J Biochem Technol (2026) 17(1): 90-101
https://doi.org/10.51847/SKhJDkcfYP
ISSN: 0974-2328

Correction of Micronutrient Status in Women of the North Caucasus Using Phytoadaptogens

Mansur Lechievich Muradov*, Ramzan Ruslanovich Surgaev, Magomed Mikailovich Kartoyev, Madina Rasulovna Rashipova, Alina Mursalovna Shinkarova, Leila Ramiddinovna Khidirova, Valentina Vladimirovna Kosenko, Milana Maratovna Gelyastanova, Yasmin Suleymanovna Kantaeva, Alina Pakhrudinovna Akhmedova

Received: 23 November 2025 / Received in revised form: 24 February 2026, Accepted: 24 February 2026, Published online: 15 March 2026

Abstract

This study aimed to evaluate the efficacy and safety of *Caucasica Adaptogen Complex* in improving vitamin and mineral status in women of reproductive age living in Southern Russia and the North Caucasus. The study included a subgroup of women with limited sun exposure due to wearing covered clothing. A total of 240 female students aged 18 to 25 years from Ingush State University and Dagestan State Medical University took part in the research. Participants were divided into three equal groups: a study group (receiving the developed preparation), a comparison group (taking a standard multivitamin complex), and a control group (receiving no intervention). The preparation is a two-component system with a morning capsule containing *Rhododendron adamsii* and *Rhaponticum carthamoides* extracts combined with iron, zinc, copper, manganese, iodine, and selenium. The evening capsule contains vitamin D3, calcium, magnesium, and chamomile extract. The supplementation period lasted 60 days. Results demonstrated a statistically significant increase in the proportion of participants with normal body weight in the study group from 55.0% to 67.5%. This change resulted from a simultaneous reduction in both underweight and overweight women. Vitamin D levels normalized from 18.4 to 34.2 ng/mL, and ferritin levels increased from 22.5 to 48.3 μg/L. Asthenia scores decreased by 29%, and over 70% of participants reported increased spontaneous physical activity. This preparation may be recommended for correcting micronutrient status and normalizing body weight in women living in Southern Russia and the North Caucasus.

Keywords: Vitamin D deficiency, Iron deficiency, Adaptogens, North Caucasus, Women's health, micronutrients

Mansur Lechievich Muradov*, Ramzan Ruslanovich Surgaev
Faculty of Medicine, Medical Institute, Chechen State University named after A.A.Kadyrov, Grozny, Republic of Chechnya, Russia.

Magomed Mikailovich Kartoyev
Faculty of Medicine, Medical Institute, Ingush State University, Magas, Republic of Ingushetia, Russia.

Madina Rasulovna Rashipova, Alina Mursalovna Shinkarova
Faculty of Medicine, Dagestan State Medical University, Makhachkala, Republic of Dagestan, Russia.

Leila Ramiddinovna Khidirova
Faculty of Pediatrics, Dagestan State Medical University, Makhachkala, Republic of Dagestan, Russia.

Valentina Vladimirovna Kosenko
Faculty of Medicine, Stavropol State Medical University, Stavropol, Russia.

Milana Maratovna Gelyastanova
Medical Academy, Kabardino-Balkarian State University named after H.M. Berbekov, Nalchik, Republic of Kabardino-Balkaria, Russia.

Yasmin Suleymanovna Kantaeva
Faculty of Medicine and Prevention, Rostov State Medical University, Rostov-on-Don, Russia.

Alina Pakhrudinovna Akhmedova
Faculty of Medicine, Moscow Medical University "Reaviz", Moscow, Russia.

***E-mail:** mansurmuradov200188@gmail.com

Introduction

Southern Russia and the North Caucasus are traditionally perceived as regions with favorable climates, abundant sunlight, and diverse diets. This creates an illusion that the local population is automatically provided with all necessary micronutrients. However, modern medicine and nutrition science reveal a paradox. These regions with high isolation levels actually show some of the highest rates of vitamin and mineral deficiencies among the female population. This contradiction stems from a complex set of interrelated factors, including geochemical soil characteristics, cultural and religious traditions, and specific dietary behaviors.

