BIOMEDICINSKA ISTRAŽIVANJA
2023;14(1):29–39

UDK: 577.161.2:641:613.292(497.6)
DOI: 10.59137/BII202301307B

Original article

Content-related quality of food supplements with vitamin D on the market of Republic of Srpska

Ljubica Bojanić[1,2],
Mirjana Djermanović[1,2]

[1]Public Health Institute of Republic of Srpska, Banja Luka, Republic of Srpska, Bosnia and Herzegovina

[2]University of Banja Luka, Faculty of Medicine, Department of Pharmacy, Banja Luka, Republic of Srpska, Bosnia and Herzegovina

Primljen – Received: 20/02/2023
Prihvaćen – Accepted: 26/04/2023

Corresponding author:
Ljubica Bojanić, mr ph
Jovana Dučića 1, 78000 Banja Luka
ljubica.bojanic@gmail.com

Summary

Introduction. Vitamin D is a liposoluble vitamin that has many important roles in the human body. Daily requirements for vitamin D are met through intake of food and exposure to sunlight. The high frequency of vitamin D deficiency is a public health problem that can be corrected using food supplements (FS), which is why its consumption is increasing. The quality of FS, including the content of active components, depends on the good manufacturing practice which is not strictly regulated for the production of FS, as well as the formulation, packaging and storage. Because of that, the quality of FS can be variable. The aim of our pilot study was to examine the conformity of the actual determined content of vitamin D and the declared content in 49 FS, in the form of tablets and capsules, present on the market in Republic of Srpska.

Method. Determination of vitamin D content was performed by high-performance liquid chromatography (HPLC).

Results. The range of the determined content of vitamin D in relation to the declared content, expressed as a percentage, was from 64,4% to 188,8%, whereby the deviation is not statistically significant (mean: 100.50%; CI 95% -0.54 to 0.17; p=0.313 tablets; mean: 98.02%; CI 95% -3.00 to 0.42; p=0.127 capsules). When measurement uncertainty is taken into account, only one sample (2.0%) was outside the legally allowed range (88.8% more than labeled).

Conclusion. Therefore, it has been shown that most of the examined products are of satisfactory quality in terms of vitamin D content, but it is necessary to continuously monitor the food supplements that are on the market.

Keywords: cholecalciferol, food supplements, safety, label, HPLC

Introduction

Vitamin D is one of the most important nutrients necessary for the proper development and functioning of our body. According to its chemical structure, vitamin D belongs to the group of steroids. The two most important forms of vitamin D are ergocalciferol (D2) and cholecarciferol (D3). Vitamin D is a fat-soluble vitamin. Due to its metabolism and mechanism of action, it is also considered a hormone [1]. The human body provides vitamin D through synthesis in the skin after exposure to UV-B radiation, as well as through intake of food and food supplements (FS) [1,

2]. The amount of endogenously synthesized vitamin D depends on the intensity of exposure to solar radiation, which is influenced by numerous factors such as geographical area, season, altitude, time spent outside, use of sunscreen, clothing, age, skin color, numerous diseases etc. In the case of reduced endogenous synthesis, due to insufficient exposure to UV-B radiation, it is necessary to compensate vitamin D through food or FS [2, 3]. Foods that are the source of vitamin D include fish (fatty fish is the best), egg yolks, some offal such as liver (especially cod liver), butter and milk (which are fortified in some countries), cocoa and cocoa products, mushrooms, meat to a lesser extent, etc. [4–6].

Today, the consumption of FS, especially vitamins and minerals, is very popular among general population. Also, the awareness about the importance of adequate intake of vitamin D is growing as the lack of vitamin D is becoming a growing public health problem. Accordingly, the intake of vitamin D through FS is increasing, which is why it is extremely important to control the quality of this group of products. The quality control of FS is very complex and includes both, the control of potentially harmful contaminants and the content of active components, as well as the labeling of products, which must comply with the requirements of current legislation. Also, FS are available to general population in pharmacies as well as in various stores and online shops, so very often people buy FS on their own, without adequate advice from health care professionals about its use. This can lead to excessive or inadequate use and numerous interactions with drugs if used together [7]. Some studies have shown possible deviations of the actual content of vitamin D in relation to the labeled value (LV) in FS [8–10]. For example, a research carried out in Slovenia showed that determined vitamin D was 36% to 206% compared to labeled one [8]. Therefore, due to inadequate product formulation, packaging or storage, there may be a change in the content of the active component in the FS compared to the LV, which may mislead the consumer in terms of product dosage. Because of that, it is very important to control the content of active substances in FS.

