple (consisting only of protein) or complex (consisting of both protein and non-protein components). The latter include a coenzyme, which is often a vitamin. The activity of complex enzymes depends significantly on the coenzyme component.

Grapes contain the following enzymes:

β-fructofuranosidase (invertase, sucrase), which catalyzes the breakdown of sucrose into glucose and fructose; this enzyme is also present in yeast.

β-glucosidase, widely found in plants (e.g., almonds and grapes) as well as in certain yeasts, fungi, and bacteria.

Other enzymes present in grapes include catalase, peroxidase, oxidase, malate dehydrogenase, proteases, and acid phosphatases.

Organic Acids

Organic acids are widely distributed in the plant kingdom and are present in tissues both in free form and as esters. While plants contain a diverse array of acyclic, cyclic, aromatic, and hydroxyaromatic acids, only a limited subset significantly influences human metabolism. Low-molecular-weight organic acids such as malic, citric, tartaric, oxalic, acetic, formic, and isovaleric acids play key roles in biochemical processes, including energy production via the Krebs cycle, maintenance of acid–base balance, facilitation of mineral absorption, and modulation of metabolic pathways. These compounds also contribute to the organoleptic properties of foods, including taste and preservation.

These compounds typically accumulate in fruits—such as cranberry, barberry, lemon, pomegranate, quince, pear, apple, raspberry, loquat, and strawberry—while their concentration in leaves (e.g., sorrel, spinach, rhubarb, cabbage, onion) is relatively low. These acids determine the sour or sweet-sour taste of fruits and leaves, stimulate appetite, improve digestion, and have thirst-quenching effects in febrile conditions. Therefore, acidic fruits are widely used to stimulate appetite and in the preparation of refreshing beverages.

Aromatic and phenolcarboxylic hydroxy acids are of particular interest in medical practice. These include benzoic, salicylic, cinnamic, caffeic, and gallic acids, as well as their derivatives. These compounds are predominantly found in plant tissues as esters, glycosides, alkaloids, and other complex forms. Phenolcarboxylic acids exhibit pronounced diuretic, choleretic, and anti-inflammatory properties and help strengthen the capillary walls.

High-molecular-weight saturated and unsaturated fatty acids, when combined with glycerol, form esters known as triglycerides, which constitute the primary components of plant fats (oils). These substances accumulate in various plant organs, predominantly in fruits and seeds, and serve as important energy sources and structural elements for humans, animals, and plants themselves. Among unsaturated higher fatty acids, oleic, linoleic, linolenic, arachidonic, and others are especially significant. They comprise the so-called vitamin F complex. These acids participate in the biosynthesis of biologically active substances such as prostaglandins, which play essential regulatory roles in the body.

Various organic acids have been identified in grapes, including tartaric, citric, malic, glycolic, oxalic, glucuronic, salicylic acids, and others, which determine the organoleptic and biological properties of grapes.

Carbohydrates

Carbohydrates in grapes are primarily represented by D-glucose and D-fructose, with minor amounts of free sucrose. In addition to glucose, polysaccharides and glycosides contain other monosaccharides such as L-arabinose, L-rhamnose, and D-xylose. Notably, starch is absent in ripe grape berries. Glucose and fructose account for approximately 50% each of the total sugar content. Among various sugars, fructose possesses a higher sweetening capacity than both glucose and sucrose. In fully ripened grapes used in winemaking, sugar content ranges from 17% to 25%.

Glycosides

Glycosides are complex compounds formed through the interaction of carbohydrates with various organic substances. They are widespread in the plant kingdom and, under the action of specific enzymes, hydrolyze into a sugar (glycone) and a non-sugar (aglycone) component. Glycosides vary in their chemical structure of the aglycone and exert diverse pharmacological effects on the human body. Vegetables, fruits, and aromatic plants contain several groups of glycosides with therapeutic relevance, including phenolic, cyanogenic, thioglycosides, monoterpenoid, and triterpenoid glycosides.

Phenolic glycosides are composed of aglycones derived from phenolic compounds and their derivatives. A notable example is arbutin, present in the leaves and unripe fruits of pear, which demonstrates potent diuretic and antiseptic activity in the urinary tract.

Cyanogenic glycosides contain nitrogen atoms in their aglycone moiety. The most well-known is amygdalin, present in the fruits and seeds of the Rosaceae family (bitter almond, apricot, peach, plum, cherry), and less commonly in leaves and flowers (e.g., bird cherry). Elderberry fruits contain sambunigrin, while linseed and flaxseeds contain linamarin. Amygdalin (present in bitter almond water) has analgesic and sedative properties.

Thioglycosides release volatile sulfur- and nitrogen-containing compounds, such as isothiocyanates (e.g., mustard essential oil), upon enzymatic breakdown. These glycosides are characteristic of seeds from the Brassicaceae family (mustard, turnip, radish, cabbage, watercress), roots (horseradish), and to a lesser extent, leaves. For example, sinigrin found in mustard seeds, upon hydrolysis, yields allyl isothiocyanate (mustard oil), which has a pungent odor and taste as well as a strong irritant effect. This compound stimulates gastric juice secretion, enhances appetite, and improves digestion.

Monoterpenoid (bitter) glycosides have a distinct bitter taste and stimulate gastric juice secretion, enhance appetite, and promote digestion. Plants containing these compounds (wormwood, bitter yarrow, tarragon, dandelion, cinnamon, etc.) are used in cases of anorexia and digestive disorders.

Triterpenoid glycosides (saponins) form stable foams when aqueous extracts are shaken. These compounds exert a complex effect on the body, including expectorant, diuretic, sedative, and tonic properties. Licorice roots are particularly rich in saponins.

In addition to saponins, triterpenoid compounds include ursolic acid (found in cranberries, lingonberries, and apple peels), crataegolic acid (in hawthorn fruits), and oleanolic acid (aglycone component of many saponins). Ursolic acid has anti-inflammatory and wound-healing properties; crataegolic acid dilates the blood vessels of the heart and brain, improves microcirculation, and has hypotensive and sedative effects.

Flavonoids

Flavonoids represent a broad class of organic compounds that are widely distributed in the plant kingdom. These substances share a common chemical structure based on a phenyl-benzopyran (C6–C3–C6) backbone. Flavonoids and the plants that contain them exhibit a wide range of pharmacological activities. Some flavonoids possess vitamin-like activity similar to that of vitamin P; notably, vitamin P (citrin) itself is a mixture of two flavonoid compounds. In addition, certain flavonoids are used as choleretic and diuretic agents, cardiotonics, sedatives, and also demonstrate anti-inflammatory and antitumor properties.

Flavonoids are abundant in a wide range of vegetables, fruits, and aromatic plants. Notable sources include black chokeberry (Aronia), black currant, rose hips, medlar, cranberries, hawthorn, cherries, apples, pears, citrus fruits (oranges, lemons, mandarins), quince, barberry, tomatoes, eggplants, peppers, onions, garlic, parsley, sorrel, spinach, rhubarb, dill, mint, basil, yarrow, clover, cereals, and numerous other plant crops.

Coumarins

Coumarins and their derivatives, furanocoumarins, are found in plants less frequently than flavonoids. These benzopyrone derivatives exhibit a wide spectrum of biological activity. Coumarins and furanocoumarins show bacteriostatic, antifungal, anticoagulant, antitumor, and antispasmodic effects, and also exert activities similar to those of vitamin P. Certain furanocoumarins exhibit photosensitizing properties by increasing the skin's sensitivity to ultraviolet radiation, which forms the basis for their therapeutic application in vitiligo (leukoderma) treatment.

Coumarins and furanocoumarins are present in a variety of plants, including parsnip, carrot, dill, cherry, hawthorn, plum, medlar, oleaster, fig, pomegranate, citrus fruits (oranges, lemons, mandarins), apples, pears, as well as in the leaves of grapes and figs, and in numerous other vegetables, fruits, and aromatic plants.

Lignans

Lignans are dimeric derivatives of phenylpropane that occur in plants in both free form and as glycosides. These compounds exhibit tonic, antitumor, and other beneficial effects on the human body. Primary dietary sources of lignans include sesame seeds (especially sesame oil) and various vegetables, fruits, and aromatic herbs.

Tannins (Astringent Substances)

Tannins are a group of widely distributed plant metabolites that accumulate in all parts of the plant in substantial quantities. They exert astringent (anti-diarrheal, wound-healing), antiseptic, hemostatic, and anti-inflammatory effects. Tannins are also used as antidotes for poisoning by certain alkaloids, glycosides, and heavy metal salts. Plants rich in tannins include oleaster, pomegranate (especially its peel), unripe walnut hulls, dogwood, field horsetail, rose hips, quince, apples, tea leaves, sorrel, and rhubarb roots, among others.

Alkaloids

Alkaloids are a group of complex organic compounds containing nitrogen in their molecular structure and are found primarily in plant tissues, though some are also found in animals. These compounds are typically heterocyclic and exhibit a high degree of structural diversity, which accounts for their broad spectrum of pharmacological effects on humans and animals. Most alkaloids are highly toxic, and plants that contain them are considered poisonous and unsuitable for food. However, certain plants containing alkaloids—such as tea, coffee, black pepper, and chili peppers—are widely used in food and pharmaceutical applications when consumed in moderation.

Pectic Substances

Pectins are a group of complex carbohydrates classified as polysaccharides. Their macromolecules are primarily composed of galacturonic acid residues. The main forms of pectic substances include protopectin, pectic acid, pectin, and pectoic acid. Pectins are widely distributed in the plant kingdom and are known for their strong antibacterial activity and their ability to bind heavy metals such as calcium, strontium, lead, cobalt, and others, forming insoluble complexes.

This chelating ability underlies their use as antidotes for heavy metal intoxication. Fruits are the main reservoirs of pectins, although these compounds are also found in leaves, stems, and other vegetative organs. The highest concentrations are observed in apples, pears, black currants, chokeberries, barberries, cranberries, hawthorn berries, eggplants, pumpkins, watermelon, melon, beets, turnips, and cabbage leaves, among many other vegetables and fruits.

In grapes, the pectin content varies by cultivar: muscat-type and related varieties contain approximately 0.2–0.3%, while most other grape varieties contain about 0.1%.

Essential Oils

Essential oils are complex mixtures of volatile organic compounds, distinguished by their strong aromatic aroma and characteristic pungent taste. Owing to their diverse chemical structures and the presence of various functional groups, essential oils exhibit a wide range of pharmacological activities in the human body, including expectorant, choleretic, diuretic, appetite-stimulating, disinfectant, antiseptic, and antispasmodic effects. These compounds are common secondary metabolites in plants, with especially high concentrations found in species native to southern regions.

Among edible plants, essential oils are primarily found in species used as aromatic herbs and spices. These substances promote the secretion of gastric juices, enhance appetite, and improve digestion.

In grape juice, the presence of methyl anthranilate (the methyl ester of anthranilic acid) has been identified at a concentration of approximately 3.8 mg/L. During the winemaking process, essential oils are retained in the final product, contributing to a complex mixture of aromatic compounds. These include hydrocarbons, alcohols, carbonyl compounds, esters, and volatile acids, all of which collectively determine the wine's organoleptic properties.

CHAPTER II
THERAPEUTIC PROPERTIES OF GRAPES – AMPELOTHERAPY

Botanical Overview of the Grape Plant

GRAPE – *Vitis vinifera* (Common Grape Vine)

Family and Distribution. Grapevine (*Vitis*), belonging to the family **Vitaceae**, is a liana-like plant that comprises approximately 10 genera and about 70 species. Its natural distribution spans tropical, subtropical, and temperate climatic zones. In the wild, grapevines are primarily found in humid forests, river valleys, foothills, and floodplains, where they may form shrub-like growths or low woody thickets. The plant possesses a well-developed root system that can reach depths of up to 20 meters.

The leaves are rounded and palmate-lobed; the inflorescences consist of small, inconspicuous flowers. Some cultivated varieties, such as white and black *Kishmish*, are seedless. The fruits are juicy berries from which juice is obtained in amounts ranging from 78% to 82% of the total fruit mass.

Grapevines are cultivated in all agro-climatic zones of Uzbekistan. Wild grapevines have been identified in the Ohangaron Valley and around the Tupolang Reservoir. Across Europe and Central Asia, more than 2,000 grapevine cultivars have been documented, with approximately 400 varieties cultivated in Uzbekistan. These are typically classified into three categories: **table grapes**, **raisin (drying) varieties**, and **wine grapes**.

- **Wine grape cultivars**: *Aleatico*, *Taifi*, *Aligoté*, *Bayan Shirey*, *Buvaki*, *Bihishti*, *Bakhtiyori*, *White Muscat*, *Riesling*, *Rkatsiteli*, *Soyaki*, *Saperavi*, among others.
- **Raisin (drying) cultivars**: *White Kishmish*, *Black Kishmish*, *Pink Kishmish*, *Shakar Angur*, *Sultoni*, and others.
- **Table grape cultivars**: *Pobeda*, *Rizamat*, *Doroyi*, *Chirgi*, *Husayni*, *Vasalkha*, *Katta-Kurgan*, *Nimra*, *Charast*, and others.

Grapes in Avicenna's Treatises: Pharmacological and Nutritional Aspects

The renowned Eastern physician and scholar Avicenna (Ibn Sina) emphasized both the nutritional and therapeutic value of grapes in his seminal medical work *The Canon of Medicine*. He noted the astringent and strengthening properties of grape juice and vine ash, and described the medicinal use of grape oil and various decoctions in treating headaches, skin eruptions, fatigue, and joint pain. Special attention was given to the nutritional benefits of raisins and their positive effects on cardiac, renal, and gastrointestinal functions.

"Properties**. There are wild and mountainous varieties of grape, as well as cultivated ones. The ash of the vine is included in the composition of cauterizing agents. Grape oil resembles rose oil, though it lacks emollient properties. Grape juice, especially when combined with oil, promotes maturation and warming. The flowers of wild grapes are strongly astringent.*

***Cosmetic use.** Grape juice is used for treating warts that resemble ant bites. Juice from wild grapes eliminates freckles and petechial hemorrhages, whereas the cultivated variety has* *a weaker effect. Fresh juice from young shoots of wild grape mixed with olive oil can cause hair loss.*

Grape juice serves as a remedy for scabies and dermatological conditions. Fruits of the wild grape reduce inflammation from dislocations.

Vine ash combined with vinegar is used for nervous disorders; vine ash with olive oil is applied for muscle ruptures and joint laxity. Occasionally, ash is diluted in water and administered orally after falls. Juice oil is applied for pain in joints, muscles, nerves, and general fatigue. Grape leaves and tendrils are applied as ointments for headaches caused by heat. Various parts of grape plants have been traditionally used for medicinal purposes. Roots of black and wild white grape are employed to cleanse earwax and may aid in alleviating hearing impairments. The bark of wild grape combined with honey is applied to strengthen bleeding gums. Grape leaves, mixed with barley flour, are used topically to reduce eye swelling and inflammation. Juice from the leaves and fruits of mountainous and wild grape varieties is administered for hemoptysis. Poultices composed of leaves and tendrils with barley flour are applied to the stomach to relieve swelling and inflammation, while leaf juice is also utilized to alleviate heat-induced gastric discomfort.

A decoction of wild grape roots, prepared with water or wine, is traditionally prescribed to treat dropsy and promote diuresis.

Wild grape fruits are beneficial for the stomach, nausea, malaise, and heartburn.

Leaf juice is used in cases of dysentery and burning anal pain.

Concentrated grape juice with wine is said to dissolve stones. Vine ash with vinegar is used for hemorrhoids and tumors. The fruits relieve rectal pain, promote urination, and have a constipating effect." (Canon of Medicine, 1982)*

***In Avicenna's medical legacy*, *grapes (Vitis vinifera*)** *were extensively discussed in terms of their medicinal uses, with clear distinctions made between cultivated and wild forms of the plant. He reported that vine ash was used in cauterizing agents, and that grape oil, similar in nature to rose oil, lacked laxative properties. Grape juice, especially when combined with oil, was believed to have warming and strengthening effects, while the flowers of wild grapes exhibited strong astringent properties.*

The therapeutic applications of grapes included treatment of dermatological conditions such as eczema, freckles, and pigmentation disorders, with wild grape being considered more efficacious than cultivated forms. A decoction of wild grape roots, especially when combined with olive oil, was recommended for auditory disorders. Leaves and young shoots were used to relieve headaches, while decoctions of the vine were employed to alleviate muscle fatigue and joint pain. Raisins were highlighted as a nourishing product that supports cardiovascular, renal, and digestive health, and also exhibits diuretic effects.

"Choice.** If firmness, softness, sweetness, and other qualities are similar, white grapes are considered superior to black ones. Grapes stored for 2–3 days after harvesting are more beneficial than freshly picked ones.*

***Nature.** The skin of grapes is cold and dry, and difficult to digest. The pulp is warm and moist. The seeds are cold and dry.*

Properties. *Fresh grapes cause bloating. Slightly dried grapes with thin skin are easier to digest and more nourishing, and they strengthen the body. Although less nutritious than figs, they surpass them in quality and digestibility. Ripe grapes are less harmful than unripe ones. If not properly digested, they provide crude nourishment, but their juice is quickly absorbed. Astringent grapes lose their astringency when hung, but sour ones do not. Raisins benefit the liver and stomach.*

Excretory effects*. Grapes and raisins with seeds are beneficial for intestinal pain, while raisins support kidney and bladder function. Fresh grapes may cause diarrhea and bloating. All grapes may be harmful to the bladder.*

A decoction of grape juice with elm bark aids in the expulsion of phlegm." (pp. 492–493, p. 194)*

Medicinal Raw Materials

In medical practice, various parts of the grapevine (Vitis vinifera) are utilized, including ripe fruits (grapes), their juice, lees (shiniss), pomace (g'urob), leaves, and vine decoctions.

Chemical Composition of Grapes

Grape berries contain between 12% and 32% sugars, primarily glucose, fructose, and sucrose. Taking glucose's sweetness as a reference unit, sucrose is approximately 1.45 times sweeter and fructose 2.2 times sweeter. In most grape varieties, glucose and fructose are present in roughly equal proportions. The sucrose content in grapes is relatively low, not exceeding 5.5%. These sugars are chemically similar to monosaccharides and, unlike beet sugar (sucrose), are absorbed directly into the bloodstream without enzymatic breakdown, thereby rapidly replenishing energy and promoting overall health.

The organic acid content of grapes ranges from 2.55% to 6%, comprising both free and bound acids. Of these, 60% is malic acid and 40% includes tartaric, oxalic, salicylic, and others. Free acids contribute to the tart flavor of the fruit, while bound acids do not affect taste. Grape juice contains between 0.2% and 0.6% of free acids.

According to G.N. Lipkan (1988), grapes are abundant in essential minerals and trace elements. Potassium constitutes over 60% of the dry matter and exerts beneficial effects on cardiac and renal functions. On average, 100 g of edible grape pulp contains approximately 250 mg of potassium, 12 mg of magnesium, 16–22 mg of calcium, 7.6–10 mg of copper, 0.6–8.7 mg of titanium, 0.9–9.2 mg of nickel, along with cobalt, aluminum, silicon, zinc, boron, and other micronutrients. Many of these elements serve as integral components of enzymes, hormones, vitamins, proteins, and other biologically active compounds.

In 100 g of grape juice, the average content is: potassium — 90–130 mg, sodium — 1.9–5.3 mg, iron — 0.91 mg, zinc — 0.5 mg, and aluminum — 0.2 mg.

Grapes also contain essential vitamins, including: ascorbic acid — 1.5–15 mg/100 g, carotene — 0.12–0.20 mg/100 g, tocopherol — 1.17–1.19 mg/100 g, riboflavin — 0.024–0.045 mg/100 g, and ergocalciferol — 0.06–0.07 mg/100 g.

The pectin content in grapes ranges from 0.2% to 1.5%. Grapes provide both essential amino acids, including lysine, histidine, arginine, methionine, and leucine, and non-essential amino acids such as cystine and glycine, which play important roles in maintaining metabolic processes. They are also rich in flavonoids and folic acid, enhancing their nutritional and functional value. According to V.Ya. Menkovich et al. (1994), 100 g of grapes contains approximately 3 mg of vitamin C, 0.06 mg of vitamin B1, 0.04 mg of vitamin B2, and 0.2 mg of vitamin PP (niacin).

Grapes also contain active enzymes—including invertase, pectinase, protease, and lipase—that contribute to carbohydrate, protein, and lipid metabolism. The energy content of 100 g of grape juice is estimated at 72 kcal.

Grape leaves are a source of glycosides, quercetin, organic acids, inositol, amino acids, carotene, vitamins C and P, and contain approximately 2% sugar.

Grape seeds contain up to 20% oil, around 8% tannins, 5.4% phlobaphenes, as well as lecithin and vanillin, contributing to both nutritional and bioactive properties.

Nutritional Value

Vitis vinifera is a highly nutritious dietary product valued for its high carbohydrate content and diverse biologically active compounds. Upon drying, grapes yield high-calorie products—black and white raisins—renowned for their nutritional and therapeutic properties. Raisins are consumed as a standalone food and as an ingredient in confectionery.

The energy value of grapes reaches 2930–3350 kJ per kilogram, accounting for 25–30% of the average daily energy requirement for an adult. One kilogram of grapes provides the caloric equivalent of 227 g of bread, 387 g of meat, 1.1 kg of potatoes, or 1105 g of milk. Due to this, grape juice is referred to in some sources as “plant-based milk” (Granev, 1983). It is employed in diet therapy to support energy balance and stimulate metabolism.