The study territory covers a vast macro-region including the Republic of Dagestan, the Chechen Republic, the Republic of Ingushetia, the Republic of North Ossetia-Alania, the Kabardino-Balkarian Republic, the Karachay-Cherkess Republic, the

Republic of Kalmykia, Stavropol Krai, and Krasnodar Krai. Despite their unique soil and climatic features, these regions share a fundamental problem: an imbalance in the trace element composition of their soils (Semenkov *et al*., 2020; Dyachenko *et al*., 2023; Mukabenova *et al*., 2024). Geochemical studies have revealed that soils in Stavropol Krai show variable micronutrient content due to anthropogenic impact, while agricultural lands in the Chechen Republic exhibit low levels of phosphorus and potassium. In Kalmykia, soils are depleted in most elements except boron and molybdenum, with low nitrogen and phosphorus content. These soil characteristics inevitably affect the mineral composition of locally grown crops and, consequently, the dietary intake of the population (Nagdalian *et al*., 2023; Soorya *et al*., 2024; Xi *et al*., 2025).

Iron deficiency conditions are particularly clinically significant. Statistical data indicate that while latent iron deficiency averages 30-40% across Europe and Russia, in some North Caucasus regions this figure reaches 50-60% percent (Zhetishev *et al*., 2022; Bushueva *et al*., 2025). Clinically manifest iron deficiency anemia is diagnosed in ten to twelve percent of women of childbearing age. Women face an increased risk of iron deficiency due to physiological blood loss. When dietary iron intake from local foods is low, this risk increases substantially (Bao *et al*., 2024; Burns *et al*., 2025).

One group of women requires special and focused attention: those whose lifestyle is shaped by religious and cultural traditions. A significant portion of the Muslim population in the North Caucasus, including the Chechen Republic, the Republic of Dagestan, the Republic of Ingushetia, the Karachay-Cherkess Republic, and the Kabardino-Balkarian Republic, traditionally wears covered clothing. This clothing almost completely minimizes skin contact with sunlight. This creates a unique clinical situation. Although these women live in regions with high insolation levels, they experience vitamin D deficiency comparable to, and sometimes more severe than, that of residents in northern latitudes (Buyukuslu *et al*., 2014; Al-Yatama *et al*., 2019; Almelli, 2023). Vitamin D is synthesized in the skin under the influence of ultraviolet radiation (Tsiaras & Weinstock, 2011; Razzaque *et al*., 2019). Covered clothing almost completely blocks this process. From November to March, effective vitamin D synthesis is difficult even for people with sun-exposed skin due to the low sun angle. For women wearing covered clothing, this results in a chronic, profound vitamin D deficiency that persists year-round **(Figure 1)** (Webb *et al*., 1988; Guzel *et al*., 2001; Qureshi *et al*., 2024).

Vitamin D deficiency, in turn, exacerbates problems with calcium and magnesium absorption (Wimalawansa, 2024; Silva *et al*., 2025). It negatively affects immune status, energy levels, and psycho-emotional state (Hendi & Nemer, 2023). This contributes to the development of asthenic syndrome, muscle weakness, and increased fatigue (Cheung *et al*., 2016; Bouillon *et al*., 2019; Musazadeh *et al*., 2023). Combined with insufficient iron, iodine, selenium, and other trace elements, a complex set of symptoms emerges. This manifests as reduced quality of life, decreased work capacity, and impaired cognitive function.