The aim of our pilot study was to examine FS with vitamin D present on the market in Republic of Srpska, what doses of vitamin D are contained and whether the determined vitamin D content corresponded to the labeled content on the product itself, i.e. to examine the quality in terms of vitamin D content in FS available to the general population.

Method

Vitamin D has been examined in 49 samples of FS in form of tablets (n=34) and capsules (n=15) present on the market of Republic of Srpska. FS with vitamin D were selected by random sampling from pharmacies and stores and did not include all supplements with vitamin D present on the market. The number of all FS with vitamin D on the market is unknown as there is no comprehensive register for these products. This pilot study was conducted from July 2019 to December 2020.

Determination of vitamin D is based on a reference document that is an extension of the standard method "SRPS EN 12821:2012 - Food products - Determination of vitamin D by high-performance liquid chromatography - Measurement of cholecalciferol (D3) and ergocalciferol (D2)". It was modified in part of the subject of test and validated by the procedure by which it was determined that the test method was reliable for the intended analytical determinations in the given conditions in accordance with the ISO/IEC 17025 standard [11]. The method is based on the determination of vitamin D2 or D3 by high-performance liquid chromatography (HPLC), which includes a technique in which a continuous flow of the mobile phase is applied along a column with a stationary phase, in order to

separate analyzed components of the mixture and their further qualitative and quantitative analyses in the examined sample [12]. Determination of vitamin D content was performed on an HPLC Agilent 1200 Series, DAD detector. Sample preparation involved the release of vitamin D from the samples by alkaline hydrolysis with a mixture of ethanol and aqueous KOH solution in the presence of ascorbic acid as an antioxidant (saponification). After saponification, vitamin D was extracted with n-hexane. Determination of vitamin D2 or D3 in the sample extract solution was performed using a semi-preparative normal phase column (silica gel, 5 μm; 4 x 250 mm), followed by determination on an analytical C18 reverse phase column (5 μm; 4 x 250 mm) by chromatography using DAD detector (UV spectrometry, λ = 265 nm) (Figure 1). A mixture of n-hexane and 2-propanol (99:1 V/V) was used as a solvent for the normal phase of semi-preparative HPLC, while a mixture of acetonitrile and methanol (70:30 V/V) was used as a mobile phase for analytical reverse phase HPLC.

Linearity for vitamin D3 was determined in the range from 2.5 μg/mL to 100 μg/mL, and for vitamin D2 in the range from 5 to 100 μg/mL (Figure 2). The measured limits of detection for both vitamins were 1.25 μg/mL, and the limit of determination for vitamin D3 was 2.5 μg/mL, while for D2 it was 5 μg/mL.

Descriptive statistics was used to analyze the results and for statistical analysis the IBM SPSS Statistics software 25 was used. The results of descriptive statistics were presented as determined values (DV) ± measurement uncertainty, rounded to 2 decimal places, and percentage of difference between DV and LV.

