The Potential of Vitamin D in Tuberculosis Pharmacotherapy: Retrospective, Marketing Review, and Application Prospects

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Abstract. This article thoroughly explores the importance of ergocalciferol, also known as vitamin D, in promoting overall human health, with particular emphasis on its role in supporting tuberculosis treatment. Vitamin D is recognized for performing a variety of critical functions: it is fundamental for maintaining strong bones, bolstering the immune system, and contributing to a healthy cardiovascular system. Based on the analysis presented, incorporating additional vitamin D into a multifaceted treatment regimen for tuberculosis may result in improved patient outcomes and enhanced quality of life. In addition to discussing vitamin D's health benefits, the article provides a detailed examination of the market for specialized foods fortified with vitamin D. This market overview encompasses an array of dosage forms, including capsules, tablets, and other supplemental formats. Key manufacturing countries identified include the United States, Poland, and Germany, reflecting the global nature of the vitamin D supply chain. Among the most prominent manufacturers is Solgar, whose substantial market share highlights the wide range of product options available to consumers. This variety ensures that individuals requiring vitamin D can select from an assortment of brands and formulations to suit their specific needs. Moreover, the article underscores the critical importance of adhering to established quality standards. By demonstrating compliance with these guidelines, manufacturers help build consumer trust and reinforce the reliability of vitamin D products in the marketplace. This commitment to quality ultimately benefits patients, enabling them to confidently incorporate vitamin D supplements into their healthcare routines.

Keywords: vitamin D, tuberculosis, medicines, special food products, dosage forms, manufacturers, availability, quality of medicines.

Introduction. Tuberculosis remains one of the most serious global health threats. The annual incidence of tuberculosis in the world reaches more than 10 million new cases, which indicates the high prevalence and complexity of controlling this infectious disease. Despite long-term efforts to create effective anti-tuberculosis drugs, the problem of resistance to treatment, especially in conditions of deteriorating socio-economic conditions and the spread of multidrug-resistant strains of the pathogen, remains unresolved [1, 2].

One of the promising areas in the fight against tuberculosis is the use of adjuvant therapeutic agents that can support the body's immune system and increase the effectiveness of basic treatment. Among such agents, vitamin D (ergocalciferol) has recently been actively studied. The role of vitamin D in the functioning of the immune system is receiving increasing attention from the scientific community. Its importance as a prophylactic agent against various infectious diseases, including tuberculosis, is attracting increasing attention due to new data on the impact on the body's protective functions [3].

Ergocalciferol, or vitamin D2, is one of the main forms of vitamin D, synthesized by plants and fungi under the influence of ultraviolet light. This form of vitamin D is important for the body because it regulates calcium-phosphorus metabolism, which affects bone health. However, recent studies indicate that it plays an important role in the functioning of the immune system, in the activation of macrophages and T-lymphocytes, which are crucial in fighting infections [4].

Interest in vitamin D as an adjunct in the treatment of tuberculosis is not new. More than a century ago, when antibiotics did not yet exist, tuberculosis patients were advised to spend more time in the sun to increase their vitamin D levels, as this improved their well-being. Modern scientific research shows that patients with tuberculosis often have a vitamin D deficiency, which may be associated with reduced immunity and an increased risk of developing infections [5].

In addition, vitamin D has been shown to reduce inflammation in the body, which may be an important factor for patients with tuberculosis. The antibacterial activity of this vitamin is based on its ability to stimulate the production of cathelicidins, natural antimicrobial peptides that help the body fight mycobacteria tuberculosis [6].

However, despite the encouraging results, the use of vitamin D as a preventive or therapeutic agent against tuberculosis remains a subject of scientific debate. Currently, there is no consensus on the optimal doses and duration of vitamin D intake for patients with tuberculosis. In addition, it is important to consider the availability of different forms of this vitamin on the market, their availability, quality, and cost-effectiveness [7].

Marketing analysis of ergocalciferol-based drugs allows us to assess their distribution on the market, their availability for patients and the level of competition among manufacturers. Since vitamin D is quite popular among the population as a general means of maintaining health, its pharmacological market is characterized by high competition. However, for use in the context of tuberculosis treatment, it is important to ensure quality control of drugs, their compliance with international standards and effectiveness. Analysis of the Ukrainian market allows us to assess the prospects for the use of ergocalciferol in the fight against tuberculosis at the national level [8].

Therefore, the integration of vitamin D into the modern system of prevention and treatment of tuberculosis is a complex but promising area of research that requires additional scientific justification and marketing research.

The purpose of the study was to research and summarize the available evidence and still open questions regarding the use of ergocalciferol in the pharmacotherapy of tuberculosis as a preventive measure for individuals at high risk of infection and development of active tuberculosis. To achieve this goal, a retrospective and marketing analysis of vitamin D was conducted, which may be useful in the pharmacotherapy of this disease. This approach allows us to comprehensively assess the potential benefits and challenges of using vitamin D in the fight against tuberculosis, as well as its availability and cost-effectiveness on the Ukrainian market.

Materials and methods. The study lasted from June 2024 to October 2024. A retrospective documentary search was conducted on the topic of the article on the websites PubMed, Scopus, Google Scholar, EMBASE, Cochrane Library, WHO, Crossref, Copernicus. The search covered the period from 1950 to 2024. Articles discussing the role of vitamin D in the treatment of tuberculosis were identified. In addition, the State Formulary of Medicines of Ukraine, 16th edition, [9] the State Register of Medicines of Ukraine [10] and the Catalog of Vitamins and Special Food Products [11] were examined to conduct a marketing analysis of the vitamin D market in Ukraine.