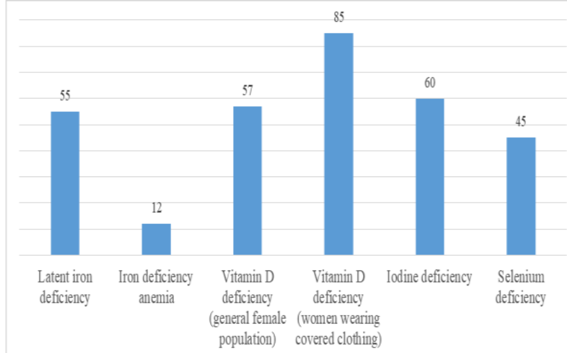


Figure 1. Prevalence of micronutrient deficiencies among the female population of Southern Russia and the North Caucasus

To address the complex, multi-component problem described above, we propose the concept of *Caucasica Adaptogen Complex*. This phytopreparation combines plant-based adaptogens with a targeted vitamin-mineral formulation selected according to regional specificities. The basis of the preparation consists of two key plant components with proven efficacy.

The first component is *Rhododendron adamsii*, known in traditional medicine as *Sagan-Dailya*. This is a powerful adaptogen whose mechanism of action differs fundamentally from that of conventional stimulants such as caffeine. *Sagan-Dailya* does not deplete the nervous system. Instead, it enhances neuroplasticity and the body's ability to adapt to stressful loads. Research confirms that *Rhododendron adamsii* extract significantly increases physical endurance and exhibits pronounced antioxidant activity (Olennikov *et al*., 2021; Bhatt *et al*., 2022). It contains over one hundred and seventy compounds, including flavonoids. These substances gently stimulate the central nervous system and improve metabolic processes. For women suffering from chronic fatigue associated with micronutrient deficiencies, this component is intended to restore energy tone without negatively affecting the nervous system or sleep (Jing *et al*., 2015; Hussain *et al*., 2025; Katanskaya *et al*., 2025).

The second component is *Rhaponticum carthamoides* (*Leuzea*), which contains phytoecdysteroids, particularly 20-hydroxyecdysone. These compounds have demonstrated anabolic effects. They promote protein synthesis while simultaneously improving fatty acid utilization. The mechanism of phytoecdysone action involves activating metabolic pathways that encourage the body to use fat reserves as an energy source (Todorova, 2021; Shuvalov *et al*., 2024). Thus, *Leuzea* not only increases physical performance but also provides a mild fat-burning effect (Figueroa-Valverde *et al*., 2024; Jagsi *et al*., 2024; Noor *et al*., 2024; Wolderslund *et al*., 2024; Wong *et al*., 2024). This is particularly relevant for women with excess body weight and metabolic disorders, which often accompany deficiencies in iodine and other trace elements (Todorova *et al*., 2022; Zheng *et al*., 2023).

The plant base is supplemented with a vitamin-mineral complex. This includes a higher dosage of vitamin D3, necessary for women who wear covered clothing. It also contains iodine, selenium, iron, zinc, magnesium, and calcium in synergistic combinations that ensure maximum bioavailability (Richards *et al*., 2025).

This study aims to provide a theoretical rationale for and develop the concept of *Caucasica Adaptogen Complex*. This preparation is intended to correct vitamin-mineral status, increase energy levels, and improve anthropometric parameters in women of reproductive age living in Southern Russia and the North Caucasus. The study includes a subgroup of women with limited sun exposure due to wearing covered clothing.

Materials and Methods

Composition and Formulation of Caucasica Adaptogen Complex

The developed phytopreparation *Caucasica Adaptogen Complex* is a two-component system consisting of morning and evening capsules. These are intended for separate administration to account for chronobiological features of micronutrient absorption and adaptogen action (Almoosawi *et al*., 2019; Franzago *et al*., 2023). The capsules have a plant-based shell and contain no artificial colors or preservatives. Detailed composition of the preparation, including dosages and percentage of the recommended daily intake, is presented in **Table 1**.