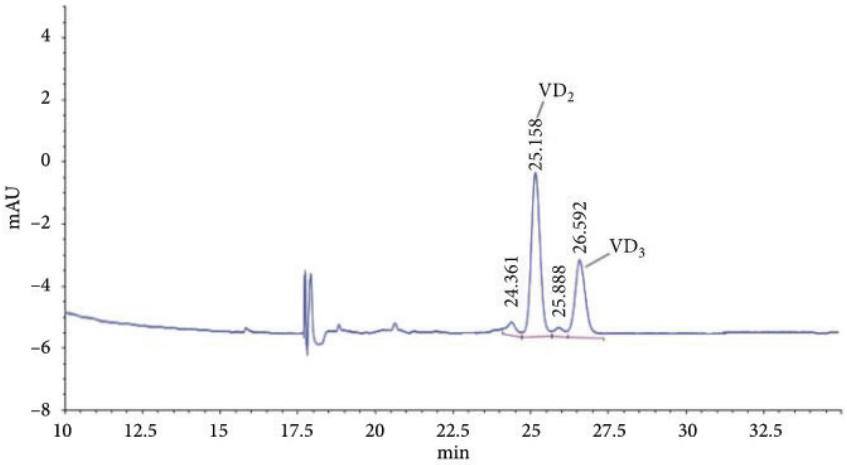

Figure 1. Chromatogram of vitamin D determination

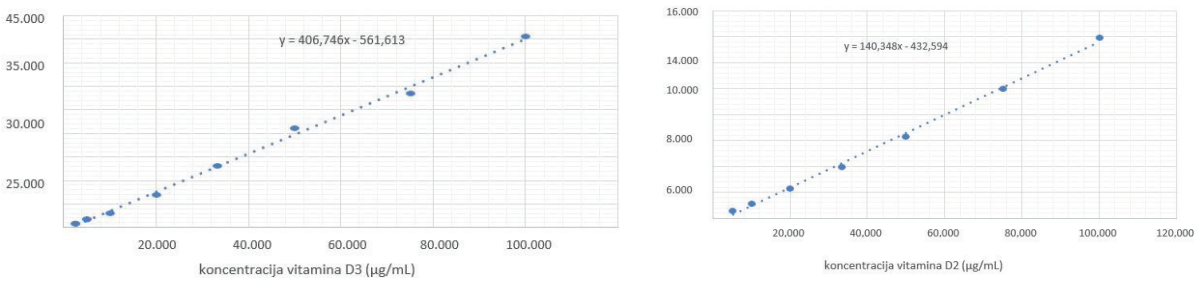

Figure 2. Calibration curve for vitamin D3 and vitamin D2

Results

Vitamin D content was tested in 49 samples of FS present on the market of Republic of Srpska and containing vitamin D2 or D3, alone or in combination with other active substances, in the form of capsules and tablets, including effervescent tablets. Thirty four samples in the form of tablets and 15 samples in the form of capsules were tested.

Tables 1 and 2 show the results obtained from the determination of vitamin D by the

Table 1. Vitamin D in FS in the form of tablets

Number of the sample	DV1 (± measurement uncertainty)	LV2 (-20% +50%)	Unit of measurement	(DV/LV) *100%	Difference of DV in relation to LV (%)
Sample 1	5.43 ± 1.10	5 (4.0–7.5)	µg/tablet	108.6	↑8.6
Sample 2	5.62 ± 1.12	5 (4.0–7.5)	µg/tablet	112.4	↑12.4
Sample 3	5.75 ± 1.15	5 (4.0–7.5)	µg/tablet	115	↑15
Sample 4	5.08 ± 0.98	5 (4.0–7.5)	µg/tablet	101.6	↑1.6
Sample 5	5.10 ± 0.87	5 (4.0–7.5)	µg/tablet	102	↑2
Sample 6	4.55 ± 0.91	5 (4.0–7.5)	µg/tablet	91	↑9
Sample 7	9.40 ± 1.88	10 (8.0–15.0)	µg/tablet	94	↑6
Sample 8	8.10 ± 1.62	10 (8.0–15.0)	µg/tablet	81	↑19
Sample 9	4.20 ± 0.84	5 (4.0–7.5)	µg/tablet	84	↑16
Sample 10	4.20 ± 0.84	5 (4.0–7.5)	µg/tablet	84	↑16
Sample 11	4.80 ± 0.96	5 (4.0–7.5)	µg/tablet	96	↑4
Sample 12	8.20 ± 1.64	10 (8.0–15.0)	µg/tablet	82	↑18
Sample 13	4.20 ± 0.84	5 (4.0–7.5)	µg/tablet	84	↑16
Sample 14	7.10 ± 1.42	7.5 (6–11.25)	µg/tablet	94.7	↑5.3
Sample 15	4.72 ± 0.94	2.5 (2.0–3.75)	µg/tablet	188.8	↑88.8
Sample 16	11.70 ± 2.34	10 (8.0–15.0)	µg/tablet	117	↑17
Sample 17	9.26 ± 1.85	10 (8.0–15.0)	µg/tablet	92.6	↑7.4
Sample 18	17.05 ± 3.41	20 (16.0–30.0)	µg/tablet	85.2	↑14.8
Sample 19	5.71 ± 1.14	5 (4.0–7.5)	µg/tablet	114.2	↑14.2
Sample 20	5.20 ± 1.04	6 (4.8–9.0)	µg/tablet	86.7	↑13.3
Sample 21	4.30 ± 0.86	5 (4.0–7.5)	µg/tablet	86	↑14
Sample 22	5.70 ± 1.14	5 (4.0–7.5)	µg/tablet	114	↑14
Sample 23	5.43 ±1.09	5 (4.0–7.5)	µg/tablet	108.5	↑8.5
Sample 24	5.51 ± 1.10	5 (4.0–7.5)	µg/tablet	110.2	↑10.2
Sample 25	5.00 ± 0.98	5 (4.0–7.5)	µg/tablet	100	0
Sample 26	4.48 ± 0.90	5 (4.0–7.5)	µg/tablet	89.6	↑10.4
Sample 27	4.77 ± 0.95	5(4.0–7.5)	µg/tablet	95.4	↑4.6
Sample 28	7.70 ± 2.00	7.5 (6.0–11.25)	µg/tablet	102.7	↑2.7
Sample 29	8.60 ± 1.72	7.5 (6.0–11.25)	µg/tablet	114.7	↑14.7
Sample 30	5.80 ± 1.16	5 (4.0–7.5)	µg/ daily dose	116	↑16
Sample 31	5.0 ± 0.98	5 (4.0–7.5)	µg/2 tablets	100	0
Sample 32	2.70 ± 0.54	3 (2.4–4.5)	µg/tablet	90	↑10
Sample 33	8.40 ± 1.68	10 (8.0–15.0)	µg/tablet	84	↑16
Sample 34	9.10 ± 1.82	10 (8.0–15.0)	µg/tablet	91	↑9