The research of the article is a fragment of research works of Lviv Medical Institute LLC on the topic of "Improving the system of circulation of drugs during pharmacotherapy on the basis of evidentiary and forensic pharmacy, organization, technology, biopharmacy and pharmaceutical law" (state registration number 0120U105348, implementation period 2021-2026); Private Scientific Institution "Scientific and Research University of Medical and Pharmaceutical Law" on the topic “Multidisciplinary research of post-traumatic stress disorders during war among patients (primarily combatants)” (state registration number 0124U002540, implementation period 2024-2028); "Pharmaceutical and medical law: integrated approaches to the system of drug circulation from the standpoint of forensic pharmacy and organization of pharmaceutical business" (state registration number 0121U000031, terms 2021-2026); Luhansk State Medical University "Conceptual interdisciplinary approaches to pharmaceutical provision and availability of drugs, taking into account organizational and legal, technological, analytical, pharmacognostic, forensic and pharmaceutical, clinical and pharmacological, pharmacoeconomic, marketing, social and economic competencies" (state registration number 0123U101632, terms 2023-2027); Petro Mohyla Black Sea National University on the topic "Conceptual interdisciplinary approaches to the drug circulation system, taking into account organizational and legal, technological, biopharmaceutical, analytical, pharmacognostic, forensic and pharmaceutical, clinical and pharmacological, pharmacoeconomic, pharmacotherapeutic aspects" (state registration number 0123U100468, implementation period 2023-2028) [12-26].

Results and discussion. A retrospective document search on the topic of the article on the websites PubMed, Scopus, Google Scholar, EMBASE, Cochrane Library, WHO, Crossref, Copernicus showed that scientists emphasize the crucial role of vitamin D in the fight against infectious diseases, in particular tuberculosis, which remains one of the leading causes of death in the world, causing 1.5 million deaths in 2021. Vitamin D can inhibit the replication of Mycobacterium tuberculosis in vitro, which makes it a promising candidate for tuberculosis therapy due to its ability to regulate the redox balance. A review of studies indicates the possible effectiveness of the combined use of vitamin D with other vitamins, such as vitamin A, which also have antimycobacterial effects. This may enhance the body's immune defense against infectious agents. In addition, scientists note the low incidence of side effects even with high doses of vitamin D, as well as the availability and low cost of this therapy, which makes it advisable to determine its level in patients with tuberculosis and in high-risk groups. Thus, it is recommended to consider the possibility of administering vitamin D to achieve an optimal level of its concentration, which can increase the effectiveness of tuberculosis therapy and reduce the risk of morbidity in vulnerable populations [27]. Scientists have investigated the potential role of vitamin D as a therapeutic immunomodulator in the treatment of tuberculosis and found that this vitamin could modulate the body's immune response. During the studies, it was found that vitamin D deficiency, which is often observed from birth, not only negatively affects the health of the bone system, but also increases susceptibility to various infectious diseases, including tuberculosis. Scientists have found that vitamin D activates antimicrobial peptides through stimulation of innate pattern recognition receptors, which significantly strengthens the innate immune system. They also found that vitamin D plays an important regulatory role in the adaptive immune response, reducing the risk of unwanted inflammation. The researchers focused on examining the effects of vitamin D in pediatric patients with tuberculosis, making their findings unique, as previous reviews have mostly focused on adults [28]. The researchers conducted a multicenter, randomized, controlled trial to examine the effects of vitamin D supplementation on the efficacy of pulmonary tuberculosis treatment in adults. The study included 146 smear-positive patients who received 2.5 mg of vitamin D_3 or placebo at baseline and 2, 4, and 6 weeks after starting standard tuberculosis treatment. The researchers found that the median time to sputum culture conversion (negativity) was 36 days in the vitamin D group compared with 43.5 days in the placebo group. Although the difference was not statistically significant (P=0.14), the study showed that the genotype of the patients had an impact on the effectiveness of the therapy. Participants with the "tt" genotype of the Taq I polymorphism of the vitamin D receptor (VDR) showed a significantly reduced time to sputum culture conversion (HR 8.09; P=0.02), while the Fok I genotype did not affect the results. The median serum 25-hydroxyvitamin D level after 8 weeks increased significantly in the intervention group (101.4 nmol/L) compared with the placebo group (22.8 nmol/L). This confirms the effectiveness of vitamin D in increasing its serum concentration during treatment. The results suggest that vitamin D supplementation may be beneficial in reducing the time to sputum conversion in patients with certain genetic characteristics [29].

Also, renowned scientists conducted a randomized controlled trial to evaluate the effectiveness of special foods containing vitamin D in preventing tuberculosis in children with vitamin D deficiency. The study included 8,851 children from Mongolia who were initially negative for Mycobacterium tuberculosis infection using the QuantiFERON-TB Gold In-Tube (QFT) test. The children were randomized into two groups: one group received a weekly dose of 14,000 IU of vitamin D_3 and the other group received a placebo for three years. The researchers found that at the end of the study, the proportion of children with a positive QFT result was 3.6% in the vitamin D group and 3.3% in the placebo group, indicating no significant difference in the risk of tuberculosis infection (adjusted hazard ratio 1.10; 95% CI 0.87-1.38). The mean 25-hydroxyvitamin D level at the end of the study was significantly higher in the vitamin D group (31.0 ng/mL) compared with the placebo group (10.7 ng/mL). The incidence of tuberculosis also did not show a significant difference: 21 cases in the vitamin D group and 25 in the placebo group (adjusted hazard ratio 0.87; 95% CI 0.49-1.55). In addition, the incidence of acute respiratory infections was almost the same: 29 cases of hospitalization in the vitamin D group and 34 in the placebo group (adjusted hazard ratio 0.86; 95%

CI 0.52-1.40). Thus, the study showed that weekly intake of vitamin D_3 in children with vitamin D deficiency reduced the risk of tuberculosis infection, tuberculosis morbidity or acute respiratory infection compared with placebo [30].