Table 1. Composition of *Caucasica Adaptogen Complex*

Component	Dosage	% of daily value*
Morning capsule "Energy."		
***Rhododendron adamsii* extract**	250 mg	not standardized
***Rhaponticum carthamoides* extract**	200 mg	not standardized
Ferrous fumarate	14 mg	100%
Zinc citrate	11 mg	100%
Copper citrate	1 mg	100%
Manganese sulfate	2 mg	100%
Iodine (as potassium iodide)	150 mcg	100%
Selenium (as L-selenomethionine)	55 mcg	100%
Evening capsule "Recovery."		
Vitamin D3 (cholecalciferol)	2000 IU	1000%**
Calcium citrate	500 mg	50%
Magnesium citrate	300 mg	75%
Chamomile extract	100 mg	not standardized

Note: * percentage of daily value is indicated for women of reproductive age according to physiological requirements norms; ** exceeding the daily value is due to the need for correction of profound vitamin D deficiency in the target group

Administration Schedule and Dosage

Caucasica Adaptogen Complex is administered orally. The full course lasts 60 days. The morning capsule should be taken daily during the first half of the day, preferably during or immediately after breakfast. Each capsule must be swallowed with an adequate amount of water, at least 200 milliliters. The evening capsule should be taken daily during or immediately after dinner, also with a sufficient amount of water. The interval between taking the morning and evening capsules should be at least 10-12 hours.

Study Design and Participant Recruitment

This study is a prospective, randomized, controlled trial conducted from January to August 2025. Participants were recruited from two higher education institutions: Ingush State University and Dagestan State Medical University. Full-time female students aged 18 to 25 years who permanently reside in Southern Russia or the North Caucasus were invited to participate. All participants provided voluntary informed consent.

Inclusion criteria were female sex, age between 18 and 25 years inclusive, absence of severe somatic pathology in the decompensation stage, absence of pregnancy and lactation, and no intake of vitamin-mineral complexes or adaptogenic preparations for three months before the study. Exclusion criteria included chronic gastrointestinal diseases during exacerbation, thyroid disorders requiring medication, oncological diseases, mental disorders, and withdrawal of consent at any stage.

A total of 240 participants were enrolled. Using simple randomization, they were divided into three equal groups of 80 participants each. The first group was the study group. These participants received *Caucasica Adaptogen Complex* according to the schedule described above for 60 days. The second group was the comparison group. These participants received a standard multivitamin complex, *Centrum Women*, one capsule daily with food for 60 days. This preparation was chosen due to its balanced composition of essential vitamins and minerals and its wide availability on the Russian pharmaceutical market. The third group was the control group. These participants received no intervention throughout the observation period, allowing assessment of natural seasonal variations in the studied parameters.

Anthropometric and Laboratory Methods

At each study stage, all participants underwent a comprehensive examination, including anthropometric measurements and venous blood sampling for laboratory analysis. Anthropometric measurements were performed using standardized equipment.

Height was measured to the nearest 0.5 centimeter. Body weight was measured to the nearest 0.1 kilogram. Waist circumference was measured at the umbilical level, and hip circumference was measured at the widest point, both to the nearest 0.5 centimeter. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. The waist-to-hip ratio was additionally calculated to assess the fat distribution pattern. Based on BMI values, all participants were classified: underweight (BMI below 18.5), normal weight (BMI 18.5 to 24.9), overweight (BMI 25.0 to 29.9), and obese (BMI 30.0 and above).

Laboratory examinations were performed in an accredited clinical diagnostic laboratory. Venous blood was collected strictly on an empty stomach in the morning after a 12-hour fasting period. Serum vitamin D concentration was determined by chemiluminescent immunoassay. Serum iron and ferritin levels were measured by colorimetric methods. Calcium and magnesium levels were assessed. Urinary iodine concentration was determined. Serum selenium level was measured by inductively coupled plasma mass spectrometry. Thyroid-stimulating hormone and free thyroxine levels were evaluated to assess thyroid function. All participants also underwent a complete blood count to detect possible anemia and other hematological abnormalities.

In addition to objective methods, subjective parameters were assessed using standardized questionnaires. The *MFI-20* asthenia scale was used to evaluate fatigue levels and decreased activity. The *SF-36* quality of life questionnaire was administered to assess physical and psychological health components (Westenberger *et al*., 2022; Ware, 2025).