1 Determined value of vitamin D
2 Labeled value of vitamin D

HPLC method, their comparison to the labeled amount, as well as the deviations of the stated values.

The results in the tables are shown in the labeled units of measurement, that is, in μg per tablet, capsule or daily dose, g or mg per 100g, or in percentages for deviations. DV of vitamin D in the examined tablets ranged from 2.70 μg to 17.05 μg per tablet, and in capsules from 1.55 μg to 46.54 μg per capsule. Measurement uncertainty included in the interpretation of the results ranged from ± 0.31 μg to ± 9.31 μg, depending on the amount of vitamin D in the samples. LV ranged from 2.5 μg to 50 μg of vitamin D per pharmaceutical dosage form, amounting from 100 IU to 2000 IU, respectively. The tables show the percentage of difference of the determined value of vitamin D in relation to the labeled value (DV/LV*100%). This value ranged from 81% to 188.8% in tablet samples, while in capsule samples this value ranged from 64.4% to 170.0%.

The statistical parameters for all examined samples showed no statistical significance in difference of DV compared to LV (mean: 100.50%; Cl 95% -0.54 to 0.17; p=0.313 for tablets; mean: 98.02%; Cl 95% -3.00 to 0.42; p=0.127 for capsules).

Table 2. Vitamin D in FS in the form of capsules

Number of the sample	DV[1] (± measurement uncertainty)	LV[2] (-20% + 50%)	Unit of measurement	(DV/LV) *100%	Difference of DV in relation to LV (%)
Sample 1	1.55 ± 0.31	1.7 (1.36–2.55)	μg/capsule	91.2	↑8.8
Sample 2	46.54 ± 9.31	50 (40–75)	μg/capsule	93.1	↑6.9
Sample 3	4.21 ± 0.84	5 (4.0–7.5)	μg/capsule	84.2	↑15.8
Sample 4	6.08 ± 1.22	5 (4.0–7.5)	μg/capsule	121.6	↑21.6
Sample 5	4.20 ± 0.84	5 (4.0–7.5)	μg/capsule	84	↑16
Sample 6	8.50 ± 1.70	5 (4.0–7.5)	μg/capsule	170	↑70
Sample 7	16.10 ± 3.92	25 (20.0–37.5)	μg/capsule	64.4	↑35.6
Sample 8	8.70 ± 1.74	10 (8-15)	μg/capsule	87	↑13
Sample 9	43.00 ± 8.60	50 (40.0–75.0)	μg/capsule	86	↑14
Sample 10	2.49 ± 0.50	2.22 (1.78–3.33)	mg/100g	112.2	↑12.2
Sample 11	4.20 ± 0.84	5 (4.0–7.5)	μg/capsule	84	↑16
Sample 12	5.0 ± 0.5	5(4.0–7.5)	mg/100g	100	0
Sample 13	2.30 ± 0.46	2.22 (1.78–2.66)	mg/100g	103.6	↑3.6
Sample 14	9.84 ± 0.51	10 (8.0–15.0)	μg/capsule	98.4	↑1.6
Sample 15	9.06 ± 0.47	10 (8.0–15.0)	μg/capsule	90.6	↑9.4

1 Determined value of vitamin D

2 Labeled value of vitamin D

Discussion

Vitamin D is one of the most important nutrients playing an important role in growth, development and functioning of the human body. It improves the absorption of calcium and phosphate in the intestines, and by stimulating the function of osteoblasts, it contributes to the mineralization of the bone system [13]. It stimulates the cells of innate and acquired immunity, thereby strengthening the body's defense against infection, including infection caused by the SARS-COV 2 virus [14–16]. The basic anti-infective mechanism is based on the expression of cathelicidin and beta-defensin 2 in phagocytes and epithelial cells, which leads to inhibition of virus replication in the body [14–18]. Most of the effects of vitamin D are achieved by binding to the vitamin D receptor (VDR) and forming a heterodimeric complex, which further binds to the promoter regions of certain DNA genes called vitamin D responsive elements (VDREs). They affect gene expression, and as a result, the synthesis of cathelicidin and defensin β-2 in macrophages is stimulated. This leads to an increased phagocytic ability and chemotaxis of macrophages and monocytes which increases the efficiency of our immune system against infection and reduce the possibility of respiratory tract infections (RTIs) [14, 17, 18].