Products derived from grape processing are extensively utilized in the food industry for the preparation of desserts and dietary dishes, including juices, compotes, jams, and pickles, as well as for the production of alcoholic beverages such as wines and brandies. Grape leaves, which are rich in ascorbic acid, are commonly used in culinary applications, for example in stuffed dishes and salads, and are frequently preserved through canning for long-term storage.

Pharmacological Properties of the Grapevine

In the 1960s, volatile antimicrobial compounds—such as alcohol, acetone, dioxane, ethyl acetate, and methyl ethyl ketone—were isolated from grapevine. These substances exhibit pronounced phytoncidal activity and high thermal stability, making them effective preservatives for food products, especially meats, by preventing microbial contamination. Studies by N.N. Petrov and colleagues (1968) on nine grape varieties demonstrated that volatile vine components possess notable antimicrobial properties.

Grape-Derived Products and Their Applications in Contemporary Medical Practice

The healing properties of grape fruits and leaves have been acknowledged since antiquity, dating back centuries before the Common Era and long before the era of Avicenna. However, the scientific foundation for grape-based therapy, known as ampelotherapy, was not formally established until the 19th century, when the chemical composition of grape-derived products was systematically investigated.

Glucose preparations derived from grapes are widely used in clinical practice for intravenous infusion in cases of severe blood loss and hypoglycemia. Grapes exhibit a broad spectrum of beneficial physiological effects, including general tonic, restorative, and antioxidant actions. Their antioxidative potential is attributed to the presence of essential oils and a complex of macro- and micronutrients that contribute to the neutralization of reactive oxygen species (ROS), which are responsible for cellular damage and accelerated aging. These properties justify the use of grapes in the management of anemia, neurotic disorders, and depressive syndromes.

Modern medicine recognizes grapes as a valuable source of bioactive compounds. According to several researchers (e.g., L.G. Dudchenko and V.V. Krivenko, 1988), the chemical profile of grapes is structurally comparable to that of human breast milk. The high content of vitamins in grapes significantly supports hematopoiesis: folic acid stimulates red blood cell production, vitamin K is essential for coagulation, and vitamin P (rutin) strengthens capillary walls and contributes to blood pressure regulation. Grape-derived trace elements further support these hematopoietic processes.

Certain grape cultivars, particularly those in the Muscat group, display notable phytoncidal activity by suppressing pathogenic microorganisms such as Escherichia coli and Vibrio cholerae. The Pink Taifi variety is especially rich in bioactive compounds that enhance immune resistance and may serve not only as a dietary supplement but also as an adjunct in treating inflammatory respiratory conditions.

Grapes are also beneficial in the early stages of tuberculosis, functioning as part of a dietary regimen due to their diuretic, mild laxative, and sudorific effects. Indications include hypersecretory gastritis, metabolic disorders, hepatic and renal pathologies, cardiovascular dysregulation (e.g., mild hypertension or hypotension), chronic fatigue syndrome, insomnia, and functional constipation.

A therapeutic course may include the daily intake of 1–2 kg of seedless grapes, divided into three doses taken one hour before meals for 1–2 months. Alternatively, 1–2 glasses of grape juice per day may be consumed. During this regimen, consumption of fatty meats, raw milk, and alcohol is discouraged.

Grapes have also been proposed as a detoxifying agent in cases of heavy metal poisoning or intoxication by toxic substances such as arsenic, morphine, strychnine, cocaine, and sodium nitrite. Grape juice is prescribed for urolithiasis, asthenia, hypertension, and to promote uric acid excretion. Decoctions of grapes have antipyretic, diaphoretic, and immune-modulating effects.

In evidence-based phytotherapy, grapes and their derivatives are utilized for their diuretic, expectorant, mild laxative, and anti-inflammatory properties. They are recommended as part of dietary management for hypochlorhydria, hemorrhoids, and hepatic disorders. The therapeutic properties of grapes have been observed in conditions such as anemia, bronchial asthma, pulmonary tuberculosis, and disorders of lipid and mineral metabolism. Grapes have also shown beneficial effects in the management of atherosclerosis, chronic nephritis, gout, neurasthenia, and early-stage hypertension.

A pharmaceutical preparation called Naturosa, produced from grapes, is used for parenteral administration in cases of hypovolemic shock and circulatory collapse. However, ampelotherapy is not intended to replace pharmacological treatments in conditions such as hypertension but rather to complement them. The antiarrhythmic effects of grapes are largely attributed to their high potassium content.

Given the strong association between cardiovascular diseases and lipid metabolism disorders, grapes contribute to the reduction of low-density lipoprotein (LDL) levels, thereby minimizing the risk of atherosclerosis, cognitive impairment, and cardiovascular events.

Grape-based dietotherapy typically involves a treatment duration of 1 to 1.5 months, during which up to 2 kg of fresh berries may be consumed daily. During this period, the intake of unpasteurized dairy products, alcohol, and carbonated beverages is restricted.

Historically, grapes have been used to treat constipation and gastrointestinal discomfort. Grape fiber enhances bowel motility and facilitates toxin elimination, while organic acids suppress pathogenic intestinal flora and help restore microbiota balance. Their cholagogue properties improve lipid digestion.

Despite these benefits, grapes are contraindicated in individuals with diabetes mellitus due to their high sugar content. Nevertheless, decoctions from grapevine leaves may exhibit hypoglycemic and vasoprotective effects.

Grapes should also be avoided in cases of obesity, active peptic ulcers, chronic purulent pulmonary infections, severe hypertension, congestive heart failure with edema, and conditions associated with enhanced intestinal fermentation (Sokolov et al., 1988).

Decoctions of grapevine leaves promote the excretion of oxalic acid and are recommended in metabolic disorders related to oxaluria (Volynsky, 1981). Dried leaves (2–4 g) are used as a hemostatic agent in uterine bleeding and demonstrate antiseptic, anti-inflammatory, and wound-healing properties. Leaf infusions may be applied for oral rinses in angina or for topical treatment of dermatological conditions.

Preparation method: Four tablespoons of dried grape leaves are boiled in 0.5 L of water over low heat for 10–15 minutes, strained, and consumed at a dosage of 100 ml 3–4 times daily before meals. Crushed fresh leaves may be applied to purulent wounds and ulcers to promote tissue repair.

The therapeutic findings discussed in this study are based on more than forty years of practical experience in grape cultivation and the processing of grape products—including raisins, wines, and juices—and are supported by systematic research exploring the pharmacological potential of Vitis vinifera in clinical medicine.

On Plant-Based 'Living Waters' — An Academic Perspective on Juices

"Physical vitality is sustained by the vital juices extracted from plants, as conveyed in Eastern traditions."

Biogenic water, present in plant and animal tissues, possesses distinct physicochemical properties compared to ordinary water. In the mid-20th century, Nobel laureate and biochemist Albert Szent-Györgyi proposed that the molecular structure of water within living organisms closely resembles that of ice. This hypothesis was later substantiated by Central Asian scientist V.M. Bakhir, who demonstrated that such "ice-like" or structured water functions as a catalyst for biochemical reactions and acts as an endogenous biostimulant. Water present in plant tissues is frequently referred to as "activated water", as it acquires a bioenergetic potential upon ingestion and is gradually incorporated into metabolic processes. This property contributes to the notable tonic and biostimulatory effects of fresh plant juices, particularly in conditions of fatigue or illness.

The eminent physician Avicenna (Ibn Sina) highlighted the superior therapeutic effectiveness of freshly pressed plant juices, such as those obtained from wormwood or horsetail, compared with decoctions or infusions prepared from dried plant material. This viewpoint aligns with modern perspectives that consider fresh juices as highly active physiological fluids rich in nutrients and medicinal compounds.

According to Bulgarian researchers D. Serbezov and M. Furnadzhieva (1970), plant-derived juices are biologically potent beverages composed of over 90% water, enriched with a complex array of bioactive compounds. Juices made from freshly harvested fruits and vegetables are particularly valued and often referred to as the "living water" of the plant.

In the preface to L.P. Mironov's monograph Raw Food and Its Preparation, the author notes that fruit and vegetable juices aid in blood detoxification and deliver energy of solar origin. Fresh juices are described as enhancing physical performance, stimulating metabolism, improving cognitive function, and promoting general well-being.

Recent investigations by A. Samsonova and V. Ushen support the perspective that fruit and vegetable juices function not only as flavorful beverages but also as genuine sources of the biologically active compounds present in whole plants. In the scientific literature, such juices are frequently referred to as "liquid fruits and vegetables." Research by V.A. Ivanchenko (1986) highlights their pronounced hydrating, thirst-quenching, and detoxifying effects, largely due to their content of organic acids, minerals, and alkaline radicals. Plant juices also stimulate salivation, help normalize blood pH, and activate various enzymatic systems in the human body.

Particularly valuable are juices that are rich in carbohydrates (glucose and fructose), pectins, and mineral salts. Pectins bind toxins in the intestine and inhibit fermentation, making such juices suitable for the prevention of endogenous intoxication and heat-related illnesses. Grape juice, for instance, is notably high in macro- and micronutrients and has the capacity to rapidly restore lost electrolytes and energy reserves.

One of the key advantages of fresh juices is their rapid absorption in the gastrointestinal tract—typically within one hour—which is significantly faster than the digestion of whole fruits or vegetables. This rapid bioavailability makes juices an excellent option for temporarily easing the digestive burden.

However, nutrition experts emphasize the importance of moderation and timing of intake (e.g., before or after meals depending on gastric acidity levels).

Modern juice extraction techniques, including centrifugation and cold pressing, help retain maximal concentrations of flavonoids, leucoanthocyanins, and other physiologically active compounds. Juices processed in this manner often include pulp, thereby enhancing both their nutritional and medicinal value.

In summary, freshly prepared plant juices represent concentrated sources of essential nutrients and endogenous biostimulants, offering high bioavailability and a broad spectrum of health-promoting effects. A general recommendation is to consume the juice immediately after preparation, as even short-term refrigeration can initiate fermentation processes, despite the flavor remaining unchanged. Consequently, the biological activity of pasteurized or stored juices is significantly lower than that of freshly squeezed ones.

Grape Juice

Grape juice is a nutrient-rich beverage characterized by a high content of natural sugars and vitamin C (1.3 mg%), along with vitamin P and a broad spectrum of mineral elements. The total sugar concentration reaches approximately 18.2%, including 11% glucose and 7.2% fructose. The mineral salt content ranges between 0.3% and 0.8%, with potassium salts prevailing—approximately 212 mg% (V.Ya. Menkovich, 1994).

One of the notable physiological effects of grape juice is its ability to promote the excretion of uric acid salts. This action underlies its therapeutic use in patients with gout, where it contributes to reducing joint salt deposits. In urolithiasis, grape juice is administered in combination with grape leaf decoction, producing an alkalinizing effect on urine and lowering urate concentration. The diuretic, diaphoretic, and hypotensive effects of grape juice support cardiovascular health by reducing cardiac workload, alleviating hypertension, diminishing peripheral edema (especially of renal origin), and easing dyspnea.

Grapes are typically consumed fresh. To prepare juice, grape clusters are cleaned of damaged or contaminated berries, crushed, and pressed. The resulting juice is stored in cool conditions in enamelware. Alternatively, it may be preserved through pasteurization and sterilization: strained juice is heated to 80–85°C, poured into glass jars or bottles, and sterilized at 90°C (15 minutes for 0.5 L bottles, 20 minutes for 1 L or jars), after which it is hermetically sealed and stored.

When adhering to strict hygienic standards, grape juice can be prepared without full sterilization. In such cases, the juice is heated to 95°C and immediately poured into steam-sterilized or sun-dried jars, sealed with boiled lids, and stored inverted. Prolonged storage may lead to sedimentation, in which case the juice should be carefully decanted. Improper sealing or storage in high temperatures may initiate fermentation and result in acetic acid formation.

A grape-based dairy beverage can also be prepared by washing and crushing 0.5 kg of Husayni grapes, straining the juice, and mixing it with 0.5 L of milk that has been boiled with 0.5–1 cups of sugar. After combining with the juice, the drink is poured into cups, each optionally sweetened with a teaspoon of syrup (D. Sodikov, 1981).

In evidence-based medicine, grape juice has been recommended as an adjunct in pleurisy management. A decoction of raisins (100 g boiled in 200 mL of water for 10 minutes and strained) and fresh grape juice help stimulate bronchial secretion. The decoction is administered in doses of ½–⅓ cup, 3–4 times daily.

According to Kh.Kh. Kholmatov and I.A. Kharlamov (1995), grape juice contributes to the regulation and normalization of blood pressure and addresses functional disturbances of the cardiovascular system. It also acts as a mild natural laxative, alleviating constipation.

In clinical settings, Naturosa—a pharmaceutical preparation derived from grape juice—is used in cases of severe hemorrhage, collapse, and shock, underscoring the medicinal value of this natural product (M. Nabiev, 1994).

Grape Qymyzak (Kvass) and Methods of Its Preparation

Kymyzaak belongs to a category of traditional fermented beverages that have been valued by the populations of Central Asia since ancient times for their distinctive organoleptic and physiological properties. Among its varieties, particular attention is given to bread-based kymyzaak (a type of kvass), which is known to enhance appetite and positively influence digestive processes. Its biological activity is primarily attributed to the presence of lactic acid bacteria and organic acids, which support intestinal motility and contribute to the maintenance of a healthy gut microbiota. In scientific literature, kymyzaak is also noted for its mild tonic effects.

Beyond its physiological benefits, kymyzaak serves as a source of essential macro- and micronutrients, including easily digestible proteins, carbohydrates, organic acids, vitamins, and mineral elements. These nutritional components underpin the beverage's value, particularly in the context of hot and arid climates common in Central Asian regions. Furthermore, the preparation of kymyzaak represents a rational approach to food utilization, as it enables the transformation of stale bread into a functional, palatable, and dietetically valuable beverage.

Types and Methods of Preparing Kymyzaak and Fruit-Based Kvass

Beverages

Bread-Based Kymyzaak

To prepare traditional bread kymyzaak, the crusts of rye bread are thinly sliced, crumbled, and placed into an enamel container. They are then covered with boiled water cooled to body temperature. The mixture is sealed and left to ferment in a warm environment for 7–8 days. The fermented liquid is filtered and used either as a vinegar-like beverage or as a base for other types of kvass.

Kymyzaak with Raisins

Crushed rye bread crusts are infused with boiling water and steeped for 3–4 hours. After sedimentation, the liquid is decanted, sweetened with molasses or sugar, and inoculated with yeast. Following a secondary fermentation of 3–4 hours, the beverage is bottled with one raisin per bottle. Bottles are sealed and stored horizontally in a cool place. To increase biological activity, a conventional preparation consists of 1 kg of dried bread, 8 liters of water, 3 cups of sugar or molasses, one-third of a yeast cake, and 1 tablespoon of raisins.

Concentrated Raisin Kymyzaak

This variant uses a reduced water ratio (4 L per 1 kg of bread), resulting in a richer taste and enhanced functional properties. Fermentation continues for 12 hours before bottling with raisins, followed by a secondary fermentation period of 48 hours in a cool environment.

Raisin and Mint Kymyzaak

This version incorporates peppermint infusion or mint essence, adding both fragrance and mild sedative effects. After initial fermentation, the liquid is bottled with raisins and left open until carbon dioxide bubbles appear, then sealed and aged for 1–2 days in a cool setting.

Fruit and Berry Kvass Beverages

Fruit and berry kvasses—made from cranberries, lemons, blackcurrants, apples, and pears—are valued for their high content of organic acids, antioxidants, and essential minerals. Their preparation includes several stages: crushing the raw material, hot water extraction, addition of sugar, yeast, and raisins, followed by primary fermentation (8–12 hours), bottling, and final fermentation in a cool space. These beverages exhibit refreshing, mildly tonic effects and enhance digestive health.

Cranberry Kvass

The preparation requires 1 kg of cranberries, 1000–1200 g of sugar, 20–30 g of dry yeast, 30 g of raisins, and 10 L of water. Cranberries are washed, crushed, and combined with hot, boiled water. After cooling, sugar and yeast are incorporated, and the mixture is allowed to ferment for 10 hours. The kvass is then bottled, with 2–3 raisins per bottle, sealed, and stored horizontally in a warm environment.

Lemon Kvass

Ingredients include 4 lemons, 50 g raisins, 50 g honey, 200–300 g sugar, 20–30 g yeast, 20 g flour, and 10 L of water. Peeled and chopped lemons (with seeds removed) are mixed with sugar and covered with hot water. Honey and raisins are added to the mixture. Once cooled, yeast and a pre-prepared sweet flour paste are stirred in. After 8–10 hours, when the lemons rise to the surface, the liquid is filtered, bottled with raisins, and placed in a cool location. The kvass reaches readiness within 2 days.

Blackcurrant Kvass

Ingredients: 1 kg blackcurrants, 800–1000 g sugar, 2–3 rose petals, 20–30 g yeast, 30 g raisins, 10 L water.

Blackcurrants are washed, mashed, and infused with hot water. Sugar and crushed rose petals are added. After cooling, yeast is introduced and the mixture ferments for 8–10 hours. It is then bottled and stored in a cool place.

Apple Kvass

The recipe requires 0.5 kg of early-season sweet apples, 100 g of raisins, 700–800 g of sugar, 20–30 g of yeast, and 10 L of water. Apples, thinly sliced and unpeeled, are combined with raisins and sugar, then covered with hot water. After cooling, yeast is introduced, and the mixture is left to ferment. Once fermentation is complete, the liquid is strained, bottled, and sealed. The kvass becomes ready within 3–4 days at room temperature.

Pear Kvass

Ingredients include 0.5 kg of pears, 600–800 g of sugar, citric acid to taste, 20–30 g of yeast, and 30 g of raisins. Pears are diced and lightly mashed with sugar, then infused with hot water. Citric acid and yeast are added to initiate fermentation. After 10–12 hours, when foam appears, the liquid is filtered, bottled with 2–3 raisins per bottle, and stored in a cool environment. Aromatic pear varieties are especially valued for imparting pleasant flavors during the fermentation process.

Scientific Approaches to the Study and Therapeutic Application of Bioactive Compounds from Grapes

Over the last ten years, our research group has undertaken comprehensive multidisciplinary studies to assess the role of grapes and grape-based products in the prevention of micronutrient deficiencies within regional populations.These studies included an in-depth analysis of the chemical composition of grapes and grape-based ingredients commonly incorporated into traditional dishes consumed by children residing in the Zeravshan Valley.

To quantitatively assess the trace element content of grapes and their derivatives, neutron activation analysis (NAA) was employed. This advanced methodology was initially developed in 1999 by A.A. Kist and L.I. Zhuk at the Institute of Nuclear Physics of the Academy of Sciences of the Republic of Uzbekistan and has since served as a foundational tool for subsequent research, enabling precise investigations into the biochemical and pharmacological properties of grape-derived substances. For the first time, our research group successfully identified the concentrations of 18 trace elements in raisins, fresh grapes, grape juice, and decoctions made from grapevines cultivated in the Samarkand region—foods that are widely consumed by children in the area.

It is noteworthy that vineyards located in several districts of the Samarkand region (Urgut, Bulungur, and Samarkand districts), as well as in the Koshrabad and Nurata districts of the Navoi region, represent a vital sector of the local agricultural economy. These vineyards contribute significantly to the regional diet in the form of fresh grapes, raisins, and grape juice.

Researchers from the Department of Propaedeutics of Pediatrics at the Samarkand State Medical Institute have previously demonstrated the high therapeutic efficacy of decoctions prepared from wild grapevines in the treatment of anemia (Rationalization Proposal No. 353, 1999). The present study expands on this finding by providing detailed data on the trace element profile of such decoctions. Using neutron activation analysis, we identified 28 chemical elements across grape samples and their processed derivatives.

These elements included:

- **Macroelements** (such as calcium, chlorine, sodium, and potassium) are fundamental for **bone metabolism,**

regulation of acid-base balance, and the maintenance of **electrolyte homeostasis**.

- **Essential trace elements** (including iron, zinc, copper, manganese, chromium, selenium, and cobalt) are critical components of **enzymatic systems** and play key roles in **hematopoiesis**.
- **Conditionally essential elements** (e.g., bromine), and
- **"Brain elements"** (e.g., gold), which may be involved in neurotransmitter activity and neural signal transmission;
- Additionally, **abiogenic elements** (e.g., rubidium, mercury, scandium, antimony, lanthanum), although possessing limited biological reactivity, may indirectly influence certain metabolic pathways.

Our findings underscore the potential of locally produced grape-based products as valuable dietary components with significant micronutrient contributions, particularly in pediatric and preventive healthcare settings.

Investigation of Trace Element Composition in Grapes and Grape Juice for Biological Value Determination

Grape juice and wine are considered nutritionally valuable products due to their rich content of biologically active microelements that play essential roles in human metabolic processes. According to data reported by Markh A.T. and Shcherbakova E.V. (1957), the microelement profile of grape juice includes the following concentrations (in mg%): manganese (Mn) — 98, copper (Cu) — 1.00–9.00, titanium (Ti) — 1.77–8.40, nickel (Ni) — 0.97–9.20, silicon (Si) — 18–

225, and aluminum (Al) — 12–197. Zinc (Zn) is present in grape juice at concentrations of 9–19 mg/L, whereas fluoride and iodine are detected at 0.25–0.30 mg/L in juice and 0.2–0.4 mg/L in wine. Phosphorus is particularly abundant in grape juice, with levels exceeding 500 mg/L. According to Nilov V.I. et al. (1967), the total mineral content of grape juice ranges from 3 to 5 g/L, highlighting its high mineralization and significant contribution to dietary intake of essential trace elements.