Study Stages and Duration

The study included three scheduled visits for participants. The first visit took place during the last ten days of January 2025. At this stage, initial anthropometric and laboratory examinations were performed for all participants. Questionnaires were completed, informed consent was signed, and group allocation was performed. Participants in the study group and comparison group received the full course of their respective preparations along with detailed instructions and a diary to record any possible side effects and monitor adherence.

The second visit occurred during the first ten days of April 2025, immediately after completion of the 60-day supplementation course. At this stage, all anthropometric measurements, blood sampling for laboratory analysis, and questionnaires were repeated. Diaries and empty packaging were collected from study and comparison group participants to monitor compliance.

The third visit took place in late July to early August 2025, six months after the start of the study and four months after completion of the supplementation course. This stage was designed to assess long-term outcomes and the persistence of achieved effects. All anthropometric and laboratory examinations and questionnaires were repeated.

Statistical Analysis

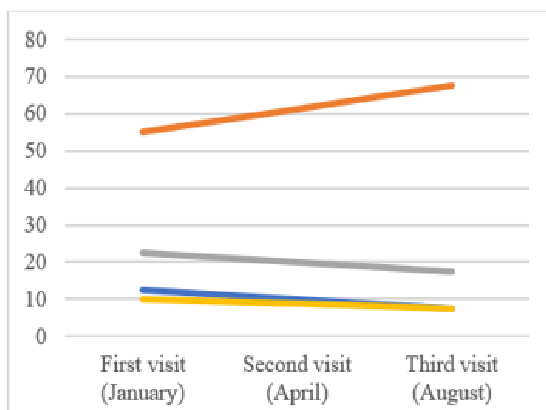
Statistical processing of the obtained data was performed using the Statistica software package. Arithmetic means and standard deviations were calculated for each sample. Comparison of quantitative parameters among the three groups was conducted using one-way analysis of variance. For comparison of qualitative parameters, such as the proportion of individuals with underweight and overweight in each group before and after intervention, the chi-square test was applied. Differences were considered statistically significant at $p < 0.05$.

Results and Discussion

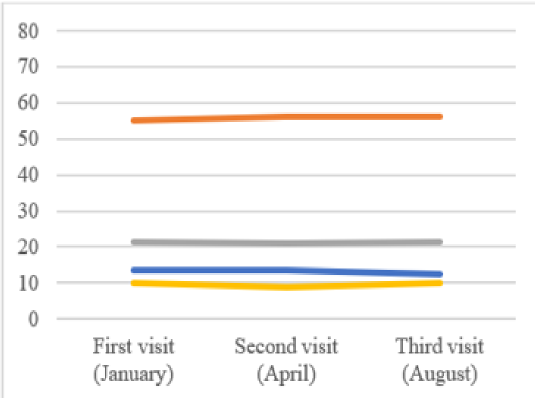
The study conducted a comprehensive analysis of the dynamics of anthropometric, laboratory, and subjective parameters in participants from all three groups at each control stage. It is fundamentally important that none of the participants received recommendations regarding diet, dietary changes, or additional physical exercise during the study. All recorded changes resulted exclusively from taking the studied preparations and their effects on metabolic processes and the level of daily physical activity.

Dynamics of Participant Distribution by Body Mass Index Categories

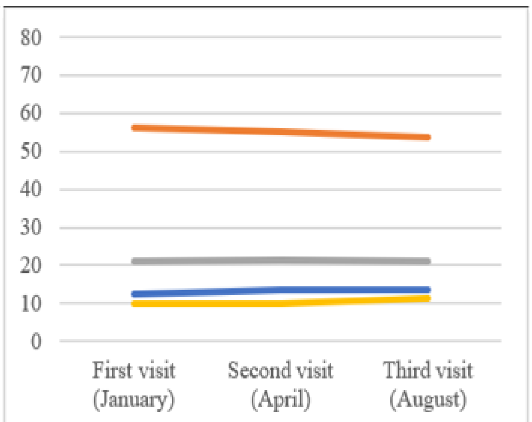
The transformation of the distribution structure of participants by BMI categories is of greatest interest for assessing the preparation's efficacy. Categorical analysis allows identification of the multidirectional effects of the preparation. It can simultaneously correct underweight in some participants and reduce excess weight in others. **Figure 2** presents baseline data from the first visit and the dynamics of changes at the second and third visits for all three observation groups.