The following is a description of Ergocalciferol (Vitamin D).

Ergocalciferol (Vitamin D)

Ergocalciferol (Ergocalciferol) has the ATC code A11CC01 and belongs to vitamin D preparations and its analogues. It is used for the prevention and treatment of hypovitaminosis D, rickets, bone diseases caused by calcium metabolism disorders (various forms of osteoporosis, osteomalacia), parathyroid gland dysfunction (tetany), and tuberculosis of the skin and bones [9].

Ergocalciferol, also known as vitamin D2, is one of the two main types of vitamin D that is necessary for human health. It provides several important functions in the body, including helping to maintain bone mass, supporting immune function, and maintaining a healthy cardiovascular system.

Biological Role of Ergocalciferol

Supporting Bone Health:

Ergocalciferol helps maintain healthy bones and teeth by aiding the absorption of calcium and phosphorus in the intestines. This is especially important for patients with tuberculosis, as vitamin D deficiency can lead to bone thinning and an increased risk of fractures.

Supporting the Immune System:

Ergocalciferol plays an important role in supporting immune system function. It stimulates the production of peptides that fight infections and regulates the production of cytokines, which helps prevent inflammation.

Improving Mental Health:

Studies show that ergocalciferol may affect mood and mental health, reducing the risk of depression and other mental disorders.

Protection against inflammation:

Vitamin D has anti-inflammatory properties that help reduce the risk of developing inflammatory diseases such as tuberculosis and ease their course.

Benefits of Ergocalciferol in the Treatment of Tuberculosis (TB)

Supporting the Immune Response in TB:

Ergocalciferol supports the immune system, which helps the body better fight the infection caused by Mycobacterium tuberculosis. This may increase the effectiveness of tuberculosis treatment and reduce the risk of complications.

Improving Bone Health in TB:

Ergocalciferol helps maintain bone health, which may be especially important for patients with tuberculosis, who may have reduced bone mass due to long-term illness and medication.

General Health Support in TB:

Ergocalciferol provides support for cardiovascular function and general health, which may help patients with tuberculosis recover faster and improve their quality of life.

Conclusion:

Ergocalciferol (vitamin D2) is an important component of supportive treatment for tuberculosis. Its role in supporting the immune system, bone health, and overall well-being may help patients with tuberculosis recover and improve their quality of life. Adding ergocalciferol to the complex therapy of tuberculosis may be beneficial for the patient [31].

The authors conducted a marketing analysis of ergocalciferol (Vitamin D) based on data from the State Register of Medicines of Ukraine (Table 1) [10].

Table 1 presents four medicines containing ergocalciferol (Vitamin D2) in different forms. All drugs have different manufacturers, but they all meet quality standards.

Manufacturers

Medicines are produced in different countries, in the Czech Republic, China and Ukraine, which indicates the international aspect of ergocalciferol production.

Table 1. Marketing analysis of registered ergocalciferols (Vitamin D) for medical use.

Trade name/dosage form	Composition of active substances	Manufacturer/ Country	No registration certificate	Validity from/to
ERGOCALCIPHEROL (VITAMIN D2) pulveris	not less than 97.0% and not more than 102.0%	Sintesia, a.s., Czech Republic	UA/12068/01/01	unlimited with 15.08.2016
VITAMIN D2 (ERGOCALCIPHEROL) pulveris	not less than 97.0% and not more than 103.0%	Xihuang Neizhang Hyuxin Pharmaceutisal Co., Ltd., China	UA/12564/01/01	unlimited with 11.10.2017
Ergocalciferol solution oleosum	1 ml contains 1.25 mg	"Vitaminy" JSC, Ukraine	UA/5393/01/01	unlimited with 22.12.2016
Ergocalciferol (Vitamin D2) solution oleosum	1 ml contains 1.25 mg	Technolog PJSC, Ukraine	UA/6299/01/01	unlimited with 30.06.2017

Release forms

Medicines are presented in two forms: powder and solution, which can satisfy different needs of patients.

Registration validity period

All medicines have an indefinite validity of the registration certificate, which indicates stability on the market.

Resume

Ergocalciferol (Vitamin D2) is presented on the medicines market by different manufacturers and in different forms, which makes it available to patients. It is important to note that all medicines meet the established quality standards and have an indefinite registration, which increases confidence in these medicines.

The market of vitamins and special food products containing vitamin D is very saturated. The author searched for products that contain only one vitamin D, or several vitamins with it in the composition. Complex products that contain many vitamins and minerals were not considered. The results of the marketing analysis of special food products with vitamin D are presented in Table 2.

Table 2. Marketing analysis of special food products with vitamin D.