As part of our ongoing research, we conducted a comparative analysis of the chemical composition of two grape varieties most commonly consumed by the population of the Zeravshan Valley: the "Husayni" and "White Kishmish" cultivars. Detailed data on the macro- and microelement content of these varieties are presented in Table 2.

Table No.2

Elemental Composition of Grapes: Levels of Macro- and Micronutrients (mg/kg)

№	**Biologically Active Elements**	**Taxonomy and Diversity of Grapes**	
		Husayni Grape Cultivar	**Agronomic and Nutritional Features of the White Kishmish Cultivar**
1	**⍰ Cl – Chlorine**	265	150-160
2	**⍰ Cu – Copper**		7
3	**⍰ Mn – Manganese**	12	5,4-5,9
4	**⍰ Na – Sodium**	82	72-120
5	**⍰ Ca – Calcium**	2280	677-1286
6	**⍰ Au – Gold**	0,105	0,0015-0,23

№	Biologically Active Elements	Taxonomy and Diversity of Grapes	
		Husayni Grape Cultivar	**Agronomic and Nutritional Features of the White Kishmish Cultivar**
7	**Br – Bromine**	0,45	0,41-0,42
8	**Hg – Mercury**		0,01
9	**Cr – Chromium**	0,24	0,1-0,46
10	**Sc – Scandium**	0,01	0,0052-0,056
11	**Rb – Rubidium**	9,1	2,1-6
12	**Fe – Iron**	25	18-110
13	**Zn – Zinc**	5,6	0,8-2
14	**Co – Cobalt**	0,01	0,01-0,058
15	**Sb – Antimony**	0,081	0,026-0,089
16	**La – Lanthanum**	0,01	0,01
17	**K – Potassium**	10110	6637-10310

The data presented in Table 2 indicate that both examined grape cultivars—*Husayni and White Kishmish*—are rich sources of essential macro- and microelements. Significantly, Husayni grapes were found to contain higher levels of manganese, calcium, rubidium, and zinc in comparison to White Kishmish, whereas White Kishmish exhibited a greater iron content. These observations reinforce the understanding that grapes, irrespective of varietal differences, serve as valuable dietary sources of essential trace elements.

In addition, macronutrients such as potassium, calcium, sodium, and chloride are present in substantial amounts, performing crucial physiological functions including regulation of acid–base balance, maintenance of cellular membrane potentials, and bone mineralization.Potassium, in particular, is found in high concentrations in grape juice—exceeding 10 g/L—which contributes to its alkalizing properties, akin to those of therapeutic mineral waters. However, unlike sodium-rich mineral waters, grape juice is abundant in potassium, iron, phosphoric, and silicic acids, making it especially beneficial for individuals with uric acid diathesis or nephrolithiasis.

Potassium deficiency is commonly observed in children, athletes, individuals under high physical stress, and patients on diuretic therapy or with cardiovascular diseases. In such cases, regular consumption of grapes or grape juice may help correct this imbalance.

Furthermore, grapes provide significant amounts of calcium in a bioavailable ionic form, which is particularly important during periods of rapid skeletal growth (e.g., in children and adolescents), as well as in the elderly to prevent osteoporosis. Based on current recommendations, grapes may be introduced into the diet from 9–10 months of age in the form of puree, and a daily intake of 200–500 g of fresh grapes or equivalent juice is advised for adolescents and older adults.

In addition to macronutrients, grapes are rich in essential microelements, including iron, zinc, copper, manganese, cobalt, and chromium. These elements play indispensable roles in hematopoiesis, redox metabolism, and enzymatic cofactor systems. A daily intake of 200–300 g of grapes is sufficient to meet a considerable portion of the body's trace element requirements. The high iron content, in particular, makes grapes suitable for inclusion in dietary regimens for patients with anemia. Copper contributes to iron absorption in the gastrointestinal tract.

Zinc is essential for growth, tissue repair, pubertal development, and endocrine regulation. Its deficiency may manifest as delayed growth, impaired pigmentation, infertility, and immune dysfunction. Grapes, being a reliable source of zinc, may help prevent or mitigate such conditions.

Moreover, trace amounts of ultramicroelements and so-called "brain elements"—such as gold, scandium, lanthanum, bromine, and antimony—have been detected in grapes, alongside conditionally essential and abiogenic elements such as rubidium, whose physiological relevance remains under investigation.

Importantly, grapes from the studied regions were free of toxic heavy metals (e.g., mercury, aluminum, cadmium, uranium), confirming their ecological safety and suitability for human consumption.

Prior to initiating a course of grape therapy, oral hygiene assessment and blood/urine glucose monitoring are recommended. For adults, the daily intake should not exceed 2 kg of grapes or 1.2 liters of juice. The therapy regimen typically starts with 0.5–0.6 kg of grapes per day (divided into three doses, taken 1–1.5 hours before meals) and gradually increases to 1.5–2 kg/day by the second week, continuing for 3–4 weeks.

In patients with decompensated heart or renal failure, a modified protocol (1–2 kg over 2–3 days) is advisable, with skin and seeds removed. During treatment, dietary restrictions include avoidance of fatty and salty foods, fermented dairy, raw vegetables, and fresh fruits.

Interestingly, Avicenna (Ibn Sina), in his Canon of Medicine (1982 edition), emphasized the therapeutic value of grape juice: "*Ten dirhams of jowshir (Ferula) are added to one cup of pressed grape juice and consumed after two months—especially beneficial for the spleen*" (p. 164).

Micronutrient Content and Health-Promoting Effects of Raisins

Considering that two types of raisins—black and white Kishmish—are most commonly consumed in the daily diet of the population, our study focused on evaluating their chemical composition and biological properties. It is well established that the concentrations of macro- and micronutrients in raisins are significantly higher than in fresh grapes, as raisins are a concentrated product obtained through the drying process. However, it must be noted that drying and subsequent storage may lead to partial loss of trace elements and a reduction in their biological activity.

Particular attention should be paid to the growing trend of increased consumption of industrially produced confectionery, often made using synthetic methods. While sugar derived from sugar beets remains a major source of caloric energy, its chemical profile is limited to sucrose and artificial additives, completely lacking vitamins, micronutrients, proteins, and other bioactive compounds. It is important to highlight that regular consumption of refined sugar or navat (crystallized sugar) in early childhood may contribute to allergic reactions, reduced immune responsiveness, and increased susceptibility to upper respiratory tract infections. Unfortunately, these health implications are often underestimated by parents, educators, and even some healthcare professionals.

In this context, raisins should be regarded not merely as a high-energy and nutritious food product but also as a valuable source of essential vitamins, macro- and micronutrients, and other biologically active substances. Their trace element content is reflected in the data presented in Table 3.

According to the table, potassium is the most prominent macroelement, with its concentration in black raisins reaching approximately 6 grams per 100 grams of product. Regular consumption of black raisins during the winter months may have a beneficial effect on both children and the elderly. This product is especially recommended for individuals with cardiovascular diseases, as it serves as a natural source of potassium and exhibits a general tonic effect on the body.

Table No.3

Mineral Profile of Raisins: Macro- and Microelemental Content (mg/kg)

№	Names of Elements	Classification of Raisin Varieties	
		Black	Kishmish
1	Chlorine	620	130
2	Copper	51	7
3	Manganese	30	3,2
4	Sodium	110	61
5	Calcium	2820	620
6	Gold	0,01	0,012

№	Names of Elements	Classification of Raisin Varieties	
		Black	Kishmish
7	Bromine	2,3	0,23
8	Selenium	-	-
9	Mercury	-	0,073
10	Chromium	0,84	0,36
11	Scandium	0,044	0,011
12	Rubidium	-	3,3
13	Iron	180	53
14	Zinc	36	6,9
15	Cobalt	0,42	0,035
16	Antimony	0,3	0,16
17	Lanthanum	-	0,05
18	Potassium	5,7	0,59

In raisins, the concentration of chlorine is two to three times higher than in fresh grapes. This characteristic allows raisins to be considered a valuable dietary component in conditions associated with chloride deficiency and as a preventive measure against hypochloremia. The levels of other macroelements such as sodium and calcium in raisins are comparable to those in fresh grapes, thereby justifying dietary recommendations for their inclusion in cases of sodium and calcium deficiency.

Among essential trace elements, raisins are particularly rich in iron, zinc, copper, manganese, and cobalt. The elevated levels of iron and copper in black raisins—both critical for hematopoiesis—further support their use in dietary regimens aimed at preventing or correcting various forms of anemia.

Furthermore, the substantial presence of bromine, classified among the so-called “brain elements,” supports the recommendation of raisins for individuals with functional disorders of the nervous system. Bromine is known for its mild sedative properties and its role in promoting sleep and regulating neurophysiological processes.

Importantly, toxic elements such as aluminum, mercury, cadmium, and uranium were not detected in the analyzed raisin samples. This confirms the high environmental purity and safety of this product, reinforcing its value as a health-supportive component of the human diet.

Grape Syrup (Shinni) as a Functional Food: Micronutrient Profile and Health Benefits

Maternal and child health, particularly the prevention of micronutrient deficiencies, remains a central public health priority in the Republic of Uzbekistan. This commitment is reflected in the enactment of the Law “On the Prevention of Micronutrient Deficiency Among the Population” (2010).

The designation of 2016 as the “Year of the Healthy Mother and Child”, alongside governmental decrees such as Resolution No. 102 of the Cabinet of Ministers (April 25, 2015), “On Further Improvement of Measures in the Field of Healthy Nutrition of the Population of the Republic of Uzbekistan,” and Resolution No. 251 (August 29, 2015), “On the Approval of the Concept and Measures to Ensure Healthy Nutrition of the Population for 2015–2020,” underscores national dedication to this issue.

These regulations emphasize the need for scientific research into micronutrient deficiencies and prioritize fundamental studies on the etiology of nutrition-related disorders, including anemia and iodine deficiency. Further support is provided through Ministerial Orders No. 352 (September 2, 2015) and No. 421 (November 2, 2015), which facilitate the implementation of these policy measures.

In the Samarkand region, the prevalence of rickets among children under one year reaches 27.8%. Frequent acute respiratory infections are observed in 49.3% of cases, while 38.6% of children spend fewer than 20 minutes outdoors daily. Additional risk factors include autumn-winter births (32.4%), perinatal complications (32.1%), and anemia (25.5%), all of which contribute substantially to the development of micronutrient deficiencies.

Clinical nutrition and nutritional support within the mother-child system address multiple health concerns, including micronutrient deficiencies in pregnant and lactating women (anemia, obesity, diabetes, cardiovascular risk) and in children (protein-energy malnutrition, rickets, anemia, food allergies, recurrent infections, and functional gastrointestinal disorders).

Despite the recognized urgency, no studies in Uzbekistan have yet evaluated early diagnostic approaches for micronutrient deficiencies or the use of national food products for nutritional support within the maternal and child health framework.Scientific literature on grape syrup (shinni) is extremely limited, usually focusing on traditional preparation methods. However, classical medical texts reference its therapeutic use.

In Ibn Sina's (Avicenna's) seminal work "The Canon of Medicine" (1982 edition), grape syrup—referred to as maybukhtaj—is described as a grape decoction with mucolytic properties: "Shinni helps expel mucus from the respiratory tract and is added to poppy juice ('diyoquzo'). It is particularly beneficial for diseases of the kidneys and urinary bladder."

This study undertakes a comprehensive chemical analysis of grape syrup (shinni) and aims to scientifically substantiate its health benefits. Unlike industrial sweets based on refined sugar, traditional natural products like shinni are losing popularity. This is problematic, as grape syrup offers significantly higher nutritional value and biological activity compared to sucrose-based confectionery. No commercial dessert, including chocolate, can match shinni in nutrient density and functional properties.

Grape syrup is rich not only in carbohydrates (glucose and fructose) but also in proteins, organic acids (tartaric, malic, oxalic, salicylic), pectins, tannins, flavonoids, and macro- and microelements. While extended heating may lead to the degradation of certain thermolabile vitamins, it simultaneously concentrates sugars by 2–3 times and increases the levels of macro- and trace elements through evaporation, producing a nutrient-dense food product with enhanced bioactive properties.

Traditional household preparation of shinni is prevalent in the Samarkand and Kashkadarya regions of Uzbekistan. Fully ripened white grapes are washed, dried, and mashed. The juice is filtered through gauze and subjected to prolonged low-boil heating with constant stirring until the volume is reduced by two-thirds. The final product's quality depends on grape variety, cleanliness, and storage conditions.

In some viticultural regions, partially fermented grapes are used, imparting a tart, wine-like aroma. To neutralize this, purified yellow clay is added during cooking, serving as a natural adsorbent to bind and precipitate odorous compounds. If fresh, clean grapes are used, the addition of clay is unnecessary.

Our long-standing experience confirms the high nutritional and health value of shinni. However, industrial-scale production remains underdeveloped. Promoting its mass production could improve public health and support the national economy, considering Uzbekistan's historical ties to viticulture.

This study marks the first comprehensive analysis of the chemical composition of grape syrup using modern analytical methods.

Objective: The study aimed to develop innovative approaches for **early detection and nutritional support** using national food products enriched with pharmaconutrients, such as **grape syrup**, to prevent macro- and micronutrient deficiencies within the **maternal and child health system**.

Materials and Methods: Early identification of micronutrient deficiencies was conducted through a comprehensive health assessment of **400 mother-child pairs**, utilizing a structured questionnaire designed by the authors. The **macro- and micronutrient profile** of grape syrup was evaluated using **neutron activation analysis** at the Laboratory of Activation Analysis, Institute of Nuclear Physics, Academy of Sciences of Uzbekistan.

A total of **23 elements** were assessed based on **Bogatov's classification (2004)**, including:

- **Macroelements:** Ca, Mg, K, Na, Cl
- **Essential trace elements:** Fe, Cu, Zn, Mn, Cr, Se, Mo, I, Co
- **Conditionally essential elements:** Br, Ni, Cd
- **Brain-active elements:** Au, Ag
- **Neutral abiogenic elements:** Rb, Sc, La
- **Toxic elements:** Hg, Sb

Sugar content was analyzed at the Khovrenko Winery Laboratory in Samarkand. To ensure consumer safety, grape syrup underwent testing for bacteriological contaminants, radionuclides, pesticides, and toxic elements in accordance with SanPiN standards at Samarkand's sanitary-epidemiological laboratory. Scientific literature provides limited data regarding grape syrup's chemical composition and therapeutic potential, and many are unfamiliar with its properties, preparation, or recommended consumption.

With the widespread use of refined sugar, health risks have emerged—particularly in children—including micronutrient deficiencies, allergies, developmental delays, anemia, compromised immunity, digestive disturbances, increased infection susceptibility, and endocrine, cardiovascular, and hematopoietic disorders.

Shinni is primarily produced in the Samarkand and Kashkadarya regions, with occasional production in other grape-growing areas of Uzbekistan. Prepared through prolonged boiling of pure grape juice, the resulting thick, brownish syrup possesses a distinctive aroma and sweet taste, and remains shelf-stable for 2–3 years, gradually becoming more viscous.

Although thermolabile vitamins degrade during heating, the concentration of carbohydrates and minerals increases, enhancing its nutritional value. Consequently, this study analyzed the sugar and chemical composition of grape syrup to evaluate its potential applications for preventive and therapeutic nutrition within the maternal-child health framework.

Results and Discussion: Our comprehensive assessment showed that 67.9% of pregnant women suffered from anemia, 64.2% experienced toxicosis, 27.3% had complications, 25.5% reported high blood pressure, 50.9% had inflammatory diseases, and 19.4% had chronic conditions. Additionally, 57.6% took medications during pregnancy, and a large proportion consumed insufficient legumes (61.2%), vegetables/fruits/greens (60%), dairy (55.8%), meat (60.6%), and fish (75.6%).

However, 85.7% frequently consumed refined sugars (navat, white sugar), and 91–100% drank tea regularly. Socioeconomic and Health Assessment: Socioeconomic limitations affected 44.2% of surveyed families, while 52.1% of mothers demonstrated limited knowledge regarding child healthcare. Pediatric health assessments revealed that 21.8% of children were born with weak crying, 37% received early complementary feeding, 35.8% experienced frequent illnesses, 35.7% had gastrointestinal disturbances, 25.5% exhibited allergic rashes, and 52% showed clinical signs of rickets.

Additional clinical observations included angular stomatitis (31.5%), unexplained crying (32.7%), heightened startle reflex (34.5%), seizures (4.8%), and anemia (13.9%). Suboptimal feeding practices, childcare, and hardening routines were noted in 40–50% of cases. Risk stratification for micronutrient deficiencies indicated 57% of children at low risk, 35% at moderate risk, and 8% at high risk.

These findings highlight a high susceptibility to micronutrient imbalances among both mothers and infants, primarily associated with limited maternal knowledge of nutrition, childcare, and preventive health measures, particularly in rural populations. The structured questionnaire proved to be an effective tool for evaluating health status and guiding preventive strategies in primary care settings.

The study also identified a prevalent consumption of refined sugars (e.g., navat, white sugar syrup) among mothers and infants, which are devoid of essential micronutrients. In contrast, grape syrup, used daily by the authors for over three decades as a sugar substitute, provides significant nutritional value and has been shown to be safe and beneficial for maternal and child health.

Consequently, we conducted a comprehensive analysis of the chemical composition of fresh and dried grapes, as well as grape-derived products, including shinni, to support recommendations for their broader dietary use. Laboratory analysis at the winery determined that the sugar content of grape syrup is approximately 70%. In the Zarafshan Valley, we performed the first regional assessment of macro- and micronutrient content in grape syrup, a product infrequently consumed by the local population. The obtained data were subsequently compared with established standards for plant-derived micronutrient levels. To support nutrition and correct macroelement deficiencies, grape syrup was thoroughly analyzed (Table 4)

Table No. 4

Macronutrient Profile of Grape Syrup (Shinni) (mcg/g)

Macronutrient	**Calcium (Ca,** cg/g**)**	**Sodium (Na,** mcg/g**)**	**Chlorine (Cl,** mcg/g**)**	**Magnesium (Mg,** mcg/g**)**	**Potassium (K,** mcg/g**)**
Shinni (n-3):	350-620	150	150	100	5800
Typical Composition in Plants [5]	12,000	1,500	2,000	1,200	15,000

As indicated in Table 4, grape syrup (shinni) exhibits a substantial concentration of organic calcium salts, ranging between 350 and 620 μg/g. This composition supports its use as both a preventive and therapeutic dietary intervention for calcium deficiency in lactating women and in children older than one year, while its application in infants under one year remains under investigation. Grape syrup may be integrated into the daily diet or employed as a complementary food. In cases of clinically confirmed hypocalcemia, additional calcium supplementation alongside dietary intake is recommended.

The levels of organic sodium and chloride in grape syrup were observed to be lower than those typically found in standard plant materials, with concentrations reaching up to 150 μg/g. Despite these lower levels, the presence of sodium and chloride supports the use of grape syrup in preventing deficiencies of these elements in vulnerable populations and in conditions associated with their loss, such as vomiting or gastrointestinal disorders. In confirmed hyponatremia, treatment should include pharmacological sodium and chloride supplementation or the administration of hypertonic saline.

Potassium in grape syrup, present as organic salts, was measured at a moderate concentration of 5800 μg/g. Given this high potassium content, grape syrup can serve as a nutritional support and preventive dietary option for lactating women and children diagnosed with hypokalemia.

Magnesium content in grape syrup was found to be lower than that of standard plant samples, approximately 100 μg/g. Nevertheless, grape syrup with this level of magnesium may be recommended for nutritional support and prevention of magnesium deficiency in children over one year of age and in lactating women. For cases of confirmed hypomagnesemia, additional magnesium supplementation is necessary.

Regarding essential trace elements, the concentrations of cobalt, manganese, chromium, selenium, molybdenum, and iodine were assessed in grape syrup derived from grape varieties cultivated in the Zarafshan Valley (Table 5).

Table No. 5

Trace Element Composition of Shinni (mcg/g)

Trace Element Composition of Grape Syrup	Shinni (n-3) mcg/g	Typical Composition in Plants [5] mcg/g
Cobalt (Co)	0.07	0.1
Manganese (Mn)	3.4	300
Iron (Fe)	78	160
Zinc (Zn)	177–960	40
Copper (Cu)	6–15	10
Selenium (Se)	0.01	0.5
Iodine (I)	—	0.1
Chromium (Cr)	0.21	1.3
Molybdenum (Mo)	0.26	0.5
Bromine (Br)	0.47	6
Nickel (Ni)	0.5	1
Gold (Au)	0.002–0.005	0.002
Silver (Ag)	0.078	0.15
Mercury (Hg)	0.05	0.01
Scandium (Sc)	0.03	0.01
Rubidium (Rb)	44	20
Antimony (Sb)	0.05	0.02
Lanthanum (La)	0.005	0.6

As presented in Table 5, grape syrup (shinni) contains cobalt at a relatively low concentration of 0.07 mcg/g. Utilization of local plant-derived products as dietary interventions represents an important strategy for preventing micronutrient deficiencies, particularly within the "Mother–Child" health system, targeting populations at risk of cobalt insufficiency.

In clinically diagnosed cobalt deficiency, supplementation with cobalt-containing preparations, such as vitamin B12 or its combined pharmaceutical formulations (e.g., Kobavit, Pikovit, Complivit, Duovit, Oligovit), is recommended.

Among grape-derived products, grape syrup exhibits a notably high iron content of 78 mcg/g. The physiological iron requirement varies by demographic group: approximately 10 mg/day for adult men, 18 mg/day for adult women, and 4–18 mg/day for children, depending on age. In plant-based sources, iron is present exclusively as non-heme iron, which is absorbed at a maximum rate of around 10%. Co-administration with vitamin C significantly enhances non-heme iron absorption.