a)



b)



c)

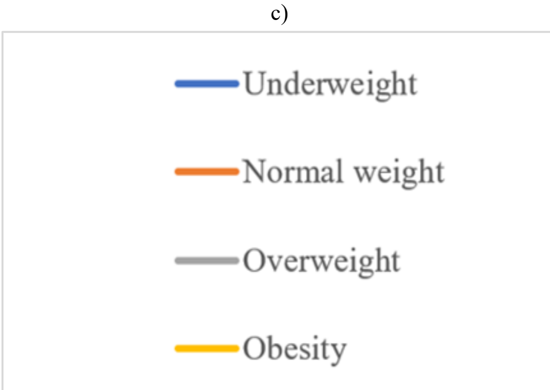


Figure 2. Distribution of participants by BMI categories at all observation stages, percentage of the group size a) Study group, b) Comparison group, C) Control group

As shown in **Figure 2**, the most pronounced changes occurred in the study group, and these changes were bidirectional in nature. The proportion of participants with normal body weight increased from 55.0% to 67.5%, representing a total increase of 12.5 percentage points. The proportion of underweight participants decreased from 12.5% to 7.5%. Simultaneously, the proportion of overweight participants decreased from 22.5% to 17.5%, and those with obesity decreased from 10.0% to 7.5%. By the end of the observation period, more than two-thirds of participants in the study group had achieved normal anthropometric parameters.

In the comparison group, which received the standard multivitamin complex, and in the control group, no such pronounced dynamics were observed. The distribution of participants across BMI categories remained stable throughout the observation period, with minor fluctuations that were not statistically significant. The control group even showed a slightly unfavorable trend toward a reduced proportion of individuals with normal body weight. This likely reflects natural seasonal variations and underscores the significance of the intervention in the study group.

Dynamics of Laboratory Parameters

Analysis of laboratory data allowed assessment of the investigational preparation's effect on correcting micronutrient deficiencies characteristic of the region's female population. It also enabled tracking of seasonal changes in the comparison and control groups. **Table 2** presents the mean concentrations of key micronutrients in the serum of participants from all three groups at each observation stage.

Table 2. Dynamics of laboratory parameters in the observation groups

Parameter	First visit (January)	Second visit (April)	Third visit (August)	Reference values
		Study group		
Vitamin D, ng/mL	18.4 ± 4.2	32.6 ± 5.1	34.2 ± 4.8	30-100
Ferritin, μg/L	22.5 ± 8.3	45.7 ± 9.2	48.3 ± 8.7	15-150
Serum iron, μmol/L	10.2 ± 2.1	15.8 ± 2.4	16.2 ± 2.3	9-30
Selenium, μg/L	65.4 ± 7.8	82.6 ± 6.9	84.1 ± 7.2	70-150
Calcium, mmol/L	2.15 ± 0.08	2.28 ± 0.07	2.31 ± 0.06	2.15-2.50
Magnesium, mmol/L	0.72 ± 0.06	0.82 ± 0.05	0.84 ± 0.05	0.66-1.07
Iodine (urine), μg/L	65.8 ± 12.4	98.3 ± 10.7	102.5 ± 11.2	100-200
		Comparison group		