No	Trade name/dosage form	Manufacturer	Country	Brand
1.	Vitamins for Children Kroha D3 Drops with Vitamin D3, 10 ml bottle	Biotics	Poland	HROHA D3
2.	Vitamin D3 SOLGAR capsules, 600 IU, 60 capsules per bottle	Solgar	USA	SOLGAR
3.	D-Vitum Spray for Children from Birth to 6 Years with Vitamin D3, 10 ml bottle	Oleofarm	Poland	D-VITUM

4.	Dietary Supplement, Source of Vitamin D3, Dekristol D3 Tablets, 2000 IU, 3 blisters of 10 tablets	Mibe	Germany	DECRYSTOL
5.	Dietary Supplement, Source of Vitamin D3, Dekristol D3 Tablets, 5600 IU, 3 blisters of 10 tablets	Mibe	Germany	DECRYSTOL
6.	Dietary Supplement, Olidetrim 2000 Vitamin D3 Soft Capsules, 4 blisters of 15 capsules	Medana farm	Poland	OLIDETRIM
7.	Dietary Supplement, Source of Vitamin D3, Dekristol D3 Tablets, 4000 IU, 3 blisters of 10 tablets	Mibe	Germany	DECRYSTOL
8.	Dietary Supplement, Olidetrim 4000 Vitamin D3 Soft Capsules, 4 blisters of 15 capsules	Medana farm	Poland	OLIDETRIM
9.	Dietary Supplement, Source of Vitamin D3, Dekristol D3 Tablets, 2000 IU, 12 blisters of 10 tablets	Mibe	Germany	DECRYSTOL
10.	Dekristol D3 Drops 1000 IU (Vitamin D3) for Immune System and Bone and Muscle Function, 25 ml bottle	Mibe	Germany	DECRYSTOL
11.	Olidetrim Kids Oral Drops 600 IU, dietary supplement for children from birth, additional source of Vitamin D3, 10 ml bottle	Medana farm	Poland	OLIDETRIM
12.	Vitamin D3 SOLGAR capsules, 600 IU, 120 capsules per bottle	Solgar	USA	SOLGAR
13.	Detrix 2000 Vitamin D3 capsules, 3 blisters of 10 capsules	Helskea softgel	India	DETRIX
14.	Vitagama D3 2000 (Vitamin D3) Tablets, additional source of Vitamin D3, 5 blisters of 10 tablets	Vervag Farma	Germany	VITAGAMA
15.	Dietary Supplement Detriximax 1000 IU (Vitamin D3) capsules, 4 blisters of 15 capsules	Kurtis Hels Caps	Poland	DETRIMAKS
16.	Dietary Supplement Detriximax 2000 IU (Vitamin D3) capsules, 4 blisters of 15 capsules	Kurtis Hels Caps	Poland	DETRIMAKS
17.	Decap 2000 Vitamin D3 Tablets, 4 blisters of 15 tablets	Vervag Farma	Poland	DECAP
18.	Dietary Supplement Detriximax 4000 IU (Vitamin D3) capsules, 4 blisters of 15 capsules	Kurtis Hels Caps	Poland	DETRIMAKS
19.	Decap 5000 Vitamin D3 Tablets, 4 blisters of 15 tablets	Vervag Farma	Poland	DECAP

20.	Vitamin D3 capsules, 700 mg, pack of 30	Pharmacist	Ukraine	PHARMACOM
21.	Vitamin D3 1000 IU capsules, 150 mg, additional source of Vitamin D3, pack of 90	Golden Farm	Ukraine	GOLDEN PHARM
22.	Vitamin D3 2500 IU capsules, 150 mg, additional source of Vitamin D3, pack of 90	Golden Farm	Ukraine	GOLDEN PHARM
23.	Vitamin D3 5000 IU capsules, 150 mg, additional source of Vitamin D3, pack of 90	Golden Farm	Ukraine	GOLDEN PHARM
24.	Vitagama D3 5600 (Vitamin D3) Tablets, additional source of Vitamin D3, 5 blisters of 10 tablets	Vervag Farma	Germany	VITAGAMA
25.	Detrix 5600 Vitamin D3 capsules, 3 blisters of 10 capsules	Helskea softgel	India	DETRIX
26.	Vitamin D3 2000 capsules, additional source of Vitamin D3, pack of 60	Red star	Ukraine	VITAMIN D
27.	Detrix 4000 Vitamin D3 capsules, 3 blisters of 10 capsules	Helskea softgel	India	DETRIX
28.	Detriseselect D3 2000 IU source of Vitamin D3 capsules, jar of 60	Phil inter	USA	DETRISELECT
29.	Detriseselect D3 4000 IU source of Vitamin D3 capsules, jar of 60	Phil inter	USA	DETRISELECT
30.	Detriseselect D3 5600 IU source of Vitamin D3 capsules, jar of 60	Phil inter	USA	DETRISELECT
31.	Videin-KV Vitamin D3 2000 IU capsules for supporting bone, muscle, and immune health, 6 blisters of 10 capsules	Kyiv Vitamin Plant	Ukraine	VIDEOS
32.	Vitamin D3 2000 IU NOW, Vit D-3, high-activity Vitamin D3 capsules, 30 capsules per bottle	Now	USA	NOW
33.	Sanivit D3 4000 IU source of Vitamin D3 capsules, pack of 30	Nutrimed	Ukraine	SANIVITAN
34.	Orthomol Vitamin D3 Plus capsules for skeletal health and bone structure for a 60-day course	Orthomol pharmazeutische vertriebs	Germany	ORTHOMOL
35.	Videc capsules, additional source of Vitamins D and K, pack of 30	Bovios Pharm	Ukraine	VIDEK
36.	Nanodetrim D3 2000 IU oral spray for fast absorption of Vitamin D3, 30 ml, 200 doses	Nordeide	Estonia	NANODETRIM
37.	Vitamin D3 + Zinc tablets, 100 pcs	Pharmacist	Ukraine	PHARMACOM