Therefore, in cases of iron deficiency—particularly among pregnant and lactating women or young children—dietary inclusion of iron-rich local foods such as grape syrup is advised. Preliminary investigations indicate that grape syrup demonstrates considerable efficacy in ameliorating various forms of anemia, warranting further research in this area.

Grape syrup was also identified as an abundant source of zinc, with concentrations reaching 960 mcg/g, exceeding typical plant values by over twentyfold. The recommended daily intake of zinc for children ranges from 3 to 12 mg, depending on age. Mild zinc deficiency in healthy children may be addressed through dietary means, including grape syrup, whereas at-risk groups may require zinc supplementation, ensuring intake levels of 15–20 mg/day.

Based on these findings, dietary consumption of zinc-rich products such as grape syrup represents the most effective and safe strategy to prevent zinc deficiency within the “Mother–Child” system. It is also recommended that from eight months of age, conventional sugar-containing products be replaced with naturally zinc-enriched alternatives derived from national diets, including grape syrup.

In terms of copper content, grape syrup demonstrates significant levels ranging from 50 to 100 mcg/g, compared with approximately 10 mcg/g in standard plant samples [5]. This supports its potential role in the prevention of copper deficiency. Manganese content was measured at 3.4 mcg/g. Although modest, grape syrup can still contribute to manganese and iron homeostasis, as manganese functions synergistically with iron and enhances its intestinal absorption.

Selenium, an essential trace element, was detected at concentrations below 0.1 mcg/g. In conditions such as Keshan disease, total parenteral nutrition, phenylketonuria, and maple syrup urine disease, dietary inclusion of selenium-rich foods or medical selenium supplementation is recommended to normalize biochemical parameters and confer therapeutic benefits. Furthermore, literature evidence suggests that selenium may exert direct cytotoxic effects on human tumor cells, indicating that long-term dietary consumption of grape syrup could potentially support oncological disease prevention.

Iodine was not detected in grape syrup, indicating that the Zarafshan Valley represents a biogeochemical region characterized by iodine deficiency.

This factor must be taken into account when designing public health strategies and preventive nutrition programs.

Chromium was present in grape syrup at a relatively low concentration of 0.21 mcg/g. In circulation, chromium binds specifically to transferrin, the same protein responsible for iron transport. Chromium is essential for potentiating insulin activity across all insulin-regulated metabolic pathways. The recommended daily intake of chromium ranges from 50 to 200 µg; however, typical diets provide only 33–125 µg, while refined products, such as white sugar and highly processed wheat flour, supply as little as 2.7 µmol/kg. Because excessive sugar intake further increases chromium excretion, a substantial deficiency is likely in the "Mother–Child" population. Incorporation of grape syrup into the dietary regimen of lactating mothers and children may help mitigate this risk.

Molybdenum was detected in grape syrup at a low level of 1.0 mcg/g. The biological significance of molybdenosis and molybdenum deficiency, however, remains poorly understood.

Among conditionally essential elements, bromine and nickel were observed at concentrations lower than those typically found in plant samples. Their specific physiological roles in maternal and child health are not well documented, and targeted nutritional interventions for deficiencies are still under development.Elements classified as "brain elements" are thought to participate in neural signaling in mammals. While their precise role in child development remains unclear, they may influence certain metabolic processes.

In our analysis, gold and silver were measured and found at very low concentrations, ranging from 0.002 to 0.078 mcg/g, below standard reference values.From the group of abiogenic elements, rubidium and scandium were examined. Rubidium was present in grape syrup at concentrations up to 44 mcg/g and, given its relatively high content in nutrient-dense foods, may be considered near-essential for human nutrition. Scandium, in contrast, was detected only in trace amounts (up to 0.03 mcg/g), suggesting minimal physiological significance. Abiogenic elements likely enter terrestrial organisms from marine sources due to their low chemical reactivity, which may occasionally contribute to pathological effects in higher animals.

Among toxic elements, mercury was detected at concentrations up to 0.05 mcg/g, with methylmercury being the most extensively studied form of mercury toxicity. Other abiogenic and toxic elements, including antimony and lanthanum, were present at extremely low levels (0.0005–0.005 mcg/g), confirming the safety of grape syrup from the Zarafshan Valley for maternal and child nutrition.

Nutritional interventions to address micronutrient deficiencies should prioritize non-pharmacological approaches, such as the consumption of functional foods enriched with pharmaconutrients for healthy children, while pharmaceutical supplementation of macro- and micronutrients remains appropriate for children at risk with clinically confirmed deficiencies.

In summary, the analysis of macro- and microelement composition in grape syrup (shinni) demonstrated elevated levels of calcium, potassium, zinc, iron, and copper, alongside trace amounts of abiogenic and toxic elements, confirming the product's safety for human consumption. Nutritional support through such functional foods is essential for preventing micronutrient deficiencies in children, enhancing overall quality of life, reducing the incidence of illness, and improving treatment outcomes.

To evaluate the safety and suitability of grape syrup for human consumption, comprehensive analyses were conducted to determine the presence of radionuclides, toxic substances, pesticides, and bacteriological contaminants.

The findings from the sanitary-epidemiological laboratory are as follows:

1. **Radionuclide Assessment**:

2. The concentrations of radionuclides Cs-137 and Sr-90 in grape syrup were within the established permissible limits, fully complying with SanPiN No. 0366-19, Section 3,
Clause 44.

3. **Bacteriological Evaluation** (SanPiN No. 0366-19, Sampling Date: January 8, 2020):

- Total microbial count (MAFAM), as per GOST 10444.15-94: 4.6×10^2 CFU (permissible limit: 5×10^3 CFU);
- Coliform bacteria (BGKP), GOST 31747-2012: Not detected;
- Pathogenic microorganisms, including Salmonella spp. in 25 g, GOST 31659-2012: Not detected;
- Yeasts and molds, CFU per 1 g, GOST 10444.2-2013: Not detected.

4. **Toxic Elements and Pesticides** (SanPiN No. 0366-19; GOST 26929-94, GOST 26927-26130-26334-86):

5. According to Protocol No. 0211-12/03 1-2, dated January 15, 2020, the concentrations of toxic elements and pesticide residues in grape syrup were fully compliant with all relevant SanPiN standards, confirming the product's safety for maternal and child consumption.

The incorporation of underutilized national food products, such as grape syrup (Shinni), which is naturally rich in essential micronutrients, is recommended as a strategy for optimizing childhood growth and development, maintaining adequate micronutrient status, enhancing recovery processes, and improving overall quality of life. In instances of macro- and micronutrient deficiencies in both pediatric and adult populations, as well as in clinically confirmed cases of micronutrient imbalance, the dietary inclusion of grapes and grape-derived products—including Shinni—may offer both preventive and therapeutic advantages. Longitudinal research has demonstrated that grapes and their derivatives serve not only as substantial sources of energy and essential nutrients but also exert notable pharmacological and therapeutic effects, supporting their integration into nutritional and clinical practice.

Analysis of the Microelement Profile of Grapevine Decoction and Its Biological Value

The scientific literature we reviewed contains no references to studies on grapevine decoction. However, in traditional medicine, decoctions of grapevine have been used by folk healers residing in mountainous regions. Some observations indicate that the antibacterial effects of grapevine branches have been scientifically studied. In this area, we also conducted research. Faculty members from the Department of Propaedeutics of Childhood Diseases at the Samarkand State Medical Institute identified a high clinical efficacy of decoction prepared from wild grapevines in the treatment of anemia, which resulted in the submission of an innovation proposal (Innovation Proposal No. 353, SamSMI, 1999).

Wild grapevines predominantly grow in the mountainous areas of the Samarkand, Kashkadarya, Surkhandarya, and Jizzakh regions. Considering that the healing properties of wild grapes may surpass those of cultivated varieties, our aim was to investigate the decoction of grapevine. The preparation of grapevine decoction was carried out as follows: wild grapevines collected from mountainous regions were cut into small pieces and dried in the shade. From the dried material, 100 grams were boiled in 1 liter of water over low heat in a covered container (preferably copper) for 30 minutes. After boiling, the container was wrapped in cloth and allowed to infuse for 3 hours. The decoction was then filtered into a glass container. The final product was administered in a dosage of half a glass twice a day, 30–60 minutes before meals. The treatment course lasted 2–3 weeks.

Clinical observations demonstrated that this decoction provided significant benefits in cases of anemia, goiter, and other diseases associated with micronutrient deficiencies. The decoction was well tolerated by both children and adults, with no side effects observed.

The chemical composition of the grapevine decoction is summarized in Table 5.

Analysis results (Table 6) indicated exceptionally high levels of chlorine and sodium in the wild grapevine decoction, measuring 13,040 mg/L and 4,230 mg/L, respectively. These findings suggest that the decoction may be effectively utilized in clinical or dietary contexts involving substantial losses of sodium and chloride, such as during dehydration, vomiting, or profuse sweating. Additionally, the decoction demonstrated a considerable potassium content of 15,630 mg/L, further supporting its potential role in maintaining electrolyte balance. The therapeutic potential of the decoction is attributed to potassium's ability to support an alkaline environment within the body.

Table No. 6

Mineral Composition (Macro- and Microelements) of Grapevine Decoction

№	Element	Content, mg/kg
1	Cl	13040
2	Cu	33
3	Mn	1,2
4	Na	4230
5	Ca	250
6	Au	-
7	Br	42
8	Se	9,3
9	Hg	0,22
10	Cr	15
11	Sc	0,17
12	Rb	74

13	Fe	366
14	Zn	950
15	Co	0,75
16	Sb	1,4
17	La	-
18	K	15630

In the reviewed literature, there is a notable absence of scientific data regarding the chemical composition and biological activity of grapevine decoction. Nevertheless, it is known that in traditional medicine, this decoction has been used by healers residing in the mountainous regions of Central Asia. Furthermore, there is evidence from several scientific studies supporting the antibacterial properties of grapevine branches. In this context, we conducted a series of investigations aimed at evaluating the therapeutic potential of grapevine decoction.

Researchers from the Department of Propaedeutics of Childhood Diseases at the Samarkand State Medical Institute reported a pronounced clinical effect of the decoction, prepared from wild grapevine, in the treatment of iron-deficiency anemia. Based on the findings of these studies, a rationalization proposal was submitted (Proposal No. 353, SamSMI, 1999).

Wild grapevines predominantly grow in the mountainous areas of the Samarkand, Kashkadarya, Surkhandarya, and Jizzakh regions. Considering that wild grape varieties exhibit more potent medicinal properties compared to cultivated ones, the objective of our study was to investigate the composition and therapeutic properties of grapevine decoction.

The decoction was prepared as follows: wild grapevine shoots collected from mountainous regions were cut into small fragments and dried in the shade. A 100 g portion of the dried material was boiled in 1 liter of water over low heat in a closed vessel (preferably copper) for 30 minutes. After boiling, the container was wrapped in fabric to steep for 3 hours, after which the decoction was filtered and transferred to a glass container. The recommended dosage was 100 ml twice daily, 30–60 minutes before meals, for a treatment course of 2–3 weeks. Clinical observations demonstrated high efficacy of the decoction in treating anemia, endemic goiter, and other conditions associated with micronutrient deficiencies. The decoction was well tolerated by both pediatric and adult patients, with no reported adverse effects.

The chemical composition of the grapevine decoction is presented in Table 5. The results revealed notably high concentrations of chlorine and sodium—13,040 mg/L and 4,230 mg/L, respectively. These findings suggest the rationale for using this decoction as a rehydration agent in conditions involving significant electrolyte loss, such as intense thirst, vomiting, hyperhidrosis, and other forms of fluid-electrolyte imbalance. Particularly noteworthy is the high potassium content (15,630 mg/L), which contributes to maintaining an alkaline environment in the body and plays a substantial role in the therapeutic effect of the decoction.

Grape Vinegar: Composition and Therapeutic Properties

Historical Background.

Grape vinegar is one of the oldest byproducts of winemaking and belongs to the group of next-generation functional food ingredients. Historical records indicate that grape vinegar was already in use as an antiseptic and medicinal agent as early as the 5th millennium BCE. During the Middle Ages in Europe, it served as a preventive and therapeutic agent against infectious diseases, including the plague. In Spain, the tradition of producing vinegar from high-quality grape varieties dates back centuries, and by the 19th century, grape vinegar was widely utilized both for food preservation and as a means of promoting human health.

In traditional Chinese medicine, as documented in the Shennong's Classic of Materia Medica, vinegar was known during the Xia dynasty (circa 2000 BCE). Archaeological findings from Egyptian pyramids suggest that vinegar had already been in use 3000 years before that era. In Islamic tradition, vinegar is regarded as one of the Prophet Muhammad's four favored condiments and is often referred to as the "divine seasoning."

In The Canon of Medicine by Avicenna (Ibn Sina, 1982 edition), grape vinegar is recommended for various medical conditions. He notes that "a cotton plug moistened with grape vinegar and camphor, combined with basil juice, when placed in the nostrils, stops nosebleeds, relieves dental pain, and, depending on the individual's condition, may either suppress or induce sneezing. A mixture of vinegar with red rose oil is effective in treating inflammatory swellings." Avicenna also advised the use of vinegar for managing epilepsy, earaches, and inflammatory disorders.

In 1864, Louis Pasteur scientifically demonstrated that vinegar is formed through the natural fermentation of ethanol. In contemporary Mediterranean cuisine, grape vinegar remains a staple food product alongside bread, olive oil, and wine. In European countries and the United States, it is appreciated both as a refined culinary ingredient and a component of health-conscious diets.

Given its polyphenolic antioxidant composition, grape vinegar continues to be employed by medical professionals in health promotion and disease prevention.

In many regions of Uzbekistan, the production of grape vinegar has been practiced since antiquity. However, in recent years, its domestic preparation and usage have declined considerably.

We believe that there is significant potential for industrial-scale production of grape vinegar, and the time has come for a comprehensive scientific evaluation of its nutritional and medicinal properties. It should be promoted not only as a gourmet food product but also as a functional and preventive dietary supplement. Achieving this goal requires coordinated efforts from healthcare professionals, food technologists, and experts across related industries.

The evidence clearly indicates that grape vinegar has been — and continues to be — a beneficial product of the grapevine, valued in both ancient and modern contexts.

Technological Aspects and Functional Properties of Grape Vinegar.

The term vinegar derives from the Old French vinaigre, meaning "sour wine." Grape vinegar is produced through a two-stage fermentation process: initially, yeasts convert the fermentable sugars in grape juice into ethanol, which is subsequently oxidized into acetic acid by acetic acid bacteria of the Acetobacter genus. There are two principal methods of vinegar production: the traditional slow fermentation, which may last for weeks or months and results in a product of superior sensory quality, and the accelerated method, which, through intensive aeration, yields vinegar within 20 hours to 3 days.

High-quality grape vinegars are typically made from varietal wines such as sherry, champagne, or Pinot Grigio, and are aged in wooden barrels for up to two years, acquiring a complex bouquet and a refined flavor profile.

Home Preparation Method. To prepare grape vinegar at home, wine is poured into containers, filling them to approximately three-quarters of their volume, and left uncovered for several days to allow natural fermentation. For larger-scale production, oak barrels (e.g., 5-liter capacity) equipped with spigots are recommended. Prior to use, new barrels should be rinsed with vinegar and thoroughly dried.

The vessel is then filled with wine, allowing a small air gap at the top, and stored at a stable room temperature of around 20 °C (68 °F). Under these conditions, fermentation typically completes within two weeks. The finished vinegar is gently drained through the spigot, ensuring the surface layer remains undisturbed.

Homemade grape vinegar is often noted for its subtler taste and more intricate aroma compared to commercially produced variants.

Storage Considerations

Improper storage conditions may lead to contamination by mold fungi, which can alter the product's organoleptic properties and interfere with fermentation. To prevent such contamination, storage vessels should be tightly sealed. Although the presence of mold is not considered hazardous to human health, filtration and pasteurization prior to bottling are recommended to improve microbiological stability.

Regulatory and Nutritional Perspectives

In some countries, regulatory limits are imposed on the acetic acid content of vinegars intended for consumption. For example, in Canada, the acceptable concentration of acetic acid in food-grade vinegar ranges from 4.1% to 12.3%.

The nutritional and functional value of grape vinegar remains a subject of ongoing scientific debate. According to Dr. Andrew Waterhouse, while grape vinegar does contain certain antioxidant compounds, many of these substances lack significant nutritional value. The extent to which these compounds exert biological effects is still under investigation, and the classification of grape vinegar as a functional food remains controversial. Nevertheless, some studies indicate that phenolic constituents derived from grapes may remain stable during the vinegar-making process, thereby retaining a degree of antioxidant activity in the final product.

Physicochemical and Bioactive Constituents of Grape Vinegar

Traditionally, grape vinegar is primarily produced from red grape varieties. The preparation involves whole grapes, freshly pressed juice, or partially fermented grape mash, which are known to be rich in flavonoids — a diverse class of polyphenolic compounds with well-established antioxidant activity. *Flavonoids* exert a broad spectrum of biological effects, including antiviral, antiallergic, antitumor, and anti-inflammatory actions. Furthermore, they are associated with reduced blood cholesterol levels and the inhibition of low-density lipoprotein (LDL) oxidation, thereby contributing to cardiovascular protection.

Among the flavonoids abundantly present in red grapes, particular attention is given to *proanthocyanidins*, which exhibit pronounced antioxidant activity, and quercetin, known as a potent antitumor agent. *Quercetin* has been shown to inhibit the proliferation of tumor cells, prevent the malignant transformation of normal cells, stimulate pancreatic function, and contribute to the normalization of blood insulin levels. Owing to these effects, it is considered a promising therapeutic agent for managing complications of diabetes mellitus, including diabetic retinopathy, neuropathy, and nephropathy.

Resveratrol, another key phytochemical found in red grapes, has demonstrated beneficial effects on lipid metabolism. It reduces atherogenic lipid fractions and supports endothelial function, particularly in the context of high-fat diets, thereby mitigating the progression of atherosclerosis.

According to Dr. Lawrence Diggs, there is a common consumer belief that the biologically active compounds present in red wine are preserved in grape vinegar. He notes that during fermentation, only ethanol is converted to acetic acid, while most polyphenols remain intact. Nevertheless, whether the full spectrum of red wine’s health-promoting properties is retained in vinegar remains insufficiently studied. It is well documented, however, that acetic acid possesses antimicrobial effects, especially when used topically. Its biological behavior following oral administration may be altered under the influence of gastric acidity.

The antioxidant potential of wine polyphenols is extensively supported by experimental research. Studies from the University of California, Davis, demonstrated that red wine polyphenols inhibit tumor cell proliferation in animal models. Researchers at the University of California, Berkeley, have also identified novel polyphenolic compounds with strong radical-scavenging activity, DNA-protective properties, and the ability to prevent malignant cellular transformation.

From a clinical nutrition perspective, researcher Whitaker has reported that a drink composed of apple cider vinegar, black grapes, and grape juice shows favorable effects on cardiovascular health. Taken twice daily, this preparation was found to be more effective than several pharmacological agents in promoting vascular function. These findings reinforce the potential of grape vinegar as an affordable, functional food with significant health-promoting effects.

As summarized in a 2009 entry in Wikipedia, grape vinegar is recognized as a natural food product with a long history of therapeutic use. The article compiles original research findings regarding its composition and bioactivity.

There are several common types of grape vinegar, including balsamic, red, and white varieties. It is widely used in culinary applications, often combined with herbs and spices. Natural grape vinegars typically contain acetic acid at concentrations ranging from 4% to 8%, with pH values between 2.4 and 3.4 when diluted; concentrated variants may reach acetic acid levels of up to 18%. Beyond acetic acid, grape vinegar also comprises minor quantities of tartaric, citric, and other organic acids, which contribute both to its characteristic flavor profile and its preservative properties. Historically, vinegar has played an integral role in the traditional cuisines of Europe, Asia, and the Middle East.

The caloric value of acetic acid is minimal: 100 g of a 5% acetic acid solution provides approximately 76 kJ (18 kcal).

Today, there exists a broad diversity of vinegar types, including balsamic, rice, coconut, palm, cane, malt, honey, Chinese black vinegar, Japanese kurosu, Cantonese red vinegar, herbal vinegar, aged Iowan vinegar, kombucha vinegar, kiwi vinegar, and distilled or spirit vinegars. Among them, Turkish-produced ANAB grape vinegar is particularly popular in Middle Eastern countries.

Pharmacological and Clinical Potential of Grape Vinegar.

Historically, the medicinal use of vinegar was rarely documented in formal medical texts; however, it is well established that vinegar has been employed for preventive and therapeutic purposes for millennia. One of the earliest recorded applications was its use as a cooling and soothing agent for sunburns, where vinegar was applied via soaked cloth compresses.

Contemporary scientific research provides support for several of these traditional uses. A 2006 experimental study in rats demonstrated that dietary acetic acid intake led to a significant reduction in serum cholesterol and triglyceride levels, as well as decreased arterial blood pressure, compared to the control group. Observational studies have also indicated an inverse association between vinegar consumption and the risk of ischemic heart disease.

Furthermore, regular intake of vinegar with meals has been shown to reduce the glycemic index of foods by approximately 30% in both healthy individuals and those with diabetes mellitus. Some evidence suggests that vinegar promotes early satiety, thereby contributing to decreased overall caloric intake.