Age and chronic comorbidities, such as obesity and diabetes, significantly complicate the clinical picture of infection with SARS-COV 2 virus. Adequate supplementation can increase the level of regulatory T lymphocytes and thus reduce the risk of pneumonia and upper RTIs [18]. To reduce the risk of RTIs, some studies suggest that people with vitamin D deficiency could take vitamin D in dose of 10000 IU/day for several weeks before peak season for RTIs, to reach an optimal level of vitamin D in circulation, and then the dose is reduced to 5000 IU/day as long as it needs. With this regimen of oral supplementation, an optimal level of vitamin D in blood of 40 do 60 mg/mL (100 do 150 nmol/L) is achieved and maintained in long-terms with no side effects [18–20]. Furthermore, some guidelines say that in vitamin D deficient individuals, optimal levels of vitamin D can be achieved by taking 50.000 IU/week or 6.000 IU/day for several months, followed by a maintenance dose of 1.500–2.000 IU/day [21]. One study showed that the use of vitamin D in the dose of 100.000–200.000 IU for 8 weeks (1800–3600 IU/day) or 10.000 IU/day for four months did not cause any side effects [19]. Current research shows that acute toxicity of vitamin D is very rare, and the acute toxic dose has not been clearly defined to date, while chronic toxicity can be manifested after taking the dose higher than 50.000 IU/day for more than a month [22]. It is also necessary for the health of the muscular system [23]. It reduces the risk of developing cardiovascular diseases, and in the case of an already present disease, vitamin D supplementation reduces the degree of possible complications and mortality [24]. Vitamin D inhibits many processes such as carcinogenesis and inflammation, which contributes to the improvement of some other conditions such as diabetes mellitus [24, 25].

Specific risk factors and population groups in which vitamin D deficiency can be expected are: people who are rarely exposed to the sun, wear protective clothing and use sun protection products, people with dark skin, obese people, people taking medications that affect metabolism of vitamin D, hospitalized patients, elderly people and pregnant women. Also, low concentrations of vitamin D in the blood can be expected in numerous diseases, especially in osteoporosis, malabsorption of various etiologies, autoimmune diseases, acute and chronic kidney and liver diseases, neurological, endocrine and psychiatric diseases.

Daily requirements for vitamin D change with age and depend on physiological needs and the state of the organism. Concentrations of 25-hydroxycholecalciferol from 75 to 150

nmol/L are desirable in the population, and those lower than 50 nmol/L are insufficient for the health of the musculoskeletal system [26]. Considering all of the above, the European Food Safety Authority (EFSA) has recommended the optimal daily intake of vitamin D in food, namely for infants and newborn children 400 IU/day of vitamin D, for children over two years of age and adolescents 500 IU/day, while for the population aged 19 to 70 a daily dose of 600 IU/day is sufficient to achieve a vitamin D concentration of 50 nmol/L or above. For the population older than 70 years the recommended daily intake is 800 IU/day (20 μg) [2, 27]. Also, EFSA has determined an upper intake limit that is considered safe - 1000 IU/day for all infants up to 1 year of age, 2000 IU/day for children from 1 to 10 years of age and 4000 IU/day for children over 11 years of age and adults [28]. According to other sources, the maximum allowed daily intake of vitamin D for children is 1000 IU/day and for adults 2000 IU/day [29]. The stated limits refer to a healthy population. In disease states, they are much higher, as well as for patients with malabsorption syndrome, and they must be determined individually [30].

Thanks to the raising of awareness about the deficiency of vitamin D due to inadequate intake and its importance, there has been a significant increase in the consumption of FS containing vitamin D, so it is extremely important that such products on the market are of satisfactory quality, including the content of active components. Conditions that must be met by FS in order to be placed on the market are prescribed according to the Law on Food (Official Gazette of Republic of Srpska, No. 19/17) and the Rulebook on Food Supplements (Official Gazette of Republic of Srpska, No. 10/18). When labeling FS, it is necessary to state the declaration of nutritional value, which includes the amount recommended for daily use of vitamins and minerals or other active substances present in the product. According to the Rulebook on providing information to consumers about food (Official Gazette of Republic of Srpska, No. 9/18), the provision of information on food should be done in such a way that does not mislead the end consumer, which particularly refers to the characteristics of food, including the composition and quantities of food ingredients.