38.	Kadesfer syrup for the prevention of calcium and Vitamin D3 deficiency, 120 ml bottle	Vega Ilac	Turkey	CADESPHERE
39.	Vitamin D3 tablets, 2000 IU, 30 pcs	Health	Ukraine	VITAMIN D
40.	Vitamin D3 2000 IU NOW, high-activity vitamin capsules, 120 capsules per bottle	Now	USA	NOW
41.	Vitamin D3 5000 IU NOW, high-activity vitamin capsules, 120 capsules per bottle	Now	USA	NOW
42.	D3-Vitamin 2000 IU source of Vitamin D3, coated tablets, Doctor Thyss, pack of 60	Natural product of the farm	Poland	DR. THEISS
43.	Vistabon D3 4000 IU capsules, 100 mcg, 50 capsules per bottle	Laboratorios	Spain	VISTABON
44.	Vitamins ZEST Vitamin D3 2000 capsules, 30 pcs	Hc Clover	Spain	ZEST
45.	Vitamins ZEST Vitamin D3 4000 chewable capsules, 30 pcs	Shandong	China	ZEST
46.	Vitamin D3 1000 IU NOW, high-activity vitamin capsules, 180 capsules per bottle	Now	USA	NOW
47.	Vitamin D-3/K2 1000 IU/45 mcg NOW, high-activity vitamin capsules, 120 capsules per bottle	Now	USA	NOW
48.	D Mex 5000 + K2 source of Vitamin D3 and K2 tablets, 50 pcs	Tactus	India	D MAX
49.	D Mex 2000 + K2 source of Vitamin D3 and K2 tablets, 50 pcs	Tactus	India	D MAX
50.	Koledan soft capsules Vitamin D3, 2000 IU, pack of 30	World medicine	Turkey	KOLEDAN
51.	Koledan soft capsules Vitamin D3, 5000 IU, pack of 30	World medicine	Turkey	KOLEDAN
52.	Additional source of Vitamin D3 + K2, pack of 90 pcs	Golden Farm	Ukraine	GOLDEN PHARM
53.	Vitamins SUNLIFE Vitamin D3 5600 IU tablets, 20 pcs	Sunlife productions	Germany	SUNLIFE
54.	Vitamin D3 SOLGAR capsules, 4000 IU, 60 pcs	Solgar	USA	SOLGAR
55.	Vitamin D3 2000 Dr. Theiss oral spray for normal immune function, 20 ml bottle	Dr. Theiss Naturvaren	Germany	DR. THEISS
56.	Olidetrim 1000 IU Vitamin D3 soft capsules, pack of 30	Polpharma	Poland	OLIDETRIM

57.	Vitamin D3 Vitavit (Vitamin D3 1000 IU) capsules, 30 pcs per bottle	Beauty and health	Ukraine	ENJEE
58.	Vitamin D3 Vitavit (Vitamin D3 500 IU) drops, 30 ml bottle	Beauty and health	Ukraine	ENJEE
59.	Vitamin D3 Vitavit (Vitamin D3 1000 IU) capsules, 60 pcs per bottle	Beauty and health	Ukraine	ENJEE
60.	Detrimax 2000 IU (Vitamin D3) Immuno capsules for strong immunity, 2 blisters of 15 pcs	Master of Polish Pharm	Poland	DETRIMAKS
61.	Detrimax Baby Vitamin D3 drops, bottle with dropper, 30 ml	Master of Polish Pharm	Poland	DETRIMAKS
62.	Vistakea D3 dietary supplement capsules, 4000 IU, 50 pcs per bottle	Laboratorios	Spain	WISTAKEA
63.	Vitamin D3 2500 IU NATHEALTH tablets, 20 pcs per pack	Nathealth	Poland	NATHEALTH
64.	Vitamin D3 SOLGAR Vitamin D3 (Cholecalciferol) 125 mcg (5,000 IU) capsules, 5000 IU, 120 pcs per bottle	Solgar	USA	SOLGAR
65.	Vitamin D3 SOLGAR Vitamin D3 (Cholecalciferol) 125 mcg (5,000 IU) gelatin capsules, 5000 IU, 100 pcs per bottle	Solgar	USA	SOLGAR
66.	Vitamin D3 1000 IU SOLGAR chewing tablets, 400 mg, 100 pcs per bottle	Solgar	USA	SOLGAR
67.	D Mex 2000 + K2 source of Vitamin D3 and K2 tablets, 5 blisters of 10 pcs	Tactus	India	D MAX
68.	Vitamin D3 (D3) 1000 IU DR. KOMAROVSKIY for maintaining bone, muscle, and immune health, capsules 1000 IU, 2 blisters of 15 pcs	Sochim	Italy	DR. KOMAROVSKIY
69.	Vitamin D3 (D3) 2000 IU DR. KOMAROVSKIY for maintaining bone, muscle, and immune health, capsules 2000 IU, 2 blisters of 15 pcs	Sochim	Italy	DR. KOMAROVSKIY
70.	Vitamin D3 (D3) 4000 IU DR. KOMAROVSKIY for maintaining bone, muscle, and immune health, capsules 4000 IU, 2 blisters of 15 pcs	Sochim	Italy	DR. KOMAROVSKIY