The Greek physician Hippocrates (460–377 BCE) reportedly employed vinegar as an anti-inflammatory remedy to treat cough, underscoring its use in classical Greco-Roman medicine. In The Canon of Medicine by Avicenna (Ibn Sina), vinegar is described as a potent resolving agent. He attributed to it properties that support the healing of burns and skin inflammation, relieve heat-induced headaches, and enhance digestive function.

Another medieval scholar, Ibn al-Qayyim al-Jawziyya, in his treatise Al-Tibb al-Nabawi (Prophetic Medicine), elaborates on the therapeutic effects of grape vinegar. According to his writings, grape vinegar alleviates inflammatory diseases of the stomach and gallbladder, neutralizes toxins in cases of poisoning (including fungal intoxications), quenches thirst, stimulates appetite, and inhibits tumor development.

Despite these recognized benefits, modern vinegar-based medicinal products vary considerably in pH and chemical composition, complicating standardization and quality control. Excessive or prolonged consumption of vinegar may lead to adverse health effects such as hypokalemia, hyperreninemia, and osteoporosis, emphasizing the need for caution in its clinical use.

In addition to its medical relevance, vinegar continues to serve a broad range of practical functions. It is widely used as a natural disinfectant for cleaning fabrics and surfaces, and in agriculture and horticulture as an eco-friendly herbicide.

Trace Element Composition of Grape G'urob

Scientific and technological approaches to the development of beverages derived from various types of plant raw materials are reflected in a number of works [1,8,17,35]. In particular, in conditions requiring targeted nutritional support, special emphasis is placed on juice-containing beverages derived from regional natural resources. These products must be suitable for mass consumption and capable of meeting the nutritional and energy needs of mothers and children, while also replenishing essential micronutrients necessary for normal physiological functioning.

In the Zarafshan Valley of the Republic of Uzbekistan, grape cultivation represents one of the region's most valuable and versatile agricultural activities. Addressing micronutrient deficiencies constitutes a major public health priority for the Ministry of Health of the Republic of Uzbekistan (MoH RUz). This is formally reflected in the 2010 Law “On the Prevention of Micronutrient Deficiency among the Population” and further reinforced by Cabinet of Ministers’ Decrees No. 102 (April 25, 2015) and No. 251 (August 29, 2015), which endorse the national strategy for healthy nutrition for 2015–2020. These legislative documents emphasize the importance of conducting scientific research on micronutrient deficiencies and highlight the need to prioritize fundamental studies investigating the etiology of nutrition-related diseases, the prevalence of deficiencies, anemia, iodine deficiency, and related conditions.

Within the domain of clinical nutrition and maternal–child health, such deficiencies are linked to anemia, obesity, diabetes, and heightened cardiovascular risk in pregnant and lactating women, while in children they manifest as protein-energy malnutrition, rickets, anemia, food allergies and intolerances, recurrent infections, and functional gastrointestinal disturbances. Enriching foods with bioelements (so-called functional foods) and using targeted mononutrient supplements or mineral complexes in cases of widespread deficiency can significantly reduce morbidity across age groups, enhance work capacity and endurance, and strengthen resistance to environmental, climatic, and geochemical stressors [20].

Grape G’urob is a traditional Uzbek product derived from the juice of unripe (green) grapes. It is one of the main processed grape products, rich in various nutritional and biologically active compounds that may contribute significantly to the maintenance of healthy nutrition.

However, no scientific studies have yet been conducted on the elemental composition or therapeutic properties of this traditional national product as a biologically active food supplement (BAFS) for nutritional support in the “mother–child” system, especially in the context of disease and micronutrient deficiencies, either in Uzbekistan or in other countries.

While grape vinegar, apple vinegar, and other types of fruit-based vinegars are well known as culinary ingredients, the beverage known as **“ghurob”** or “grape residue drink” remains relatively unknown outside the regions where it is traditionally produced and consumed. It is widely used in areas surrounding Samarkand and in grape-growing regions such as Urgut, Kushrabat, and Bulungur. Today, ghurob can still be found in local markets in these areas.

Notably, there is no available scientific or medical literature on ghurob. Data on its production technologies, biochemical composition, pharmacological properties, potential health benefits, side effects, and application methods are virtually nonexistent. Given its place among grape-derived products—including fresh grapes, grape leaves, wine, syrup (shinni), grapevine decoction, and grape vinegar—it may be hypothesized that ghurob also possesses therapeutic properties and is worthy of systematic scientific investigation.

Etymologically, the term “ghurob” derives from Persian, where “ghur” means “unripe” or “green,” and “ab” means “water.” Thus, ghurob refers to a drink made from the juice of unripe grapes.

Traditionally, ghurob is consumed as a food additive. It is typically served with meals and used in the preparation of salads. Firsthand experience in viticulture and home production of ghurob has allowed us to assess not only its sensory qualities but also its potential in addressing certain health conditions. To evaluate its health-promoting potential, we conducted a chemical analysis of its composition.

Ghurob is a fermented beverage that resembles grape vinegar in some respects. Its preparation involves natural fermentation under sunlight. However, unlike vinegar, ghurob is not made from ripe grapes or wine, but rather from the juice of unripe (green) grapes.

Technology for the Preparation of Grape Pomace-Based-G‘urob.

Historically, g‘urob has been prepared by local populations using traditional methods. However, in recent years, we have developed and tested improved technologies for its production. The conventional method of preparing g‘urob involves the use of unripe grape clusters—typically from cultivars such as Husayni, Toyfi, and Kishmish—which are harvested at early stages of ripening, before a significant accumulation of sugars. Harvesting is usually carried out during the hot summer months, primarily in early July.

Juice extraction is performed by crushing the green grapes in traditional wooden mortars (kelicha—hollowed wooden vessels customarily used for processing dried fruits) or by pressing them in cloth bags under heavy weights. The extracted juice is then filtered through a cloth and poured into sterilized glass containers that have been pre-dried under direct sunlight.

To create semi-anaerobic conditions, the necks of the containers are wrapped in cloth and sealed with a layer of clay. The vessels are then exposed to sunlight for a period of 4 to 6 weeks. This sealing technique enables a controlled fermentation process by allowing limited air exchange while preventing contamination by pathogenic microorganisms. The resulting g‘urob is stored in cool environments throughout the autumn and winter months, making it available as a dietary product during the colder seasons.

A modernized method of preparation combines traditional techniques with selected elements of contemporary food technology. After meticulous cleaning, unripe grape clusters are juiced using manual or electric presses. In small-scale domestic production, standard household juicers and fermentation containers may be employed. At present, industrial-scale production of g‘urob has not yet been established. To enhance the organoleptic properties, nutritional value, and bioactive compound content, additional fruits—such as white mulberries (Morus alba)—can be incorporated into the grape juice.

Prior to bottling, glass containers are carefully washed and sterilized by sun exposure over several days. The juice is filtered to remove mechanical impurities, filled into prepared bottles, tightly sealed with airtight caps, and subjected to pasteurization at 70 °C for 40 minutes. Post-pasteurization, the bottles are returned to sunlight to facilitate the continuation of fermentation, which proceeds for another 4 to 6 weeks.

Quality indicators of g‘urob include a high degree of clarity, absence of suspended solids, and lack of sediment. The final product should be stored in cool, shaded areas during the colder months. After opening, g‘urob is best consumed within 1–2 days, as prolonged exposure to air can lead to the development of surface fungal films. While these microorganisms are not generally hazardous to human health, extended storage of the opened product is discouraged. For short-term storage, it is advisable to keep the beverage in dry, cool cellars that maintain a stable temperature and are protected from direct sunlight.

Chemical Composition of G‘urob (Fermented Juice of Unripe Grapes)

The macro- and microelement profile of grape g‘urob—a traditional plant-based food product infrequently consumed by the local population—was investigated at the Laboratory of Activation Analysis, Institute of Nuclear Physics, Academy of Sciences of the Republic of Uzbekistan (INP AS RUz), employing neutron activation analysis [6]. A total of 23 chemical elements were examined, following the classification framework proposed by A.V. Bogatov [5].

These elements were systematically categorized as follows: macroelements (calcium, magnesium, potassium, sodium, chlorine); essential biogenic trace elements (iron, copper, zinc, manganese, chromium, selenium, molybdenum, iodine, cobalt); conditionally essential microelements (bromine, nickel, cadmium); brain-associated elements (gold, silver); neutral abiogenic elements (rubidium, scandium, lanthanum); and toxic or potentially aggressive abiogenic elements (mercury, antimony), whose physiological roles remain insufficiently elucidated.

In accordance with sanitary regulations (SanPiN), additional analyses were conducted to ensure the product's safety for consumption. These included:

Sanitary-bacteriological testing, radionuclide assessment, and evaluation for pesticide and toxic element residues, performed at the Sanitary and Epidemiological Service Laboratory in Samarkand.

Sanitary-bacteriological analyses were carried out in accordance with SanPiN No. 0366-19 using the MVI MN 1181-2011 method (O'zO'U 0547-2011).

Radionuclide content, including Cs-137 and Sr-90, was quantified utilizing a gamma-beta spectrometer MKS-AT-1315 under controlled conditions (+20°C, 63% relative humidity).Toxic element and pesticide residue determinations adhered to SanPiN 0366-19 and GOST standards 26929-94, 26927-26330-23334-86 (Klysenko Collection, 1992).

At present, there is a notable lack of comprehensive scientific literature regarding the chemical composition and therapeutic applications of grape g'urob. Furthermore, public awareness regarding its preparation, consumption practices, and potential health and nutritional benefits remains limited. The term g'urob is derived from Persian, where "gura" means "unripe" and "ob" means "water". Grape g'urob is traditionally prepared by the rural population in Samarkand, Kashkadarya, and partially in other regions of Uzbekistan where viticulture is common. The product is made from freshly pressed juice of unripe (green) grapes of any variety.

The juice is filtered, sterilized by boiling for up to 3 minutes, poured into a glass bottle, sealed with a breathable sponge (traditionally sealed with clay), and then left to ferment in sunlight for 2–3 months. After fermentation, it is stored in a dark place.

Grape g‘urob is used to stimulate appetite and aid digestion, consumed in small amounts alone or with salads. It is a clear, yellowish-brown liquid with a sour and refreshing taste. When properly stored, g‘urob remains stable and retains its biological properties for up to 2–3 years. Although some vitamin loss occurs due to heat treatment, the concentration of mineral elements remains stable.

Currently, there is no industrial production of this traditional product. Based on its potential functional and medicinal value, we determined the content of chemical elements in g‘urob to explore its potential for preventive and therapeutic use, including for children and vulnerable populations.

Results Obtained.

To provide nutritional support and address macronutrient deficiencies, the macro- and microelement composition of grape g‘urob was studied in three samples of this rarely consumed traditional product. The concentrations of the elements were determined in accordance with the standard values for plant materials established by the Institute of Nuclear Physics [18]. The macroelement composition analyzed in this study is summarized in Table 7.

Table No. 7

Macroelement Profile of Grape-Derived Food Products (mcg/g)

Produc	Ca	Na	Cl	Mg	K
Grape "G'urob" (n=3)	2600-21120	440 - 11445	5500-12540	1000-152570	31000-662770 (0,31%-6,6%)
Typical concentrations in plants (Kist A.A., 1987)	12000	1500	2000	1200	15000

As shown in Table 7, the content of organically bound calcium in grape g'urob reaches a high concentration—up to 21,120 mcg/g (2.1%), which is twice the amount found in standard plant samples.

The concentrations of organic sodium and chlorine are also elevated: in grape g'urob, they range from 11,445 mcg/g to 12,540 mcg/g.

Potassium, present as an organic salt, occurs at exceptionally elevated levels in grape g'urob, reaching 662,770 mcg/g (6.6%). This remarkably high potassium content is distinctive to this traditional product.

Magnesium is also present in elevated amounts in grape g'urob, ranging from 1,000 to 152,570 mcg/g.

Within the category of essential trace elements, the concentrations of iron, zinc, cobalt, manganese, chromium, selenium, molybdenum, and iodine were determined in grape g'urob samples cultivated for this study (see Table 8).

Analysis revealed that grape g‘urob exhibits an exceptionally high iron content of 3,566 mcg/g, markedly exceeding typical plant reference values. This level of iron is unparalleled among commonly consumed food products.

Zinc, in contrast, is present at a moderate concentration of 25 mcg/g, which falls below standard reference levels for plant-based foods.

Table No. 7

Trace Element Content in Grape G’urob (mcg/g)

Macroelements and Microelements	Grape "G’urob"	Typical concentrations in plants (Kist A.A., 1987)
Fe	3566	160
Zn	25	40
Co	0,12-21,6	0,1
Mn	1000-1210	300
Se	0,01-0,1	0,5
I	0,1	0,1
Cr	2,6-10,4	1,3
Mo	0,54-55,6	0,5
Br	1-21,7	6
Ni	4,0	1
Au	0,048-0,057	0,02
Ag	0,01-0,17	0,15
Hg	0,42-0,07	0,01
Sc	0,004-0,05	0,01
Rb	5,3-46	20
Sb	0,13-1,06	0,02
La	0,1-0,005	0,6
U	0,77	

Macroelements and Microelements	Grape "G'urob"	Typical concentrations in plants (Kist A.A., 1987)
Lu	0,01	
Th	0,0034	
Hf	0,014	0,1
Ba	36-364	5

Cobalt is present in high concentrations in grape g'urob, reaching up to 21 μg/g (mg/L). Manganese is present in grape g'urob at notably high levels, ranging from 1,000 to 1,210 μg/g. Selenium, an essential trace element, occurs at very low concentrations, measuring less than 0.1 μg/g. Similarly, iodine is found at minimal levels of approximately 0.1 μg/g.

These low iodine concentrations in grape g'urob and other locally produced foods suggest that the Zarafshan Valley constitutes a biogeochemical region characterized by iodine deficiency, a factor that must be considered when designing targeted preventive interventions.

Chromium levels in grape g'urob exceed those of standard plant samples, ranging from 2.6 μg/g to 10.4 μg/g—ten times higher than reference levels. Molybdenum is also found in high concentrations in grape g'urob—up to 56 μg/g. However, the biological role of molybdenum excess and deficiency, particularly in children, remains insufficiently studied.

Among conditionally essential trace elements, bromine and nickel were studied in grape products and found within the range of standard plant samples. Further research is needed to assess their nutritional role in deficiency states.

Within the category of so-called “brain elements,” gold and silver were analyzed in the grape products under study. Both elements were detected at extremely low levels, ranging from 0.002 µg/g to 0.17 µg/g, which are below standard reference values. Regarding abiogenic elements, rubidium, scandium, and barium were examined. Rubidium was present in relatively high concentrations, ranging from 5 to 46 µg/g in grape g‘urob. Barium levels varied between 36 µg/g and 364 µg/g; while its deficiency in children has not been investigated, both acute and chronic baritosis resulting from poisoning are well documented.

Scandium was detected in very low amounts, from 0.001 µg/g to 0.01 µg/g, suggesting it likely plays no significant biological role. Among aggressive toxic elements, mercury was analyzed. In the studied samples, mercury concentrations ranged from 0.07 µg/g to 0.42 µg/g.

Discussion of Results:

The study of the physiological role of elements for identifying and correcting mineral imbalances in various pathologies remains highly relevant, as most macro- and microelements participate in mineralization processes, form part of bone tissue, activate enzymes, influence blood clotting, and regulate numerous biochemical processes including membrane permeability to potassium, sodium, and calcium ions. Additionally, metal ions are involved in generating membrane potential, cellular growth, development, contraction, division, secretion, regeneration, and intracellular signaling.

Higher plants are the primary dietary source of trace elements for many living organisms. Abnormally low levels of trace elements in plant tissues are detrimental not only to plants themselves but also to organisms that consume them. At least 50 nutrients are required for normal human life, including 17 trace elements. Therefore, minerals and trace elements play a vital role in maintaining human health. Of particular importance is the study of macro- and microelement composition in natural food products cultivated by local populations of the Zarafshan Valley, including the rarely used grape g'urob.

Grape g'urob contains ionized (organic) calcium salts in high concentrations. Thus, it can be recommended as a preventive and corrective dietary source of calcium, particularly for lactating women and children over one year old (as a complementary food). In cases of confirmed hypocalcemia, calcium supplementation can be administered in conjunction with dietary intake.

Grape gʻurob, owing to its substantial content of organic sodium and chlorine, is recommended for the prevention of sodium and chloride deficiencies in at-risk populations, as well as for mitigating electrolyte losses associated with vomiting, diarrhea, or other gastrointestinal disorders. In instances of clinically diagnosed hyponatremia, therapeutic correction should include the administration of sodium and chloride supplements or hypertonic saline solutions.

Grape g'urob is the only vineyard product with a high potassium content, making it suitable for use in dietary potassium correction in lactating women and children with hypokalemia. Due to its high magnesium content, grape g'urob can be used as a nutritional source for magnesium supplementation in children over one year and lactating women at risk of deficiency or with diagnosed hypomagnesemia.

Among essential trace elements, grape g’urob is particularly rich in organic iron, with concentrations several times higher than standard plant references. No other known product contains such high iron levels, making grape g’urob a suitable therapeutic and preventive food-based substrate in iron-deficiency states.

The high cobalt content in grape g’urob supports its use in nutritional support—especially in the "Mother–Child" health system for cobalt-deficient individuals. In diagnosed cobalt deficiency, vitamin B12 or cobalt-containing supplements are recommended.

As a food rich in both iron and manganese, grape g’urob can be used to correct deficiencies in both elements. Manganese acts as a synergist for iron and enhances its absorption in the intestine. Some studies (e.g., Rubenstein A.H. et al., 1962) link manganese to glucose metabolism disturbances in insulin-resistant diabetes. Manganese chloride administration was found to significantly lower blood glucose levels in such patients. Preliminary findings suggest a positive effect of grape g’urob in diabetes, potentially due to its high manganese content. This area is under ongoing investigation.

Selenium, as an essential trace element, plays critical physiological roles. Selenium supplementation has been shown to be therapeutically effective in conditions such as Keshan disease, total parenteral nutrition, kwashiorkor, phenylketonuria, and maple syrup urine disease. According to A.P. Avtsyn et al. (1991), selenium exhibits a direct cytotoxic effect on human tumor cells. These findings suggest that long-term dietary consumption of grape g‘urob could contribute to oncological disease prevention.

Chromium levels in grape g’urob are 10 times higher than in standard plant samples, highlighting its significant biological value. In the circulatory system, chromium is primarily transported via transferrin, which also carries iron. Chromium plays a critical role in potentiating insulin activity across all insulin-dependent metabolic pathways. Although the recommended daily intake ranges from 50 to 200 µg, typical diets supply only 33–125 µg, with highly refined foods such as white sugar and flour-based products containing minimal amounts. Given that sugar consumption further accelerates chromium loss, a pronounced deficiency is likely within the “Mother–Child” population. Consequently, incorporating grape g‘urob into the diet of lactating mothers and children may help mitigate the risk of chromium insufficiency.

The high molybdenum content in grape g’urob supports its use in molybdenum-deficient states, although its role in child development remains under investigation.

Abiogenic elements entered animal metabolism due to their weak reactivity despite wide lithospheric distribution, often first appearing in marine life. This early competition shaped their metabolic roles, sometimes resulting in pathology in terrestrial organisms. Rubidium was detected at relatively elevated concentrations in grape g‘urob, suggesting its functional proximity to essential trace elements. Elements classified as “brain elements” are postulated to contribute to neural signal transmission in mammalian tissues.

While their specific roles in pediatric populations remain largely uninvestigated, they may participate in fundamental metabolic processes. The detection of these elements in locally sourced, plant-based foods indicates their safety for maternal and child consumption. Regarding toxicology, the effects of methylmercury are well-established. Analysis of abiogenic and potentially toxic elements in grape g‘urob from the Zarafshan Valley revealed very low concentrations of mercury and scandium, confirming the product’s safety for human use.

Compliance with Sanitary-Epidemiological Standards:

To ensure suitability for consumption, grape g‘urob underwent testing for radionuclides, microbial contamination, toxic substances, and pesticide residues. The results demonstrated:

1. **Radionuclides (Cs-137, Sr-90):** Concentrations were within permissible limits, fully complying with SanPiN RUz No. 0366-19, Clause 44.

2. **Microbial Safety (Sample Date: 08.01.2020):**

- Total microbial count (MAFAM) = 4.6×10^2 CFU (permissible limit = 5×10^3 CFU)
- No coliform bacteria (BGKP), pathogenic organisms (e.g., Salmonella), or fungal contamination detected.

3. **Toxic Elements and Pesticides:** Levels met all SanPiN 0366-19 and GOST regulatory standards (Protocol No. 0211-12/03 1–2, January 15, 2020).

Conclusions:

1. Grape g‘urob contains high concentrations of ionized salts, including calcium, sodium, chlorine, potassium, and magnesium—up to 21,120, 12,540, 662,770, and 152,570 µg/g, respectively. These properties make it suitable for the prevention and correction of mineral deficiencies, particularly in lactating women (50–100 mL/day) and children over 1 year of age (5–10 mL/day as a complementary food).

2. Among essential trace elements, grape g’urob contains high levels of iron and manganese (up to 3566 µg/g and 1210 µg/g), greatly exceeding reference values. Moderate concentrations of molybdenum, zinc, cobalt, and chromium (up to 56, 25, 21, and 10.5 µg/g, respectively) were observed, with selenium and iodine present in low concentrations (up to 0.1 µg/g). Therefore, grape g’urob may serve as a nutritional and therapeutic biosubstrate for trace element deficiencies.

3. Abiogenic and toxic elements (e.g., mercury and scandium) were found in very low concentrations, confirming the product’s safety.