Research carried out in Slovenia showed that out of 24 tested FS containing vitamin D, two samples did not correspond to the prescribed permitted deviation of vitamin D from the LV, whereby one sample had a lower value than the labeled (36%), while the other contained a significantly higher amount than labeled (206%) [8]. Other studies showed that among examined samples, the measured value of vitamin D deviated by 8% to 177% from LV or 93% to 172% [9, 10].

The obtained results of our research show that there are certain minor differences in the determined content of vitamin D compared to the declared content, depending on the form of the FS itself. According to the Rulebook on Food and Health Claims (Official Gazette of Republic of Srpska, No. 19/18), the permitted deviation of the LV from the actual DV may be from -20% to +50% for vitamins in FS, i.e. the content must be within the range of 80% to 150% of the LV, including the measurement uncertainty.

During the analysis of FS in the form of tablets (Table 1), the DV of vitamin D was above the LV on the package itself in 14 samples (41.18%). The deviations ranged from +1.6% to +88.8%. In 20 samples (58.82%) the DV was below the declared value and the deviations ranged from -4% to -16%. It should be noted that only one sample (sample 15) was outside the permitted range according to the Regulation on Food and Health Claims, even when the measurement uncertainty was taken into account. This means that out of a total of 34 samples in tablet form 2.9% of the samples did not meet the requirements of the regulation or 2.0% of all examined samples.

During the analysis of products in the form of capsules (Table 2), in four samples (26.67%) the mean DV was above the LV of vitamin D on the packaging itself, with the range of deviations from +3.6% to +70%. In 11 samples (73.33%) the DV was below the declared value. The range of deviations was from -1.6% to -35.6%. One sample (sample 6) had a deviation of 70% higher than the LV and one sample (sample 7) had a deviation of 35.6% lower than the LV when mean values was taken into account. But if the measurement uncertainty for the DV was taken into account, the vitamin D content would met the requirements of the Rulebook on Food and Health Claims. In summary, the deviation of vitamin D content in nutritional supplements in the form of tablets and capsules amounts to -35.6% to +88.8%, i.e. the content is in the range of 64.4% to 188.8% of the declared value, which is close to the results obtained in EU countries [8, 9]. Only one sample does not meet the requirements of the legislation when measurement uncertainty is taken into account. The statistical analysis shows that there is no statistical significance in difference of DV compared to LV in examined samples (mean: 100.50%; Cl 95% -0.54 to 0.17; p=0.313 for tablets; mean: 98.02%; Cl 95% -3.00 to 0.42; p=0.127 for capsules).

Conclusion

The use of FS has recently been widespread in the general population, especially vitamin D. The content of physiologically active components in FS is a very important segment of product quality, because an insufficient amount does not lead to satisfactory efficiency and misleads the consumer, while an excessive amount can endanger consumers' health due to inadequate dosage, which is why we conducted a pilot study related to vitamin D content in FS. Our pilot research showed that most of the samples were safe and of satisfactory quality in terms of composition. One sample did not have the appropriate content of vitamin D (it was higher than labeled) and it had no statistical significance. Considering that only one sample out of 49 samples (2,0%) did not meet the quality requirements prescribed by legal acts, the quality of the tested FS present on the market of Republic of Srpska could be considered satisfactory.

Given the fact that taking the FS can influence consumers' health, it is necessary to control the qualitative and quantitative composition continuously, especially the active ingredients. In general, the quality and safety of FS should be imperative for producers and subjects in the food business who put them on the market.

Funding source. The authors received no specific funding for this work.

Ethical approval. This article does not contain any studies with human participants performed by any of the authors.

Conflicts of interest. The authors declare no conflict of interest.