71.	Dietary Supplement Olidetrim 2000 Vitamin D3 soft capsules, 3 blisters of 30 pcs	Polpharma	Poland	OLIDETRIM
72.	Vistabon D3 5600 IU gelatin capsules, 60 pcs per bottle	Laboratorios	Spain	VISTABON
73.	Vistabon D3 2000 IU gelatin capsules, 50 mcg, 60 pcs per bottle	Laboratorios	Spain	VISTABON
74.	D Mex 5000 + K2 source of Vitamin D3 and K2 tablets, 5 blisters of 10 pcs	Tactus	India	D MAX
75.	Vitamin D3+K2 SOLARAY Vitamin D3+K2 capsules, 120 pcs per bottle	Nutra Manufacturing	USA	SOLARAY
76.	Vitamin D3 and K with Sea Iodine LIFE EXTENSION Vitamins D and K with Sea-Iodine capsules, 60 pcs per bottle	Quality supplements	USA	LIFE EXTENSION
77.	Vitamin D3 PURITAN'S PRIDE Vitamiv D3 50 mcg (µg), 2000 IU (IU) fast-acting capsules, 100 pcs	Puritan's Pride	USA	PURITAN'S PRIDE
78.	Vitamin D3 PURITAN'S PRIDE Vitamiv D3 125 mcg (µg), 5000 IU (IU) fast-acting capsules, 100 pcs	Puritan's Pride	USA	PURITAN'S PRIDE
79.	Mega D3 and MK7 NOW Mega D-3 & MK-7 5000 IU (IU)/180 mcg (µg) capsules, 60 pcs per bottle	Now	USA	NOW
80.	Dietary Supplement Olidetrim 2000 Vitamin D3 soft capsules, pack of 60	Medana farm	Poland	OLIDETRIM
81.	Vitamin D3 (D3) 400 IU DR. KOMAROVSKIY for maintaining bone, muscle, and immune health, chewy tablets, 400 IU, jar of 30 pcs	ChemProf	Poland	DR. KOMAROVSKIY
82.	Vitamin D3 (D3) 400 IU DR. KOMAROVSKIY for maintaining bone, muscle, and immune health, chewy tablets, 400 IU, jar of 60 pcs	ChemProf	Poland	DR. KOMAROVSKIY

Table 2 presents 82 special food products that contain vitamin D. The products are presented in different dosage forms. The specific gravity of each dosage form is shown in Fig. 1.

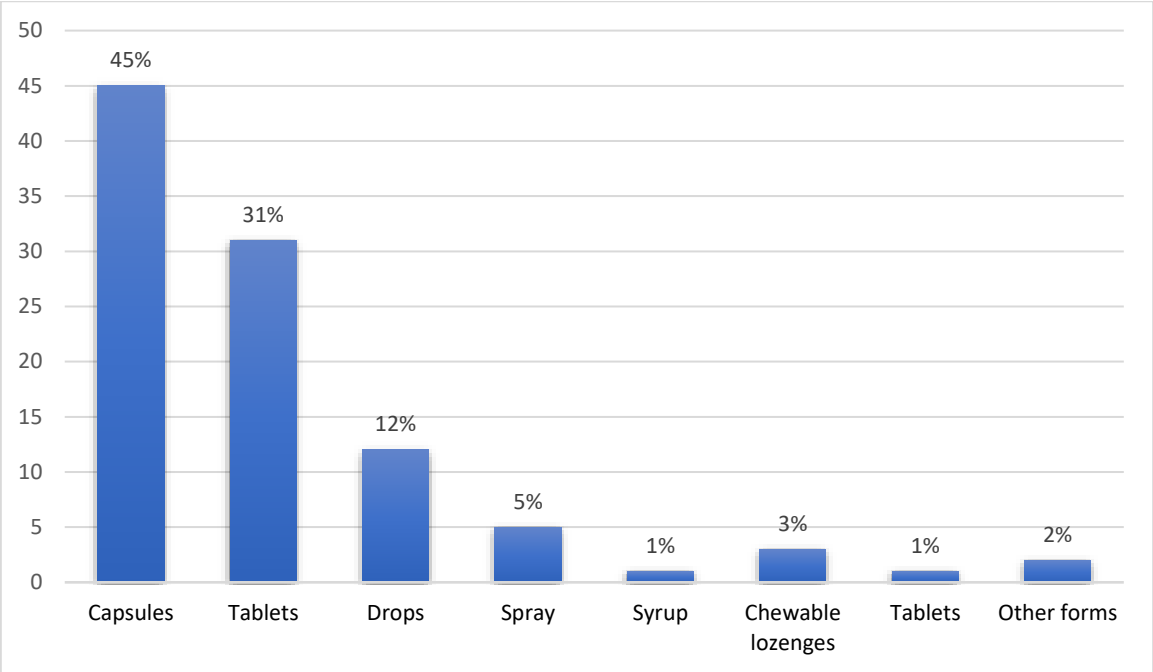

Fig. 1. Distribution of dosage forms of special food products with vitamin D.

The diagram illustrates the distribution of dosage forms of special food products with vitamin D, in which capsules occupy the largest share – 45%, followed by tablets with a share of 31%. Drops are represented by 12%, while sprays, syrups, chewable lozenges, and tablets make up only 5%, 1%, 3% and 1%, respectively. Additional dosage forms, such as oral solutions and soft capsules, make up 2%. This indicates the popularity of capsules and tablets as the main forms of vitamin D delivery, while other forms are used much less frequently. The share of each manufacturer is shown in Fig. 2.