4. Compliance with SanPiN was confirmed through testing for radionuclides, pathogens, toxic substances, and pesticides. Grape g’urob meets all requirements and is safe for use as complementary food for children over 1 year old.

5. The promotion of nutritional support through underutilized national foods, such as grape g‘urob—which is naturally rich in essential micronutrients—should be prioritized to prevent and correct deficiencies, enhance optimal growth and development in children, and strengthen overall health outcomes within the “Mother–Child” system.

6. Further research, including randomized controlled trials, may be necessary to determine optimal intake levels and confirm the efficacy of grape g'urob as a bioactive dietary supplement containing essential macro- and microelements.

7.

Avicenna's Medical Insights into the Therapeutic Use of Unripe Grape Juice
(G'urob)

In his seminal work The Canon of Medicine, Avicenna (Ibn Sina) provides a detailed account of the therapeutic properties of unripe grape juice (ghura) and its incorporation into various medicinal formulations. Specifically, he offers the following recommendations:

- *"To treat purulent ear discharge, mumiyo in an amount equivalent to a barley grain should be mixed with rose oil and the juice of unripe grapes (ghura), then introduced into the ear canal using a cotton wick" (p. 391).*
- *"When aged olive oil is boiled with unripe grape juice until it thickens and applied to loose teeth, it facilitates their removal" (p. 495).*
- *"An enema prepared from a mixture of concentrated aged olive oil and unripe grape juice is beneficial in the treatment of rectal ulcerations" (p. 242).*

These prescriptions illustrate that unripe grape juice, when combined with other natural ingredients, was employed as an anti-inflammatory, astringent, and wound-healing agent. This affirms its widespread use in medieval traditional medicine and highlights its pharmacological significance within Avicenna's therapeutic system.

Therapeutic Limitations and Risks Associated with Grape-Derived Products

The use of grapes as a therapeutic and dietary remedy is associated with certain limitations. In particular, grape consumption is not recommended in individuals with oral inflammatory conditions such as stomatitis, gingivitis, or glossitis. The penetration of grape juice into the interdental spaces, especially in the presence of dental caries, may enhance enamel demineralization and accelerate tooth decay. To mitigate these effects, it is advisable to rinse the oral cavity with a weak solution of baking soda following grape consumption, in order to neutralize acidity and remove residual sugars.

Grape therapy is contraindicated in several medical conditions, including diabetes mellitus, acute and chronic enterocolitis, active pulmonary tuberculosis and pleuropneumonia, exacerbations of chronic tuberculosis, idiopathic hypersensitivity reactions, individual intolerance to grapes, obesity, and other metabolic states where high sugar and organic acid content may exert detrimental effects. Excessive intake of grapes may also lead to dyspeptic symptoms and other undesirable gastrointestinal effects.

Furthermore, special attention must be given to the ecological safety of grape products. In some instances, excessive use of agrochemicals during vineyard management may result in the accumulation of chemical residues in grape berries, posing potential health risks. Therefore, before incorporating grapes into therapeutic regimens, it is essential to verify their origin and ensure proper hygienic processing of the fruit.

CHAPTER III.
TRADITIONAL MEDICINE AND THERAPEUTIC BEVERAGES DERIVED FROM GRAPE-BASED PRODUCTS

Ethnomedical and Traditional Therapeutic Uses of Grape-Based Preparations

In traditional medicine, both fresh grapes and their derived products have long been employed to manage a diverse array of health conditions, encompassing disorders of the urinary system, liver, cardiovascular system, and gastrointestinal tract. Their use has also been documented in the treatment of gout, hemorrhoids, and various hemorrhagic conditions, largely due to their notable choleretic and diuretic properties. Classical references, such as Makhzan al-Adwiyah, highlight grapes as a nutritive agent that promotes blood circulation and facilitates the softening of hardened tissues. Moreover, grapes are believed to benefit the respiratory system and lung tissue, promote weight gain, and contribute to fat accumulation in the renal tissues.

Raisins are said to possess even more pronounced tonic effects, improving both the volume and quality of circulating blood. Prolonged storage is thought to increase their medicinal value, particularly for individuals recovering from severe infectious and inflammatory diseases, such as malaria or acute respiratory infections.

Grape consumption is reported to increase blood volume, exert a gentle laxative effect, improve appetite, and strengthen the nervous system. When included in the daily diet, grapes contribute to better digestion. According to ethnomedicine researcher A. Altymishev (1976), a decoction of raisins combined with onion juice has been used effectively for laryngeal stenosis accompanied by a choking sensation.

Grapes are traditionally indicated for conditions such as cachexia, anemia, pulmonary tuberculosis, pneumonia, dyspnea, and a range of gastrointestinal disorders. Therapeutic benefits are attributed not only to the fruit itself but also to grape leaves and tendrils. Notably, Avicenna (Abu Ali Ibn Sina) documented the medicinal application of grape leaves and tendrils in the management of headaches, ocular inflammation, gastric ailments, and ear-related disorders.

In The Canon of Medicine (1982, p. 194), Avicenna notes: "*A decoction made from one miskal of elm bark mixed with grape decoction and cold water facilitates the expulsion of phlegm from the respiratory tract*." In folk medical texts, it is also stated that the juice of the govshir plant (Ferula foetida), when applied topically to an enlarged spleen, yields therapeutic benefits. Additionally, a medicinal preparation involving ten dirhams of govshir and a glass of freshly pressed grape juice infused over two months is said to be effective in treating dropsy (ascites) (p. 164).

Grape leaf juice is traditionally believed to enhance vision, and infusions prepared from the leaves are recommended for gout as a harmless remedy. In the folk recipes of Bulgarian healer Vanga, sour grape decoction is used to reduce fever in children.

A decoction of raisins with onion juice is also used to alleviate dyspnea and restore vocal function (A. Altymishev, 1976). Abu Bakr al-Razi (865–926) recommended roasted flour decoction, pomegranate juice, barberry decoction, and raisins to treat childhood diarrhea.

Grape berries are thought to stimulate metabolism and promote mucus clearance from the respiratory tract. Grapes are recommended for individuals experiencing wasting syndromes, anemia, pulmonary tuberculosis, pneumonia, dyspnea, gastrointestinal disturbances, gout, and chronic urethritis. Additionally, infusions prepared from grape leaves are traditionally employed as a gargle for sore throat and as a topical wash for cutaneous lesions in various skin conditions. Crushed grape leaves are applied to wounds and ulcers to accelerate healing. Dried grape leaf powder, administered at a dose of 2–3 grams, serves as a hemostatic agent, including for uterine bleeding.

Dishes prepared from young grape shoots are traditionally consumed to strengthen the body and aid digestion. In traditional folk medicine, grapes and grape juice are extensively used to manage disorders of the urinary bladder, kidneys, liver, cardiovascular system, and gastrointestinal tract, and they are also employed in the treatment of hemorrhoids, due to their hemostatic and diuretic properties.

In the treatise Secrets of Learning (1901) by Imam Zarnuji, the cognitive benefits of certain foods are highlighted. The author states: "*The consumption of honey, walnuts with honey, and the daily intake of twenty-one red raisins strengthens the intellect. Thorough mastication of raisins along with saliva is said to aid in the treatment of certain ailments.*

One must remember: anything that reduces phlegm and oral moisture sharpens cognitive function, whereas excess *saliva and moisture—often resulting from overconsumption of water—diminish intellectual performance and increase forgetfulness. Thoroughly chewed dry bread and raisins help reduce mucus. However, excessive raisin consumption may induce thirst, thereby leading to renewed mucus production*."

In traditional folk medicine, grape seeds have been applied for their anthelmintic and antipyretic properties, as well as for managing kidney disorders, urolithiasis, liver and biliary diseases, hemorrhoids, respiratory issues such as cough and voice disorders, and various skin conditions. A decoction of grape seeds, prepared at a 1:10 ratio, has traditionally been used as a diuretic (V. Vostokov, 1994).

Furthermore, The Canon of Medicine includes a recommendation for using a mixture of grapevine ash and human urine to stop bleeding. Avicenna also described a method for preparing grape leaf decoctions at home: "*Four tablespoons (40–50 g) of dried grape leaves are added to 0.5 liters of boiling water, simmered for 10–15 minutes, strained, and consumed in half-cup doses 3–4 times a day before meals*."

Special attention in traditional medicine has been given to g'urob, a beverage made from unripe grapes. In Persian, this drink is known as "angurugura". K. Zahidov, in his book Qanzi Shifo (1991), provides detailed accounts of its traditional uses.

« The juice of unripe grapes (ghura) is characterized by the second degree of coldness and the second degree of dryness in its nature.

<u>Properties.</u> *Internal consumption of unripe grape juice (ghura) helps reduce blood pressure, eliminates bile, and breaks down mucus formed in the stomach. It also has an astringent*

effect. When foreign substances enter the body, it strengthens the liver, quenches thirst, and alleviates general weakness.

When applied to the skin, dried unripe grape juice eliminates unpleasant body odor and imparts a pleasant fragrance. It promotes the healing of skin eruptions, relieves itching, and eases bodily fatigue.

However, in individuals with a "cold" digestive temperament, the use of unripe grape juice may slow down the digestion process and reduce sexual function. It can also cause abdominal bloating (especially in cases of high stomach acidity) and intestinal discomfort. To neutralize potential toxic effects, it is recommended to combine the juice with gulkand (rose petal jam) or figs. During off-season periods when unripe grapes are unavailable, rhubarb or sorrel can serve as suitable substitutes.

Unripe grape juice prepared by sun exposure quenches thirst, reduces gastric heat, alleviates symptoms caused by excess bile, and stimulates appetite.

It strengthens the uterus, helping prevent miscarriages, and is used as a remedy for intestinal disorders and abdominal pain related to bile congestion.

Oral intake of sun-infused unripe grape juice is beneficial for sore throat, laryngeal swelling, nasal bleeding, and hematemesis (vomiting of blood). When combined with leek, it dries and heals hemorrhoidal swellings.

Topical application of the juice to female reproductive organs promotes cleansing; when mixed with vinegar, it is effective in treating all types of ulcers and fistulas. Instilling the juice into the ears helps eliminate earwax, and gargling with it relieves throat swelling and inflammation. When applied to the eyes in the form of kohl, it reduces tearing and heals ulcers on *the eyelids. Enemas with this juice support intestinal ulcer healing and reduce excessive uterine discharge. Internal consumption also enhances digestion.*

However, it should be noted that unripe grape juice may irritate the chest organs and cause coughing. The recommended dosage is 4.5 grams. In the absence of unripe grape juice, sour apple juice can be used as an alternative. Moreover, wine can be prepared from unripe grape juice.

Treatment of Anemia:

In traditional medicine, there is a simple and accessible method that helps to increase blood volume. For this purpose, one bottle of Cahors wine (historically, grape wine was prepared in clay vessels) and approximately 250 g of sugar (about 300 g) are combined with six liters of water and boiled until the total volume decreases to five liters.The resulting decoction is recommended to be taken in the amount of three glasses per day. Immediately after ingestion, a noticeable rush of blood to the face is observed.

Grape-Based Functional Drinks and Culinary Preparations: Hot, Cold, and Dessert Variants

1. Medicinal Herbal Tea **Ingredients (per 1 L):** • Dried black currant —2 g • Dried basil — 1 g • Dried grape leaves — 2 g • Water — 1050 mL • Sugar — 75 g	**Preparation:** The dry plant material is infused in boiling water for 10–12 minutes, then strained and sweetened with sugar. The tea is consumed warm and may offer mild

	antioxidant and digestive benefits due to the inclusion of grape leaves and black currant

2. Aphrodite Beverage **Ingredients (per 1 L):** • Water — 180 mL • Sugar — 100 g Flower petals — 0.1 g • Cinnamon — 0.2 g • Vanillin — 0.05 g • Lemon (finely chopped) 60 g • Concentrated grape juice — 600 mL • Egg white — 120 g	**Preparation:** Sugar, spices, vanillin, lemon, water, and grape juice are combined in a stainless-steel container, thoroughly mixed, and brought to a boil. The mixture is filtered through a sieve while stirring continuously, then bottled. This beverage combines sensory appeal with the functional properties of grape juice.

3. Sea Buckthorn Grog **Ingredients (per 200 mL):** • Sea buckthorn juice -30 mL • Grape juice — 70 mL • Mint infusion — 70 mL • Citric acid — 0.5 g • Honey — 30 g • Cinnamon — 0.2 g • Flower petals — 0.2 g • Vanillin — 0.01 g	**Preparation:** All juices are blended with honey and spices. The mixture is gently heated in a water bath until the honey fully dissolves, then allowed to infuse for 1 hour to extract bioactive compounds. The grog is filtered and maintained at 75–80 °C for warm consumption throughout the day.

4. **Frozen Punch with Lemon Juice** **Ingredients (per 130 g serving):** • Lemon juice — 10 g • Orange juice — 20 g • Mango juice — 30 g • Sugar — 25 g • Grape juice — 20 g • Egg white — 12 g • Lemon/orange zest — 1 g • Water — 20	**Preparation:** A sugar syrup is prepared by combining sugar, citrus juices, zest, and water, then chilled and filtered. The cooled syrup is processed through a freezer drum (frezor), after which whipped egg white and grape juice are incorporated. Finally, mango juice is gradually added to achieve a uniform texture. The frozen dessert is served in chilled tall glasses.

5.F**resh Fruit Salad** **Ingredients (per 200 g portion):** • Watermelon — 30 g • Black currant — 40 g • Apple — 30 g • Pear — 30 g • Grape — 30 g • Sour cream (36% fat) -30 g • sugar — 10 g	**Preparation:** Cut the watermelon into cubes, and dice the apples and pears. Halve and deseed the black currants. Combine all the fruits and mix gently. Top the salad with grapes and finish with a smooth cream made from sour cream blended with powdered sugar.

6. Fruit Salad-Cocktail (per 100 g serving)

The fruit salad-cocktail consists of a standardized portion of 100 g, incorporating diced apple (25 g), pear (25 g), and peach (15 g), along with grapes (10 g) to provide textural contrast. The mixture is homogenized with 20 g of a fruit-based mayonnaise emulsion and 5 g of freshly extracted lemon juice to enhance flavor, acidity, and overall palatability. This formulation ensures a balanced distribution of fruit types while maintaining consistent nutritional content and organoleptic properties suitable for dietary and clinical applications.

Thermally Modified and Chilled Grape-Based Drinks with Reduced Ethanol Content

The negative impact of alcohol on human health is well known. Ethanol has been proven to exert toxic effects on both the central and peripheral nervous systems, leading to decreased physical and cognitive performance, promoting dehydration, and impairing intellectual functioning.

Alcohol, in all forms and doses, constitutes a risk factor for health. Therefore, at official and high-level ceremonial events, it is advisable to offer alternative beverages with reduced ethanol content instead of strong alcoholic drinks. It is worth noting that a significant proportion of alcoholic beverages are made from grapes (such as wine, brandy, rum, vermouth, liqueur, etc.).

To minimize potential harm and enhance both the organoleptic and therapeutic properties, such grape-based products can be incorporated into complex mixtures and drinks—such as cocktails, spritzers, cups, mazagrans, fizzes, and punches—where the ethanol content is reduced by the addition of juices, infusions, and other ingredients.

Grape-Based Chilled Low-Ethanol Beverages

These beverages are characterized by their simple composition and easy preparation methods that do not require complex processes. Varieties such as spritzers, cups, mazagrans, and fizzes are typically made using carbonated water, sweet low-alcohol drinks, and fresh fruits. Such drinks are usually served in large, colorful glass containers, tall tumblers, or goblets, often accompanied by special spoons for ice. Drinking through a straw is also acceptable. A separate category includes thick, opaque beverages—sorbets—which are further textured and chilled by the addition of ice cream.

Examples of Light, Fruit-Based and Functional Grape-Infused Beverages

- **Spritzer**
- *Ingredients:* 1 glass of white wine, 1–2 glasses of sparkling water, ice cubes.
- White wine is poured into a glass pitcher, followed by sparkling water, and the mixture is stirred gently. Ice is then added. The beverage is served with individual glasses and drinking straws. Spritzer is a light, refreshing drink with a low alcohol content, ideal for summer consumption.
- **Classic Fruit Punch (Coupé de Cruchon)**
- *Ingredients:* ½ bottle of white wine, 1 shot of cognac, 200 g sugar, 1 orange, 1 lemon, 2–3 glasses of sparkling water, ice cubes.
- A beverage is prepared by blending wine and cognac with carbonated water and a measured quantity of sugar. Fruits are thinly sliced and incorporated into the liquid along

with ice to achieve uniform cooling. The mixture is presented in transparent glass bowls or carafes and served with a ladle for portioning. Each individual serving contains an ice cube and is accompanied by a straw to facilitate consumption, ensuring both aesthetic appeal and practical usability.

- **Fruit Punch (Yield: 10–12 servings)**

Ingredients: 1 bottle of white wine, 1 serving (shot) of rum or cognac, 3–4 glasses of carbonated water, 200 g sugar, 2–3 apricots, 1 glass of fresh mulberries, ½ glass of blackcurrant juice, ice. Preparation: White wine is combined with rum or cognac, carbonated water, and sugar to form a homogenous mixture. Subsequently, fresh fruits are incorporated, and ice is added to maintain a chilled temperature. The beverage is then ready for serving.

Apricots are thinly sliced, mulberries added whole or halved, and blackcurrant juice is poured in. Ice is added before serving in large glass containers with ladles.

- **Mazagran**
- *Ingredients:* 1 glass of strong brewed coffee, 2–3 glasses of chilled boiled or sparkling water, 1 shot of rum or cognac, 3–4 teaspoons of sugar, ice, and 1 lemon.
- Cooled, filtered coffee is blended with water, an alcoholic spirit, sugar, and a minimal quantity of ice. The drink is served chilled in tall glasses and garnished with lemon slices, accompanied by straws for consumption.
- **Chocolate Drink**
- *Ingredients: 50 g chocolate (½ bar), 2 glasses of water, 2 tablespoons sugar, 2 servings (shots) of cognac, ½ pinch of vanilla, juice from ½ lemon, ice cubes*.

- Chocolate is dissolved in warm water, then cooled and mixed with the remaining ingredients. Served over ice in tall glasses with a straw.
- **Blackcurrant Fizz**
- *Ingredients:* 1 glass of blackcurrant wine, ½ glass of champagne, sparkling water, ice cubes.
- The wine is poured into glasses, followed by ice, champagne, and sparkling water. Served with straws.
- **Orange Fizz**
- *Ingredients:* 1 glass of fresh orange juice with pulp, 1 glass of semi-dry champagne, 4 sugar cubes, several ice cubes, shredded orange zest, sparkling water.

Zest, sugar, and ice are added to each glass, followed by juice and champagne. Sparkling water is poured last. Served with straws.

- **Vermouth Cocktail**

Ingredients: 2 glasses crushed ice, 1 shot orange liqueur, 2 shots vermouth, 4 sugar cubes, ½ orange, sparkling water.

Ice and sugar are placed in tall glasses, followed by vermouth and liqueur. Orange slices are added and topped with sparkling water. Served with a spoon and straw.

- **Orange Tonic Beverage**

Ingredients: *Semi-dry white wine — 2 shots,Sugar — ½ glass,Orange — 1,*

Lemon — ½,Sparkling water — 2–3 glasses.

Peel and slice the orange, then combine it with sugar and white wine. After 3–4 hours of refrigeration, sparkling water is added. Served with lemon and orange pieces, along with a spoon and straw.

- **Mulberry Tonic Drink**

Ingredients: 2 glasses mulberries, ½ glass sugar, 2 shots white wine, 1 shot orange liqueur (30 mL), 2 glasses crushed ice, sparkling water.
Washed mulberries are sprinkled with sugar, chilled for 1 hour, then mixed with wine and liqueur. Sparkling water is added before serving in glasses filled one-third with crushed ice and berries.

- **Pineapple Compote Drink**

Ingredients: ½ can pineapple compote, 2–3 tbsp sugar, ½ lemon, 1 glass white wine, sparkling water, 1 glass crushed ice.
Pineapple chunks with syrup are mixed with sugar, lemon slices, and wine, chilled for 2–3 hours, and topped with sparkling water before serving in glasses with fruit and ice.

- **Ice Cream Punch (per portion)**

Ingredients: 1 scoop fruit ice cream, ½ shot rum, ½ shot sparkling wine, ice cube.
Served in a wide, chilled glass with the ice cube at the base, followed by the ice cream. Rum is poured over, and sparkling wine is gently added to surround the scoop. Served immediately.

- **Vanilla Sorbet**

Ingredients: 4 scoops vanilla ice cream, 2 shots cherry liqueur, ½ glass red wine.
The ingredients are blended into a smooth mixture and served in chilled dessert glasses.

- **Mulberry Beverage**

Ingredients: 500 g fresh mulberries, 1 glass sugar, 1 glass white wine.

Mulberries are pureed, combined with chilled syrup (1 glass water + sugar), and white wine is added. The mixture is served chilled in wide bowls with spoons and small glasses.

- **Mixed Fruit Beverage**

Ingredients: *Mixed fruits — 500 g,Sugar — 1 glass,White wine — 1 glass*

Grated fruits are blended with sugar syrup and a bit of lemon juice, then mixed with wine and served in pre-chilled glasses.

- **Frozen Mulberry Beverage**

Ingredients: 2 glasses mulberries, 1 glass sugar, 1 glass red wine.

Grate the fruits and combine them with sugar syrup and a small amount of lemon juice. Mix thoroughly with white wine and serve in pre-chilled glasses.