References:

1. Kulda V. Metabolizmus vitaminu D [Vitamin D metabolism]. Vnitr Lek 2012;58(5):400–4.
2. EFSA PANEL ON DIETETIC PRODUCTS, NUTRITION AND ALLERGIES (NDA), et al. Dietary reference values for vitamin K. EFSA Journal 2017;15(5): e04780.
3. Holick MF. Sunlight, UV Radiation, Vitamin D, and Skin Cancer: How Much Sunlight Do We Need? Adv Exp Med Biol 2020;1268:19–36.
4. Guo J, Lovegrove JA, Givens DI. 25(OH)D3-enriched or fortified foods are more efficient at tackling inadequate vitamin D status than vitamin D3. Proc Nutr Soc 2018;77(3):282–91.
5. Benedik E. Sources of vitamin D for humans. Int J Vitam Nutr Res. 2022;92(2):118–25.
6. Borel P, Caillaud D, Cano NJ. Vitamin D bioavailability: state of the art. Crit Rev Food Sci Nutr 2015;55(9):1193-205.
7. Poniedziałek B, Niedzielski P, Kozak L, Rzymski P, Wachelka M, Rzymska I, et al. Monitoring of essential and toxic elements in multi-ingredient food supplements produced in European Union. J Consum Prot Food Saf 2018;13:41–8.
8. Žmitek K, Krušič S, Pravst I. An Approach to Investigate Content-Related Quality of Nutraceuticals Used by Slovenian Consumers: A Case Study with Folate and Vitamin D Supplements. Foods 2021;10(4):845.
9. Verkaik-Kloosterman J, Seves SM, Ocké MC. Vitamin D concentrations in fortified foods and dietary supplements intended for infants: Implications for vitamin D intake. Food Chem 2017;221:629–35.
10. Andrews KW, Pehrsson PR, Betz JM. Variability in Vitamin D Content Among Products for Multivitamin and Mineral Supplements. JAMA Intern Med 2013;173(18):1752–3.
11. Projekat SRPS EN 12821:2012 - Prehrambeni proizvodi - Određivanje vitamina D tečnom hromatografijom visoke performanse - Određivanje holekalciferola (D3) i ergokalciferola (D2). Institut za standardizaciju Srbije. Available from: https://iss.rs/sr_Cyrl/project/show/iss:proj:33686
12. Jelić D, Đermanović M. Instrumentalne metode. Banja Luka: Prirodno-matematički fakultet, 2020.
13. Bouillon R, Marcocci C, Carmeliet G, Bikle D, White JH, Dawson-Hughes B, et al. Skeletal and Extraskeletal Actions of Vitamin D: Current Evidence and Outstanding Questions. Endocr Rev 2019;40(4):1109–51.
14. Arikoglu T, Akyilmaz E, Yildirim DD, Batmaz SB, Ulger ST, Aslan G, et al. The relation of innate and adaptive immunity with viral-induced acute asthma attacks: Focusing on IP-10 and cathelicidin. Allergol Immunopathol (Madr) 2017;45(2):160–8.
15. Vranešić Bender D, Giljević Z, Kušec V, Laktašić Žerjavić N, Bošnjak Pašić M, Vrdoljak E, et al. Smjernice za prevenciju, prepoznavanje i liječenje nedostatka vitamina D u odraslih. Lijec Vjesn 2016;138(5-6):121–32.
16. Ilie PC, Stefanescu S, Smith L. The role of vitamin D in the prevention of coronavirus disease 2019 infection and mortality. Aging Clin Exp Res 2020;32(7):1195–8.
17. Chung C, Silwal P, Kim I, Modlin RL, Jo EK. Vitamin D-Cathelicidin Axis: at the Crossroads between Protective Immunity and Pathological Inflammation during Infection. Immune Netw 2020;20(2):e12.
18. Grant WB, Lahore H, McDonnell SL, Baggerly CA, French CB, Aliano JL, et al. Evidence that Vitamin D Supplementation Could Reduce Risk of Influenza and COVID-19 Infections and Deaths. Nutrients 2020;12(4):988.
19. Hadizadeh F. Supplementation with vitamin D in the COVID-19 pandemic? Nutr Rev 2021;79(2):200–8.
20. McCullough PJ, Lehrer DS, Amend J. Daily oral dosing of vitamin D3 using 5000 TO 50,000 international units a day in long-term hospitalized patients: Insights from a seven year experience. J Steroid Biochem Mol Biol 2019;189:228–39.
21. Holick MF, Binkley NC, Bischoff-Ferrari HA, Gordon CM, Hanley DA, Heaney RP, et al. Evaluation, treatment, and prevention of vitamin D deficiency: an Endocrine Society clinical practice guideline. J Clin Endocrinol Metab. 2011;96(7):1911–30.
22. Holick MF. Vitamin D Is Not as Toxic as Was Once Thought: A Historical and an Up-to-Date Perspective. Mayo Clin Proc 2015;90(5):561–4.

23. Dzik KP, Kaczor JJ. Mechanisms of vitamin D on skeletal muscle function: oxidative stress, energy metabolism and anabolic state. Eur J Appl Physiol 2019;119(4):825–39.