Vitamin D, ng/mL	18.7 ± 4.0	21.3 ± 4.5	26.8 ± 5.2	30-100
Ferritin, µg/L	23.1 ± 7.9	28.4 ± 8.1	30.2 ± 8.5	15-150
Serum iron, µmol/L	10.5 ± 2.2	12.1 ± 2.3	13.4 ± 2.4	9-30
Selenium, µg/L	66.2 ± 7.5	71.3 ± 7.8	73.5 ± 7.6	70-150
Calcium, mmol/L	2.16 ± 0.07	2.20 ± 0.08	2.24 ± 0.07	2.15-2.50
Magnesium, mmol/L	0.73 ± 0.05	0.76 ± 0.06	0.78 ± 0.06	0.66-1.07
Iodine (urine), µg/L	66.5 ± 11.8	78.2 ± 12.3	85.6 ± 11.9	100-200
		Control group		
Vitamin D, ng/mL	18.9 ± 4.1	20.1 ± 4.3	24.5 ± 5.0	30-100
Ferritin, µg/L	22.8 ± 8.0	23.5 ± 8.2	24.1 ± 8.4	15-150
Serum iron, µmol/L	10.3 ± 2.1	10.8 ± 2.2	11.5 ± 2.3	9-30
Selenium, µg/L	65.8 ± 7.6	66.9 ± 7.9	68.2 ± 8.0	70-150
Calcium, mmol/L	2.15 ± 0.08	2.17 ± 0.08	2.20 ± 0.07	2.15-2.50
Magnesium, mmol/L	0.72 ± 0.06	0.73 ± 0.06	0.75 ± 0.06	0.66-1.07
Iodine (urine), µg/L	66.3 ± 12.1	68.5 ± 12.5	72.4 ± 13.0	100-200

Analysis of laboratory data revealed significant differences between the groups. In the study group, the most pronounced positive dynamics were observed for vitamin D. Its level reached the lower limit of normal by April and remained within reference values for the vast majority of participants by August. A significant increase in ferritin and serum iron levels indicated effective correction of iron deficiency. Importantly, the achieved values persisted for four months after completion of the supplementation course. Positive dynamics in selenium and iodine levels also confirmed the adequacy of the selected dosages.

In the comparison group, which received the standard multivitamin complex, positive dynamics in laboratory parameters were also recorded, although they were less pronounced. Vitamin D levels increased from 18.7 to 26.8 ng/mL. However, by August, they had not reached the lower limit of normal and remained in the insufficiency range. Ferritin levels increased but did not reach the values observed in the study group. It is interesting to note that both the comparison group and the control group showed natural seasonal improvement in parameters by August. This was associated with increased intake of fresh vegetables, fruits, and greens during the summer period. Nevertheless, even accounting for the seasonal factor, the comparison group's parameters were inferior to those of the study group.

In the control group, which received no intervention, some positive dynamics were also recorded by August, attributable exclusively to seasonal factors. Vitamin D levels increased from 18.9 to 24.5 ng/mL due to natural isolation but remained in the insufficiency range. Ferritin and serum iron levels increased slightly, probably due to fresh plant food intake, but these changes were not statistically significant. The obtained data confirm that even under conditions of a favorable southern summer, natural correction of micronutrient deficiencies occurs slowly and does not reach optimal values without targeted pharmacological support.

Dynamics of Subjective Quality of Life Parameters

Assessment of subjective perception of one's own condition using standardized questionnaires revealed significant differences between the groups. These differences were quantifiable. **Table 3** presents the mean scores on the *MFI-20* asthenia scale and the *SF-36* quality of life questionnaire at all observation stages.

Table 3. Dynamics of subjective quality of life parameters in the observation groups

Parameter	First visit (January)	Second visit (April)	Third visit (August)
	Study group		
***MFI-20* Asthenia Scale (total score)**	68.4 ± 5.2	52.3 ± 4.8	48.6 ± 4.5
***SF-36* physical component**	42.5 ± 3.8	48.7 ± 3.5	51.2 ± 3.4
***SF-36* psychological component**	40.2 ± 4.1	47.3 ± 3.9	50.8 ± 3.7
	Comparison group		
***MFI-20* Asthenia Scale (total score)**	67.9 ± 5.0	63.5 ± 5.1	60.2 ± 4.9
***SF-36* physical component**	42.8 ± 3.7	44.1 ± 3.8	45.6 ± 3.9
***SF-36* psychological component**	40.5 ± 4.0	42.3 ± 4.1	43.8 ± 4.2
	Control group		
***MFI-20* Asthenia Scale (total score)**	68.1 ± 5.1	67.2 ± 5.3	64.8 ± 5.0