- **Wine-Infused Fruit Salad**

Ingredients: *Apple — 40 g,Pear — 30 g,Red currants — 20 g,Melon — 20 g, Grapes — 20 g,White table wine — 50 g,Powdered sugar — 20 g,Lemon juice — to taste*

All fruits are carefully peeled, cored, and diced into uniform pieces. The prepared fruits are combined with grapes and white wine, then lightly mixed to ensure even distribution of flavors. The mixture is subsequently enhanced with fresh lemon juice and powdered sugar, stirred gently, and refrigerated for approximately one hour to allow the flavors to meld before serving.

Grape-Based Low-Alcohol and Non-Alcoholic Cocktails

Cocktail preparations utilize fresh fruits, fruit compotes, natural grape juices, and syrups, frequently incorporating minimal quantities of alcohol.These beverages are characterized by their pleasant taste, natural sweetness, refreshing effect, and thirst-quenching properties. In addition to their organoleptic appeal, cocktails offer functional health benefits: they support digestion, enhance muscle strength, improve mood, supply essential micronutrients, and serve as a nourishing source of energy.

Some cocktail recipes incorporate dairy ingredients such as whole milk, kefir, cream, or cultured milk. To achieve a thicker texture, egg yolk or whipped egg white with sugar is sometimes added. In certain formulations, lemon juice, sour apples, or citric acid are used to enhance flavor complexity and acidity. Alcoholic components and ice are usually introduced at the final stage of preparation to provide cooling and preserve freshness. The use of specialized mixers is recommended for optimal consistency and integration of ingredients. Finished cocktails are typically served in glasses or tall, colored tumblers filled with ice cubes for visual appeal and thermal effect.

Many cocktail types bear international names that reflect their origins or style. For instance:

Cobbler – a fruit-based beverage containing fresh fruit pieces and fruit juices.

Flip – a creamy cocktail made from fresh whole eggs or yolks, sugar, an alcoholic base, and additional components.

Depending on the fruits used, cocktails provide various essential vitamins and minerals. The inclusion of milk and dairy products further enhances their nutritional profile.

The moderate inclusion of alcohol in cocktail formulations is considered relatively harmless, particularly when compared to the consumption of strong alcoholic beverages in pure form, which may pose significant health risks.

While there exists a wide variety of cocktails globally, this manual focuses specifically on a selected group of cocktails and other drinks prepared from grapes and their derivatives, especially those containing sweeteners or mild alcoholic components.

Alcoholic Cocktails Made with Grape-Based Products

Historical evidence suggests that cocktails have been known for over two centuries. Contemporary beverage classification frameworks categorize cocktails into multiple types, encompassing fruit-based, vegetable-based, dairy-based, mixed, alcoholic, and non-alcoholic formulations.Alcoholic cocktails are typically prepared according to the conventional formula: **A + 2B + 7C**, where:

- **A** denotes a sweet component (e.g., liqueurs, fruit syrups, *shinnis* [grape syrup]);
- **B** represents a sour component, most commonly lemon or other citrus juice;
- **C** is the alcoholic base, which includes spirits such as vodka, brandy, gin, or rum.

Apparatus and Tools

The preparation of cocktails necessitates the use of specialized equipment, including:

- **A shaker**—a metal vessel with a secure lid—employed for thorough and vigorous blending of ingredients**;**
- A **mixer**, an electromechanical device for rapid homogenization of liquids;
- **Juicers**, **measuring glasses**, **strainers**, **graters**, **bar spoons** with elongated handles, **ice tongs**, and a variety of serving vessels including thick-walled glasses, goblets, tumblers, and candy bowls for serving ice.

Technological Process

A key step in cocktail preparation is **pre-chilling**: 2–3 ice cubes are placed into the shaker, which is then closed and shaken. Once the resulting meltwater is discarded, the remaining ingredients are added, followed by intensive shaking for 20 to 60 seconds. **Carbonated ingredients** (e.g., soda water) are never added to the shaker and are instead incorporated directly into the prepared drink once poured into the serving glass.

Preparation of Sugar Syrups

A basic sugar syrup is prepared by boiling **four parts sugar to three parts water** for 10–15 minutes. The longer the boiling time, the thicker the resulting syrup. For instance, 1 kg of sugar with ¾ liter of water yields approximately 1 liter of syrup. Properly stored in a sealed container in a dark place, the syrup remains stable for extended periods.

To create **flavored syrups**:

- **Vanilla syrup**: Add four pieces of vanilla pod and a small amount of vanillin to the syrup base brought to a boil.
- **Cocoa syrup**: Add 150 g of cocoa powder to 1 liter of base syrup and boil for 15 minutes.
- **Coffee syrup** is prepared similarly.
- **Rose syrup**: Add 30–40 g of powdered rose petals to the base syrup. Various fruit or spice extracts may also be introduced to produce customized aromatic blends.

Cocktails are typically served **with drinking straws**, and their presentation may be enhanced with **decorative umbrellas**, **fruit slices**, and **citrus wedges** (lemon, orange, kiwi) placed on the rim of the glass.

Nutritional Considerations

Due to their relatively high caloric content, **frequent consumption of cocktails is not recommended for individuals following calorie-restricted diets**.

The approximate caloric values of selected alcoholic beverages are as indicated below:

- A single serving (shot) of gin, whiskey, brandy, or rum contains approximately 60 kcal.
- A standard glass of dry vermouth provides around 55 kcal.
- A standard glass of sweet vermouth contains about 70 kcal.
- A glass of dry red or white wine (12% alcohol) delivers roughly 75 kcal.
- A glass of sweet or fortified wine (12% alcohol) provides approximately 100 kcal.

• A small mug (0.3 L) of light beer (4% alcohol) contains around 100 kcal.

• A small mug (0.3 L) of strong beer (6–7% alcohol) delivers about 180 kcal.

• **Raspberry Cocktail**

Ingredients: 250 g fresh raspberries or 1 cup raspberry purée, 2–3 tablespoons sugar, 1 cup cream, ½ cup fortified red wine or ¼ cup cherry liqueur, ice.
The raspberries are thoroughly rinsed and blended with the remaining ingredients using a mixer. The beverage is served in broad glasses or tall porcelain mugs, accompanied by a straw and a spoon.

Peach Compote Beverage

Ingredients: 250 g pitted peach compote, 1 cup milk, 1 egg, 2 dessert spoons sugar, ¼ cup brandy, citric acid, crushed ice.
The egg is whisked together with sugar and subsequently combined with the peach compote, milk, citric acid, brandy, and crushed ice. The mixture is thoroughly blended and served in either tall glasses or shallow cups.

Coffee-Based Beverage

Ingredients: 1 egg, 2 tablespoons sugar, 2 cups milk, 10 g ground coffee, 2 shots brandy, ice.

Egg and sugar are combined, followed by the gradual incorporation of milk, ground coffee, and brandy. The resulting mixture is shaken with ice and served in tall or stemmed glassware.

Cherry Flip with Egg Yolk

Ingredients: 2 egg yolks, 2 tablespoons sugar, 2 shots red wine, 1 cup pitted cherries, 1 shot cherry juice, 1 cup milk, ice, sparkling water. Egg yolks are beaten with sugar and then blended with red wine, cherry juice, and pitted cherries. The drink is poured over ice into glasses and finished with sparkling water, served with a straw and spoon.

White Wine Cocktail

Ingredients: 2 cups semi-dry white wine, 3 egg yolks, 3 tablespoons sugar, 1 shot herbal liqueur, ½ cup pineapple juice, crushed ice.

Egg yolks are incorporated with sugar, then combined with white wine, herbal liqueur, pineapple juice, and crushed ice. The beverage is mixed until homogeneous and served in tall glasses with straws.

"Ratafia" Cocktail

Ingredients: 1 egg, 2 tablespoons ground almonds, 1½ cups assorted fruits (grapes, raspberries, strawberries, peaches), 1 cup white wine, 1 tablespoon lemon juice, sugar, ice.

Egg is whisked with sugar, followed by the addition of prepared fruits. The mixture is blended with white wine and lemon juice, poured over ice, and served in glasses.

Milk and Pineapple Cocktail

Ingredients: 1 cup milk, 2 pieces canned pineapple, 1 egg, 1 tablespoon lemon juice, 2 tablespoons sugar, 2 shots brandy, ½ cup ice.

Egg is mixed with sugar, after which milk, lemon juice, brandy, and pineapple juice are incorporated. The beverage is served in tall glasses, garnished with pineapple, and accompanied by a straw and spoon.

Grape and Carrot Beverage

Ingredients: 1 cup grape juice, ½ cup carrot juice, 1 tablespoon sugar, 1 tablespoon lemon juice, 2 shots white wine, ice, ½ teaspoon grated nutmeg.

Grape and carrot juices are combined with sugar and white wine. The mixture is served in glasses over ice and finished with a sprinkle of nutmeg, accompanied by a straw.

Fresh Tomato Cocktail

Ingredients: 2 large ripe tomatoes, ½ cup dry white wine, 1 small shot brandy, lemon juice, sugar to taste, ½ cup sparkling water, ice.

Tomatoes are peeled, halved, and deseeded, then puréed and mixed with lemon juice, sugar, white wine, and brandy. Sparkling water is added prior to serving over ice.

Alcoholic Hot Beverages

In addition to traditional soft and low-alcohol refreshments, the culinary tradition includes a relatively narrow category of **hot beverages** that contain small amounts of alcohol. These drinks are typically consumed during the autumn-winter season and at informal gatherings among family and friends.

The formulation of these beverages exhibits considerable variation depending on regional traditions and historical practices, frequently incorporating diverse components such as sugar, eggs, milk, honey, fresh or preserved fruits, citrus fruits (notably lemon and orange), berries (including currants, strawberries, and raspberries), lightly sweetened fruit juices (e.g., pineapple juice), and aromatic substances such as crushed rose petals, nutmeg, and vanilla. When an alcoholic element is included, it is typically provided in small culinary quantities, using red or white wine, beer, rum, liqueur, or vodka.

From a physiological standpoint, the consumption of such warm beverages can contribute to thermoregulation in cold environments, provide transient increases in energy and mood, and supply certain vitamins and trace micronutrients, thereby supporting overall nutritional status.Due to their low ethanol content and occasional use, they present a minimal risk of alcohol dependence when consumed in moderation.

Thus, this category of hot drinks may be regarded not only as part of gastronomic heritage but also as **functional seasonal products** with general restorative potential.

Selected Recipes

Hot Wine Preparations

- **Classic Hot Wine:** The beverage is prepared by gently heating one glass of red wine with three tablespoons of sugar, a small pinch of cinnamon, two to three rose petals, and one-quarter of a lemon. The mixture is simmered and immediately served in glasses, each garnished with a slice of lemon peel.
- **Hot Wine with Egg Yolk and Vanilla:** This variant involves one glass of white wine, two egg yolks, three tablespoons of sugar, a fractional amount of vanilla, and one-quarter of a lemon. A split vanilla pod is infused into the boiling wine, while the egg yolks are whipped into a foam and gradually incorporated into the hot wine. Each serving is pre-decorated with a slice of lemon peel prior to pouring.

• **Hot Wine with Egg Yolk and Syrup**

Ingredients: 1 glass white wine, 2 egg yolks, 2 tablespoons sugar, ⅓ glass syrup (e.g., mulberry, raspberry). The wine is heated to 70–80 °C. Yolks are beaten with sugar until white and foamy, then the wine is added gradually, followed by the syrup. The mixture is stirred and served hot.

• **Punch:** Prepared by combining two cups of strong tea with half a cup of water, three to four rose petals, a pinch of cinnamon, one to two bottles of red wine, a large shot of rum, five to six tablespoons of sugar, and the juice of one lemon. The mixture is sweetened, infused with citrus slices (lemon or orange), and served in a large bowl using a ladle.

• **Boiling Grog:** Consists of two cups of strong tea, half a cup of rum or brandy, lemon peel, one tablespoon of sugar, and half a lemon. Chilled tea is poured into glasses with lemon peel and juice, filling them two-thirds full. Alcohol is then added, and the mixture is gently boiled in porcelain ware before serving immediately.

• **Egg-Chocolate Liqueur:** Composed of five egg yolks, one whole egg, one cup of milk, 50 g of chocolate, 150 g sugar, and one cup of brandy. Egg yolks, whole egg, and sugar are whisked over a hot water bath until smooth. Hot milk combined with melted chocolate is gradually incorporated, followed by slow addition of brandy while continuously stirring. The final mixture is thickened and served hot in small glasses or cups.

CHAPTER IV
Grape Wine and Its Characteristics

Alcohol consumption and human health

Academician of the Russian Academy of Medical Sciences, Professor Alexander Bronstein, head of the multidisciplinary clinic CELT, adopts a critical stance toward the consumption of artificially produced alcoholic beverages. In his expert opinion, such products should be regarded as toxic compounds with cumulative effects, which exert adverse impacts on human health. He strongly emphasizes the need for strict consumption limitations, recommending that such beverages be consumed no more frequently than once every 4–5 days, even during festive occasions, with mandatory intervals of at least 2–3 days between uses.

At the same time, Professor Bronstein makes an exception for natural dry red wines, which, according to his clinical experience, may exert beneficial effects on the body. Referring to his personal regimen, he notes that over the past 15–20 years, he has regularly consumed one to two glasses (100–150 mL) of red wine daily following dinner. Importantly, he does not limit himself to elite wines but permits both locally produced and imported varieties, including affordable options, provided they are natural, dry, red, and free from additives.

Professor Bronstein places particular emphasis on the growing issue of adolescent alcohol use, identifying it as one of the most pressing medico-social threats of the contemporary era. He highlights the dramatic decrease in the age of initial alcohol exposure: while initiation previously began around the age of 16, current trends indicate alcohol use starting as early as 11–12 years old. Early and systematic consumption of alcoholic beverages, he warns, leads to severe and often irreversible organic damage, including cortical brain atrophy, cognitive decline, and pathologies of the liver and pancreas. These outcomes often result in permanent disability and premature death, with fatal cases reported as early as 25–30 years of age.

Professor Bronstein concludes that the prevention of adolescent alcoholism requires immediate and multifaceted intervention at the levels of government policy, civil society, and educational systems.

Enotherapy

As early as the 19th century, Louis Pasteur described wine as one of the most effective hygienic and therapeutic beverages. Modern data on the chemical composition and physiological-biological properties of grape wine confirm its potential value in preventive and restorative medicine. The use of wine for medicinal purposes is known as **oenotherapy** (from the Greek *οἶνος* — wine, and *θεραπεία* — treatment). Oenotherapy or Enotherapy is a method of treatment involving wine-based preparations, primarily red wine, as well as other products derived from grapes. This ancient practice is widely applied in alternative medicine and cosmetology.

In the present study, the microelement composition of one wine product produced in the Samarkand region was examined. The elemental composition was determined through neutron activation analysis performed in a dedicated laboratory at the Institute of Nuclear Physics, Academy of Sciences of the Republic of Uzbekistan (Table 9).

A comparison of individual microelement concentrations in grapes and the wine produced from them revealed significant differences (Table 7). The wine sample exhibited diminished concentrations of chlorine, copper, and mercury, alongside significantly reduced levels of calcium and potassium, which were more than 40-fold lower than reference values. In contrast, levels of elements such as sodium, gold, bromine, chromium, scandium, rubidium, cobalt, antimony, and lanthanum were found to be considerably higher in the wine compared to the raw grape material.

Of particular interest are the concentrations of manganese, zinc, and iron. In wine, these elements were present in amounts several times greater than those found in fresh grapes: iron reached 4920 mg/L compared to 18–110 mg/L in grapes; zinc — 76.4 mg/L (vs. 0.8–2 mg/L); manganese — 125.7 mg/L (vs. 5.4–5.9 mg/L). These findings indicate a high enrichment of grape wine with biologically significant microelements involved in hematopoiesis.

Consequently, grape wine demonstrates a notable microelement composition and can be suggested as a complementary dietary source for elderly individuals and for the management of various types of iron-deficiency anemia. Its high copper content may benefit individuals with copper deficiency, while its zinc content supports its use in managing conditions associated with hypozincemia.

The data obtained provide grounds for considering grape wine as a functional beverage with therapeutic properties, suitable for use in both traditional and scientific medicine for the prevention and treatment of a range of pathological conditions.

Table No. 9

Concentration Levels of Trace Elements in Wine Products (mg/L)

Element	**Dry table wine**	**Element**	**Dry Table Wine**
Cl	145,3	□ **Cl** (Chlorine)	150-160
Cu	3,34	□ **Cu** (Copper)	7
Mn	125,7	□ **Mn** (Manganese)	5,4-5,9
Na	146,4	□ **Na** (Sodium)	72-120
Ca	17,6	□ **Ca** (Calcium)	677-1286
Au	0,056	□ **Au** (Gold)	0,0015-0,23
Br	9,6	□ **Br** (Bromine)	0,41-0,42
Cr	10,5	□ **Hg** (Mercury)	0,01
Hg	<0,1	□ **Cr** (Chromium)	0,1-0,46
Rb	33,7	□ **Rb** (Rubidium)	2,1-6
Fe	4920	□ **Fe** (Iron)	18-110
Zn	76,4	□ **Zn** (Zinc)	0,8-2
Co	0,92	□ **Co** (Cobalt)	0,01-0,058
Sb	0,9	□ **Sb** (Antimony)	0,026-0,089
La	1,2	□ **La** (Lanthanum)	0,01
K	240,8	□ **K** (Potassium)	6637-10310
Nickel	<100	□ **Ni** (Nickel)	

Based on the findings of V.I. Nilov et al. (1967), the microelement composition of grape wines exhibits variability depending on the type of wine and the production methods employed. For instance, fluoride and iodine concentrations in table wines typically range from 0.10 to 0.20 mg/L, whereas semi-dry wines may contain 0.40–0.60 mg/L. Rubidium levels in wines generally average 0.30 mg/L, with white wine varieties showing a mean concentration of 1.15 mg/L, spanning from 0.22 to 1.0 mg/L. The molybdenum concentration spans a broad interval of 1.5 to 40 µg/L. Notably, lead, a toxicologically significant element, is present at concentrations between 0.1 and 0.25 mg/L, highlighting the importance of monitoring potentially hazardous trace metals in enological products.

Medicinal Properties of Wine

The medicinal use of grape wine has deep historical roots. Since antiquity, its therapeutic properties have been recognized by leading physicians and scholars, including Hippocrates, Avicenna (Ibn Sina), Galen, Paracelsus, I.P. Pavlov, and others. Hippocrates emphasized that, when consumed rationally, wine could be beneficial for both healthy and ill individuals. He utilized wine as an antiseptic, diuretic, and sedative, as well as a solvent for medicinal compounds.

The renowned French microbiologist Louis Pasteur also praised the physiological value of wine, describing it as one of the safest and most beneficial beverages. According to Pasteur, grape wine possesses high dietary value, is easily digestible, and has a positive effect on the body's physiological processes.

Since antiquity, particularly in ancient Greece, wine has been extensively utilized in medical applications, serving both as a topical antiseptic for wound care and as an internal therapeutic agent for various injuries. During the Middle Ages in Europe, wine therapy (oenotherapy) became widespread, with wine being regarded as a "divine drink" endowed with sacred properties.

Contemporary perspectives affirm that, due to its chemical, biological, and organoleptic characteristics, wine aligns well with human physiological needs. It exerts a tonic and bioenergetic effect, aids recovery from physical and psycho-emotional fatigue—especially in the elderly—and contributes to overall well-being and mood enhancement.

In folk medicine, it was said: "Wine is milk for the elderly," highlighting its nutritional and biologically active value. Natural grape wine is a source of microelements, vitamins, and amino acids and demonstrates anti-atherogenic effects, reducing the risk of atherosclerosis.

Of particular interest is the natural polyphenol present in wine—trihydroxystilbene (notably, resveratrol)—which exhibits antioxidant properties, slows aging processes, and may prevent carcinogenesis.

In addition to their well-known organoleptic qualities, wines exhibit a pronounced antibacterial effect. Epidemiological data indicate that in regions with a tradition of regular wine consumption, the incidence of infectious diseases is significantly lower compared to areas where wine is not consumed. Results from several studies show that grape wine possesses antimicrobial activity, inhibiting the growth of pathogens such as those causing tuberculosis, cholera, malaria, and other infectious diseases.

These properties remain even when wine is diluted with water in a 1:1 ratio. In light of this, during outbreaks of infectious diseases, especially in endemic regions, specialists recommend the use of diluted wine as a disinfected alternative beverage. Additionally, dry white wines are known for their refreshing properties and ability to quench thirst.

Natural wines are used in the treatment of respiratory infections, including acute viral diseases, bronchitis, and pneumonia. In such cases, mulled wine—heated red wine with spices and sugar—is recommended for its warming and anti-inflammatory effects.

Health Benefits of Red Wine:

Anticancer properties...

Prevention of age-related memory loss...

Cardiovascular disease prevention...

Anti-inflammatory and blood-thinning effects...

Red wines, particularly those high in tannins such as Cabernet Sauvignon and Cabernet, are associated with potential health benefits, including the prevention of dementia and Alzheimer’s disease, slowing of the aging process, and reduction of diabetes risk. Additionally, these tannin-rich wines are regarded as beneficial in managing functional gastrointestinal disorders and ulcerative-erosive lesions of the gastric mucosa.

These compounds stimulate gastric secretory activity and promote the repair of damaged tissues.

Grape wine has also been shown to have a positive effect on obesity and metabolic disorders. It promotes the elimination of metabolic byproducts, normalizes lipid metabolism, and lowers cholesterol levels. This cholesterol-lowering effect has been confirmed in experimental models, including studies on laboratory animals (e.g., rabbits), and in population studies, showing lower cholesterol levels among individuals who regularly consume moderate amounts of wine.