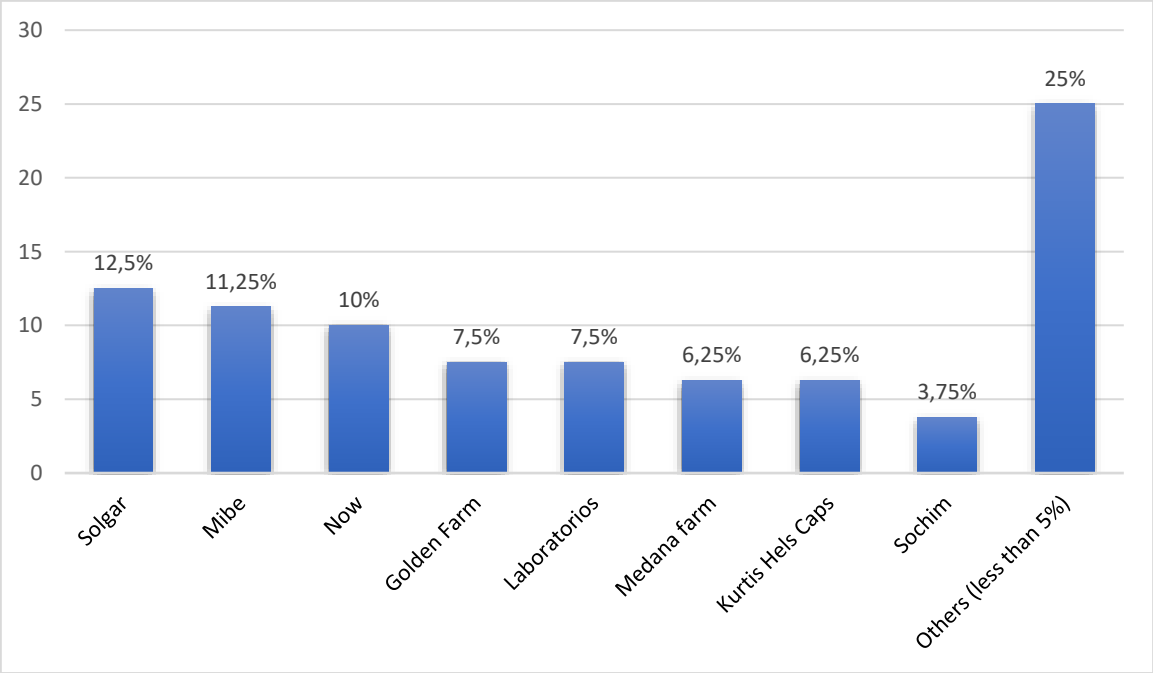

Fig. 2. Distribution of manufacturers of speciality foods with vitamin D.

The diagram in Fig. 2 shows the distribution of shares of manufacturers of speciality foods with vitamin D. The largest share is held by Solgar, representing 12.5%, followed by Mibe with 11.25% and now with 10%. Golden Farm and Laboratorios share the same share of 7.5%, while Medana Farm and Curtis Health Caps have 6.25% each. Sochim has a less noticeable share – 3.75%, and the category "Others" covers 25% and includes manufacturers with a share of less than 5%. This

indicates the diversity of manufacturers in the market, with a predominance of a few main brands. The share by country of manufacturer is shown in Fig. 3.

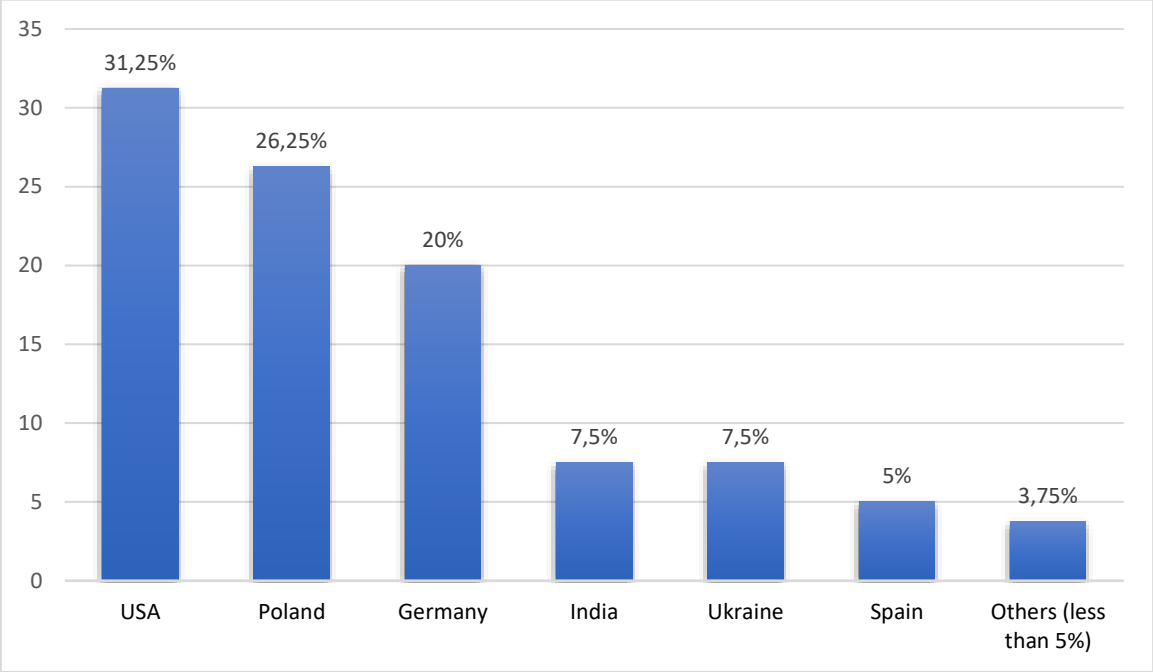

Fig. 3. Distribution of countries producing special foods with vitamin D.