24. Manson JE, Cook NR, Lee IM, Christen W, Bassuk SS, Mora S, et al. Vitamin D Supplements and Prevention of Cancer and Cardiovascular Disease. N Engl J Med 2019;380(1):33–44.

25. Cojic M, Kocic R, Klisic A, Kocic G. The Effects of Vitamin D Supplementation on Metabolic and Oxidative Stress Markers in Patients With Type 2 Diabetes: A 6-Month Follow Up Randomized Controlled Study. Front Endocrinol (Lausanne) 2021;12:610893.

26. Vranešić Bender D, Giljević Z, Kušec V, Laktašić Žerjavić N, Bošnjak Pašić M, Vrdoljak E, et al. Smjernice za prevenciju, prepoznavanje i liječenje nedostatka vitamina D u odraslih. Lijec Vjesn 2016;138:121–32.

27. Martínez Redondo I, García Romero R, Calmarza P, de Arriba Muñoz A, Martínez-Redondo D, Sanz Paris A. Déficit de vitamina D en una población pediátrica sana. La importancia de una adecuada profilaxis [Vitamin D insufficiency in a healthy pediatric population. The importance of early prophylaxis]. Nutr Hosp 2021;38(6):1155–61.

28. Agostoni C, Bresson JL, Tait SF, Flynn A, Golly I, Korhonen H, et al. Scientific Opinion on the Tolerable Upper Intake Level of Vitamin D. EFSA panel on dietetic products, nutrition and allergies (NDA). EFSA Journal 2012;10(7):2813.

29. Fuleihan GH, Bouillon R, Clarke B, Chakhtoura M, Cooper C, McClung M, et al. Serum 25-hydroxyvitamin D levels: variability, knowledge gaps, and the concept of a desirable range. J Bone Miner Res 2015;30(7):1119–33.

30. Fletcher J, Cooper SC, Ghosh S, Hewison M. The Role of Vitamin D in Inflammatory Bowel Disease: Mechanism to Management. Nutrients 2019;11(5):1019.

Sadržajni kvalitet dodataka ishrani sa vitaminom D na tržištu Republike Srpske

Ljubica Bojanić[1,2], Mirjana Đermanović[1,2]

[1]JZU Institut za javno zdravstvo Republike Srpske, Banja Luka, Republika Srpska, Bosna i Hercegovina

[2]Univerzitet Banja Luka, Medicinski fakultet, Katedra za farmakologiju, Banja Luka, Republika Srpska, Bosna i Hercegovina

Uvod. Vitamin D je liposolubilni vitamin koji ima mnogobrojne značajne uloge u ljudskom organizmu. Dnevne potrebe za vitaminom D zadovoljavaju se unosom hrane i izlaganjem sunčevoj svjetlosti. Visoka učestalost nedostatka vitamina D je javnozdravstveni problem koji se može korigovati dodacima ishrani, te danas postoji sve veće nastojanje u potrošnji dodataka. S obzirom da njihov kvalitet, uključujući i sadržaj aktivne komponente, zavisi od dobre proizvođačke prakse, koja nije strogo regulisana za proizvodnju dodataka ishrani, kao i formulacije, pakovanja i načina čuvanja, na tržištu se mogu naći dodaci ishrani različitog kvaliteta. Cilj našeg pilot istraživanja je bio ispitati usklađenost stvarno utvrđenog sadržaja vitamina D i deklarisanog sadržaja u 49 dodataka ishrani u obliku tableta i kapsula prisutnih na tržištu u Republici Srpskoj.

Metod. Određivanje sadržaja vitamina D je izvršeno tečnom hromatografijom visokih performansi (HPLC).

Rezultati. Opseg utvrđenog sadržaja vitamina D u odnosu na deklarisani sadržaj, izražen u procentima, bio je od 64,4% do 188,8%, pri čemu odstupanje nije statistički značajno (mean: 100,50%; Cl 95% -0,54 do 0,17; p=0,313 tablete; mean: 98,02%; Cl 95% -3,00 do 0,42; p=0,127 kapsule). Kada se uzme u obzir mjerna nesigurnost, samo jedan uzorak u obliku tableta je bio izvan zakonom dozvoljenog opsega (88,8% više od označenog).

Zaključak. Dakle, pokazano je da većina ispitanih proizvoda ima zadovoljavajući kvalitet u pogledu sadržaja vitamina D, ali je i dalje neophodno vršiti kontinuiranu kontrolu dodataka ishrani koji se nalaze na tržištu.

Ključne riječi: holekalciferol, dodaci ishrani, sigurnost, deklaracija, HPLC