Furthermore, scientific literature notes the radioprotective effects of grape wine. In the former USSR, individuals working in radiation risk zones (e.g., on nuclear submarines) were advised to consume controlled amounts of red wine (Cahors) to reduce the harmful effects of ionizing radiation.

Clinical observations suggest that in diabetes mellitus, limited consumption of dry wines with minimal sugar and glucose content (less than 4 g/L) is permissible.

White wines, especially sparkling varieties (e.g., champagne), are believed to positively affect the cardiovascular system. Semi-dry white wine helps improve vascular wall elasticity, reduces the risk of thrombosis and myocardial infarction, stimulates the respiratory center, and increases lung ventilation capacity.

Potential Therapeutic Value of Red Grape Wine: Literature Review and Expert Opinion

Red table wine is traditionally viewed as beneficial in iron-deficiency anemia due to its content of iron, organic acids, and biologically active compounds that aid micronutrient absorption. Both red and white semi-dry wines, having mild diuretic effects, may assist in eliminating excess salts from the body, making them suitable for metabolic disorders involving salt deposition in joints (e.g., gout and salt-induced arthropathies).

Research shows that daily consumption of 100–200 ml of dry or table wine reduces the risk of stroke and pre-stroke conditions by 70%. It is the dosage that determines whether wine is harmful or beneficial.

Rational consumption of dry red wine—specifically 200 ml after the evening meal—is considered by many experts to be the optimal method of inclusion in a dietary regimen. Wine consumed in moderation after meals aids digestion, stimulates digestive enzyme secretion, and optimizes metabolic processes.

In cases of hypovitaminosis, general fatigue, and asthenic conditions, fortified wine beverages such as port wine are recommended. Port and vermouth, due to their bitter herbs and alcoholic extracts, may serve as aperitifs that stimulate appetite. Effective doses include 50 ml of vermouth or 100–150 ml of port wine 20–30 minutes before meals. However, excessive consumption of fortified wines, especially those rich in extractive substances, is not recommended due to potential gastrointestinal side effects.

Epidemiological data confirm that regular moderate consumption of red wine is associated with a lower prevalence of cardiovascular diseases (such as atherosclerosis, myocardial infarction, and stroke), especially in Mediterranean countries (France, Italy, Spain, Portugal), in contrast to regions where strong spirits or beer are predominantly consumed.

Historical records indicate that in Ancient Crimea, red wine was used to disinfect water during cholera outbreaks due to its potent antiseptic properties—particularly its ability to inhibit the activity of cholera vibrio, Escherichia coli, and typhoid pathogens. Modern studies also support the potential of wine in cancer prevention, in part due to its content of resveratrol, which exhibits antioxidant and cytoprotective activity.

Nutritional and Biochemical Value of Red Wine

When consumed moderately and rationally, red wine can be considered a geroprotective agent that promotes normalization of sleep, metabolism, and emotional well-being in elderly individuals. The French saying "wine is milk for the elderly" reflects its nutritional and preventive value in this context.

The chemical composition of red wine includes all essential amino acids and a range of micro- and macroelements that play key roles in metabolic processes, cellular defense, and tissue growth and regeneration.

These include:

- **Magnesium, zinc, and iron** – essential for enzymatic and antioxidant systems.
- **Chromium** – regulates lipid metabolism and carbohydrate homeostasis.
- **Rubidium** – aids in the elimination of radionuclides.

Approximate chemical composition of 150 ml of red wine:

- **Proteins:** 0.11 g
- **Fats:** 0 g
- **Water:** 127.7 g
- **Ethanol:** 15.9 g
- **Sugar (in sweet wine):** 0.3 g
- **Potassium:** 190 mg
- **Sodium:** 6 mg
- **Calcium:** 12 mg
- **Magnesium:** 18 mg
- **Iron:** 0.69 mg
- **Selenium:** 0.3 µg
- **Copper:** 0.017 mg
- **Zinc:** 0.21 mg

Thus, red wine, as a source of biologically active compounds, can be used as an adjunctive agent in preventive medicine and spa therapy, provided that the dosage is strictly observed.

Potassium (K): Potassium content in wine (calculated as K_2O) typically ranges from 0.45 to 1.35 g/L. This concentration tends to decrease during wine storage. Dessert wines generally exhibit higher potassium levels.

Sodium (Na): The average sodium concentration in wine, expressed as Na_2O, ranges from 0.02 to 0.15 g/L. In exceptional cases, particularly when grapes are grown in saline soils, sodium levels may reach up to 2 g/L.

Calcium (Ca): Calcium content, expressed as CaO, typically varies between 0.3 and 0.5 g/L. These values are influenced by both the grape cultivation conditions and the technological processes used during winemaking.

Iron (Fe): According to M. Vitaliano (1967), iron content is influenced by grape processing, pressing, and fermentation methods. Laboratory conditions show 9 mg/L of iron in grape pomace, while industrial processing yields 11–12 mg/L. After pressing into barrels, iron can range from 2 to 18 mg/L, and during fermentation in concrete tanks, it can increase significantly to 22–114 mg/L.

Copper (Cu): Grapes contain 1.4–2.2 mg/L of copper, which reduces to 1–1.36 mg/L in grape pomace, and ranges from 0.13 to 2.5 mg/L in wine. Increased copper levels in wine are often associated with technological processes involving copper vessels, pipes, and taps.

Zinc (Zn): Zinc content in Czech wines ranges from 0.2 to 0.8 mg/L. German wines can contain up to 5.27 mg/L, while Italian wines show a range from 0.45 to 5.6 mg/L.

Lead (Pb): In Australian wines, lead content fluctuates from 0.04 to 0.86 mg/L, with an average of 0.23 mg/L. White wine (0.21 mg/L) generally contains less lead than red wine (0.15 mg/L). Lead content has been observed to decrease by 29–67% during fermentation.

Magnesium (Mg): Magnesium levels in wine can reach up to 0.51 mg/L.

Manganese (Mn): The manganese content in wine is relatively low, approximately 3 mg/L, but can be as high as 7 mg/L in hybrid wines. Molybdenum was also identified in high-quality wines (V.I. Nilov, 1967).

The healing properties of wine are associated with the presence of biologically active substances in its composition—flavonoids, quercetin, resveratrol, as well as polyphenols and tannins. Polyphenols not only halt destructive processes but also promote the elimination of free radicals from human cells, thereby rejuvenating all organs and tissues of the body.

The Impact of Wine on the Human Body: Contemporary Scientific Approaches

Despite containing various nutrients with biological value, wine isn't classified as a complete food product. While it can stimulate appetite and enhance the palatability of food, it doesn't fall into the category of flavoring additives and cannot replace a balanced diet. The physiological impact of wine on the human body is highly complex, involving multiple mechanisms that remain insufficiently explored within scientific discourse.

Nevertheless, from a medical and public health perspective, certain psychotropic properties of wine are evident. Consequently, its consumption extends beyond purely gastronomic practice, acquiring socio-economic and governmental significance. Wine abuse can lead to impaired physical and mental health, increased risk of injury, reduced work capacity, and other adverse outcomes.

In this context, conducting rigorous, evidence-based research on the physiological effects of wine is of critical importance, as is the formulation of rational guidelines for its consumption. The dissemination of accurate, scientifically validated information should promote responsible and informed wine consumption, highlighting its potential health benefits while supporting public health and individual well-being.

The positive effects of wine are largely attributable to the presence of bioactive components: ethanol, methanol, higher alcohols, organic acids, mineral compounds, vitamins, polyphenols, and compounds with antimicrobial activity. Together, these ensure a complex physiological action, which can manifest depending on the dosage, form, and frequency of consumption.

In the scope of this work, the primary focus is on the role of minerals and trace elements in wine within the body's metabolic and regulatory processes. The recommendations presented are based on contemporary scientific research and assessments from experts in medicine, biochemistry, and dietetics. The author would be grateful for any constructive comments and suggestions from the professional community interested in this subject.

Scientific Research and Expert Opinions on the Biological Activity of Grape Wine

The Historical and Therapeutic Significance of Wine

Grape wine, known as le Vin (French), der Wein (German), and wine (English), is among the most ancient beverages, accompanying humanity throughout its history. In a historical and cultural context, Egyptian mythology considered it a divine gift from the sun deity, intended to protect humans from the wrath of higher powers. Louis Pasteur's legendary statement, "Wine is the most healthful and hygienic of beverages," is now finding scientific validation. A number of contemporary studies, including those conducted by British and Danish scientists, indicate a beneficial effect of controlled wine consumption on antioxidant activity, blood lipid profiles, and overall cardiovascular health. For instance, daily consumption of 300 ml for men and 150 ml for women is associated with a reduced risk of atherosclerosis and extended lifespan, provided the wine is of high quality.

Varied Pharmacological Activities of Wine Types

According to N. Prostoserdov's observations, different types of wines exhibit distinct pharmacological activities:

- **White wines** offer a moderate diuretic and tonic effect.
- **Red wines** possess nutritive and restorative properties.
- **Fortified wines** boost the body's energy potential.
- **Sweet wines** are characterized by high caloric content.
- **Sparkling wines** contribute to improved pulmonary ventilation.

In therapeutic practice, wine is used as an auxiliary agent with appetite-stimulating, choleretic, vasodilatory, secretagogue, and antitoxic effects. Moderate wine consumption helps increase high-density lipoprotein (HDL) concentrations and lower low-density lipoprotein (LDL) levels. It also reduces vascular spasms, particularly under stressful conditions.

Wine components, especially those found in red varieties, include phenolic compounds with potent antioxidant activity. Modern biomedical research suggests these compounds can reduce the risk of cardiovascular and oncological diseases. While white wine contains fewer phenolic compounds, it exhibits stronger antiseptic properties, effective in eradicating pathogenic microflora in the gastrointestinal tract.

Experimental data confirm that certain bioactive substances in wine are potentially effective in treating gastric ulcers, neurodegenerative diseases (including Alzheimer's disease), cataracts, and other pathological conditions. Plato's famous assertion that "wine is the milk of the aged" is now supported by clinical observations, indicating that small amounts of wine have a sedative effect, normalize sleep, and reduce anxiety.

Recommendations for Potential Prophylactic Effects

To achieve potential prophylactic benefits, the following conditions are recommended:

1. Consume no more than 1–2 glasses of dry wine per day.
2. Drink wine only during meals.
3. Maintain regular consumption, avoiding episodic excesses.

Cardiologists and dietitians emphasize that **moderation and regularity** are the determining factors for the effectiveness of wine-based prophylaxis.

The well-known “French paradox” exemplifies this phenomenon: although the French diet is relatively high in saturated fats, the prevalence of cardiovascular disease remains considerably lower than in other nations with comparable dietary patterns. This effect is partly linked to the habitual intake of red wine, which contains natural antioxidants that inhibit lipid peroxidation and reduce the development of atherosclerotic plaques.

Important Considerations and Contraindications

Nevertheless, the medical community acknowledges not only the positive but also the potentially negative consequences of wine consumption. French nutritionist Michel Montignac, in his work "The Amazing Properties of Wine," emphasizes the permissible daily dose: **no more than 500 ml of wine per day**. Exceeding this limit can lead to alcohol dependence and the development of associated diseases.

The physiological effect of wine is due to the combined action of alcohol, phenolic compounds, and other micro-components. However, the **dosage remains the crucial factor** determining whether the beverage is beneficial or harmful. This idea, first articulated by Paracelsus in the aphorism, "All things are poison, and nothing is without poison; only the dose makes a thing not a poison," remains relevant concerning wine products.

It is important to remember that wine consumption is **contraindicated in certain conditions**, including liver cirrhosis, nephritis, gallstone disease, and peptic ulcers.

The Role of Grape Wine as an Adjunct in the Therapy and Prevention of Diseases

1. Wine as a Complex Bioactive Product

Grape wine constitutes a multicomponent bioactive system, encompassing a wide array of essential substances. These include structural components, vitamins, amino acids, and biostimulants, all of which are instrumental in regulating metabolic and physiological processes within the body.

2. Energetic and Bioenergetic Value

Wine serves as a significant source of both caloric energy and enzymatic/trace element support for metabolism. One liter of dry wine can provide up to 700 kcal, while port wine can offer up to 1500 kcal. Furthermore, the beverage contains active cofactors crucial for biochemical reactions.

3. Antimicrobial and Antiviral Activity

Wine demonstrates pronounced bacteriostatic, bactericidal, and antiviral properties against various pathogenic microorganisms, including agents causing cholera, typhoid fever, and malaria. These effects arise from the synergy of ethanol, phytoncides, organic acids, salts, colloids, and other bioactive compounds.

4. Antitoxic (Antidote) Function

Due to its chemical composition, wine can partially neutralize a range of toxic substances, such as alkaloids (e.g., strychnine), hydrocyanic acid, and even animal venoms (e.g., snake venom), suggesting its potential as a natural antidote in certain situations.

5. Impact on the Central Nervous System

Depending on the dose and variety, wine can exert either a stimulating or a sedative effect. It is employed as an analgesic and anxiolytic, contributing to the alleviation of stress and traumatic shock.

6. Role in Addiction Management

In several clinical observations, grape wine has shown properties capable of modulating the reactivity of neural receptors, making it potentially beneficial within the comprehensive therapy of patients with substance use disorders.

7. Activation of the Sympathoadrenal System

Wine consumption leads to the stimulation of the sympathoadrenal system, accompanied by enhanced secretion from endocrine glands, as well as activation of salivary and gastric glands.

8. Gastrointestinal and Hepatorenal Effects

Wine contributes to the normalization of gastric acidity, activates intestinal motor-secretory function, and exhibits choleretic and moderately pronounced diuretic effects.

9. Stimulation of Protein Synthesis

According to G. Arkeptin, wine facilitates the activation of protein synthesis processes, which is particularly valuable in gerontological practice. This underlies the aphoristic expression: "wine is the milk of the aged." Concurrently, its hypocholesterolemic action is noted.

10. Regulation of Acid-Base Balance

The organic acids in wine are transformed into carbonates, which contribute to the alkalization of the body's internal environment. Given that wine's acidity (pH 2.7–3.2) is close to that of gastric juice, it may be intentionally used to modulate the latter's composition.

11. Hydro-Electrolyte Balance

The mineral salt content in wine (1.5–2.5 g/L) approximates their concentration in blood plasma, suggesting its potential as a remineralizing agent in cases of dehydration (e.g., hot climates, intense physical exertion, work in high-temperature environments).

12. Antioxidant and Radioprotective Action

Thanks to its natural antioxidants, wine demonstrates promise as an auxiliary agent during radiation exposure, as well as in the prevention of premature aging and oncogenesis.

13. Polyphenols and Cardioprotective Action

The polyphenol content in wine contributes to a reduction in total cholesterol levels, improves blood rheology, activates platelet function, and lowers the risk of thrombus formation. These effects are famously associated with the "French Paradox," characterizing the low prevalence of heart attacks and strokes in regions with regular red wine consumption.

14. Technological Prospects

Modern technologies enable the controlled modification of wine composition to create therapeutic beverages, pharmaceutical preparations, dietary supplements, and cosmetic products. In several countries (e.g., France), a specialized industry focused on the health-promoting application of grape products has developed.

15. Pharmacopoeial Recognition

Considering the accumulated scientific and clinical data, it seems advisable to initiate discussions regarding the potential inclusion of specific types of wines in official pharmacopoeias, such as that of Ukraine.

16. General Physiological Influence

Wine positively affects metabolism, microcirculation, myocardial contractility, and resistance to infections. It normalizes blood pressure, activates the excretory functions of the liver and kidneys, and aids in the elimination of metabolites and toxic substances.

Prevention of Oncological Diseases through the Use of Red Wine

Cancer remains the second leading cause of mortality globally, trailing only cardiovascular disease. Statistical data consistently show a rising incidence of malignant neoplasms worldwide, attributed to adverse environmental conditions, exposure to synthetic compounds in cosmetics, and dietary and lifestyle factors.

While complete protection from cancer is impossible and its onset is often random and multifactorial, contemporary research suggests a potential for reducing cancer risks through the consumption of foods rich in natural antioxidants—notably, red wine. Red wine is a biologically active beverage containing over 200 compounds, with polyphenolic compounds making up over 70% of its non-alcoholic fraction. Among the most studied are resveratrol, quercetin, and catechins—potent antioxidants capable of exerting protective effects not only on cellular structures but also on molecular mechanisms linked to carcinogenesis.

Polyphenols are predominantly located in the skins and seeds of grapes, from where they migrate into the wine during fermentation. The polyphenol content in red wine can reach up to 3 g/L, accounting for its significant biological activity.

According to data published in the FASEB Journal (November 2009), polyphenols inhibit angiogenesis—the process of new blood vessel formation essential for tumor growth and development. A lack of vascularization deprives tumor cells of the conditions necessary for nourishment and proliferation, thereby hindering their growth.

Laboratory and preclinical studies conducted by scientists at the University of Illinois (USA) demonstrated that resveratrol exhibits significant anti-tumor activity. For instance, when applied to tumor cell lines, resveratrol's effectiveness was observed at 43–47% for breast cancer, 37–48% for liver cancer, and 34–41% for stomach cancer. These findings highlight the potential of polyphenols as auxiliary agents in cancer prevention and possibly in the therapy of malignant neoplasms.

The consumption of red wine holds particular relevance for preventing lung cancer in individuals with nicotine dependence. However, there is no consensus in the scientific community regarding the optimal dose of red wine for achieving an oncoprotective effect. Some authors suggest that 1–2 glasses per day are sufficient, while others allow for up to one bottle (≈750 ml) daily. Nevertheless, excessive wine consumption, even of natural wine, carries the risk of developing alcohol dependence and other metabolic disorders, necessitating a strict risk-benefit assessment.

A promising direction involves the development of pharmaceutical formulations enriched with polyphenols, particularly resveratrol, to create non-alcoholic drugs with anti-tumor activity. Until such agents are integrated into clinical practice, moderate and regular consumption of high-quality red wine can be considered one element within a comprehensive cancer prevention strategy.

The paradoxically low cancer incidence rates in countries with a strong wine-drinking culture (e.g., France) are a subject of ongoing scientific research, aimed at identifying protective factors associated with traditional diets and lifestyles.

Alcoholic Beverages in Traditional Medicine: History and Practical Applications

Traditional folk medicine suggests that an pathological craving for alcoholic beverages might stem from a potassium deficiency within the body. Proponents of this hypothesis believe that the urge for alcohol reflects a compensatory attempt to replenish deficient macroelements involved in regulating metabolic processes, primarily potassium. Potassium, a crucial intracellular cation, plays a key role in maintaining water-salt and acid-base balance.

The American physician and naturopath D.C. Jarvis sought to experimentally validate this hypothesis. In his study, he performed a basic chemical experiment by combining different alcoholic beverages with mineral water and assessing the reaction of each mixture using litmus paper.

The results of these observations led Jarvis to hypothesize that alcohol, being an acid-forming agent by nature, might alter the body's acid-base balance. Based on these observations, Jarvis proposed a possible link between alcohol consumption and a disturbance in electrolyte metabolism, specifically potassium deficiency.

While Jarvis's data require further verification and lack sufficient evidence for definitive clinical conclusions, his approach is interesting as an attempt to provide a biochemical explanation for behavioral phenomena characteristic of alcohol dependence. In this context, further study of the influence of electrolyte balance, especially potassium content, on the pathogenesis of addictive behavior appears warranted.

Beverage	Measured pH	Acid–Base Character
Whiskey	6.0	Slightly acidic
Rum	5.5	Acidic
Vichy (mineral water)	7.0	Neutral to mildly alkaline
Beer	4.5	Strongly acidic
Gazli (mineral water)	5.5	Acidic
Sherry	4.5	Strongly acidic
Port wine	4.5	Strongly acidic
Vermouth	4.5	Strongly acidic
Crème de menthe (liqueur)	6.0	Slightly acidic
Gin	6.0	Slightly acidic

From a physiological perspective, humans possess an innate predisposition toward the consumption of acid-forming foods, which is attributed to the essential role of acids in regulating metabolic processes, including digestion. Within this framework, the tendency to seek beverages with pronounced acidity following physical or mental exertion can be considered a compensatory mechanism aimed at restoring acid-base balance.

For example, individuals performing intense physical labor frequently develop a natural inclination toward beer, which is characterized by a pH value close to 4.5. In contrast, persons engaged primarily in intellectual activity are more likely to prefer light, low-alcohol cocktails consumed prior to meals. Such consumption habits may represent adaptive, instinct-driven mechanisms aimed at restoring imbalances in acid–base homeostasis.

Within the spectrum of alcoholic beverages, wine and beer are distinguished by their particularly strong acidogenic effects.Of particular physiological significance is tartaric acid, present in grape wine, which enhances the activity of pepsin—the principal enzyme of gastric juice. This facilitates protein digestion, stimulates appetite, and promotes the normalization of both motor and secretory functions of the gastrointestinal tract.

From a therapeutic standpoint, rape wine, when consumed in carefully individualized doses, can serve as an effective means of stimulating gastric secretion, enhancing appetite, and alleviating psychoemotional disturbances linked to physical or mental exhaustion.

Similarly, the widespread consumption of low-pH beverages such as tea and coffee, both of which have an approximate pH of 4.5, may be viewed as a physiological mechanism aimed at sustaining acid–base balance through the intake of acidogenic agents.

Traditional medical practices often recommend tea in the management of various pathological conditions, which further reflects the long-standing recognition of the supportive role that acidic beverages play in maintaining physiological equilibrium.

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