The diagram shows the distribution of countries producing special foods with vitamin D. The USA has the largest share, which is 31.25%, which indicates the leading role of American manufacturers in the market. In second place is Poland with 26.25%, followed by Germany, which represents 20%. Both countries also have a significant contribution to the production of vitamin D. Next come India and Ukraine, both with a share of 7.5%, indicating their contribution to the market. Spain has 5%, and the category "Others" covers 3.75%, which includes countries with a share of less than 5%. Overall, the diagram shows the diversity of producing countries, with an emphasis on the USA, Poland, and Germany as the main sources of vitamin D products.

The specific weight by brand is shown in Fig. 4.

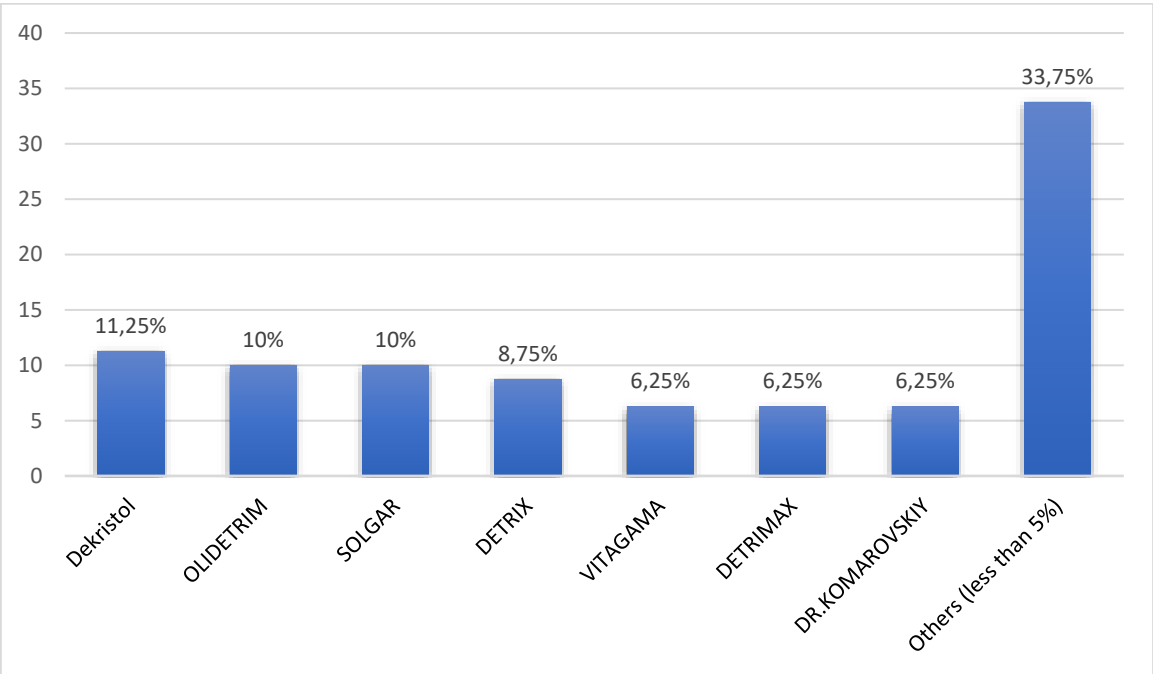

Fig. 4. Distribution of brands of special food products with vitamin D.

The diagram in Fig. 4 illustrates the distribution of brands of special food products with vitamin D. The largest share is occupied by the brand Dekristol, which is 11.25%, which indicates its popularity in the market. In second place are the brands OLIDETRIM and SOLGAR, which have 10% each, demonstrating their importance among consumers. The brand DETRIX follows with a share of 8.75%, while VITAGAMA, DETRIMAX and DR. KOMAROVSKIY represent 6.25%, indicating their contribution to the production of vitamin D. The category "Others" covers a significant part of the market - 33.75%, which includes several brands with a share of less than 5%. Overall, the diagram reflects the diversity of brands in the vitamin D segment, with an emphasis on leading brands and a significant volume of lesser-known brands.

The conclusion of the four charts shows a comprehensive overview of the vitamin D specialty food market, focusing on dosage forms, manufacturers, producing countries and brands. The first chart shows that capsules (45%) and tablets (31%) are the most popular forms of vitamin D delivery, while other forms are used less frequently. The second chart highlights the distribution of manufacturers, where Solgar holds the leading position with 12.5%, and 25% are manufacturers with less prominent shares. The third chart shows that the USA (31.25%), Poland (26.25%) and Germany (20%) are the main producing countries, confirming their importance in the market. Finally, the fourth chart shows that the Decristol brand is the most popular (11.25%), while a significant share of the market (33.75%) is occupied by less well-known brands. Overall, the results indicate a diverse offering on the vitamin D market, combining popular and lesser-known dosage forms, manufacturers, countries, and brands.

Conclusions. The article examines in detail the important role of ergocalciferol (vitamin D) in maintaining health, especially in the context of tuberculosis treatment. Vitamin D not only contributes to the maintenance of bone mass and supports the immune system, but also has a positive effect on the cardiovascular system, which is critically important for patients with tuberculosis. Adding ergocalciferol to complex therapy can improve the quality of life of patients and promote their recovery. In addition, the article provides an analysis of the vitamin D market, indicating the diversity of dosage forms, manufacturers, countries of manufacture and brands. It is noted that capsules and tablets are the most popular forms, and leading manufacturers, such as Solgar, occupy a significant market share. The main producing countries are the USA, Poland, and Germany, which underlines their importance in the production of vitamin D. Overall, the results indicate the availability of ergocalciferol for patients and its compliance with established quality standards, which increases confidence in the products on the market.

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