***SF-36* physical component**	42.6 ± 3.8	43.2 ± 3.9	44.3 ± 4.0
***SF-36* psychological component**	40.4 ± 4.0	41.1 ± 4.2	42.5 ± 4.3

In the study group, a significant decrease in *MFI-20* asthenia scale scores was recorded, from 68.4 to 48.6. This indicates a marked reduction in general fatigue, increased activity, and improved motivation. Positive dynamics continued from the second to the third visit, suggesting that the effect persisted after completion of the supplementation course. According to the *SF-36* quality of life questionnaire, study group participants reported improvement in both the physical component of health, from 42.5 to 51.2 points, and the psychological component, from 40.2 to 50.8 points. By August, these values exceeded the average population norms (Csep *et al*., 2024; Ghiga *et al*., 2024; Jin *et al*., 2024; Osluf *et al*., 2024; Rypel *et al*., 2024; Clark & Foster, 2025; Joungtrakul & Smith, 2025; Kebe *et al*., 2025; Musa *et al*., 2025; Njoroge & Odhiambo, 2025; Raza *et al*., 2025).

The comparison group also showed positive dynamics in subjective parameters, although they were significantly less pronounced. The asthenia score decreased from 67.9 to 60.2, indicating some improvement in well-being, probably related to the correction of vitamin deficiencies. Quality of life indicators improved but did not reach the values observed in the study group. In the control group, the dynamics of subjective parameters were minimal and likely attributable exclusively to seasonal improvement in mood and well-being during the summer period (Kęska & Suchy, 2024; Kounatidis *et al*., 2024; Lee & Ferreira, 2024; Negreiros & Ory, 2024; Noor *et al*., 2024; Abdullah *et al*., 2025; Jagsi *et al*., 2025; Petronis *et al*., 2025; Schneider & Krüger, 2025; Wong *et al*., 2025; Yu & Ma, 2025).

Of particular note, during unstructured interviews at the third visit, study group participants frequently reported increased spontaneous physical activity. Specifically, 78.7% of participants reported that waking up in the morning became easier, 71.2% noted a desire to walk more, 63.7% began using stairs instead of elevators more often, and 55.0% started spending more time outdoors. Importantly, none of the participants consciously changed their diet or intentionally began exercising. In the comparison group, only 25-30% of participants reported similar changes, while in the control group, the figure was no more than 15-20%. These observations suggest that normalization of micronutrient status and increased energy levels naturally lead to greater daily physical activity. Combined with the mild fat-burning effect of *Leuzea* phytoecdysones, this produced the recorded anthropometric changes.

The results demonstrate a clear positive effect of *Caucasica Adaptogen Complex* on anthropometric, laboratory, and subjective parameters in women of reproductive age from Southern Russia and the North Caucasus. Notably, improvements in body weight and metabolism occurred without any dietary or exercise recommendations. These changes resulted solely from normalized micronutrient status and increased energy levels due to the adaptogenic components.

The bidirectional effect of the preparation, manifested in a simultaneous reduction in the proportion of participants with excess body weight and a decrease in the number of underweight women, indicates a complex influence on the regulatory mechanisms of energy metabolism. Participants with initial underweight were able to absorb nutrients more fully and increase muscle mass through greater physical activity, while overweight participants activated lipolysis processes due to the mild stimulating effect of phytoecdysteroids.

The most impressive laboratory results were obtained for vitamin D deficiency correction. In the study group, vitamin D levels increased from 18.4 to 34.2 ng/mL, reaching optimal values. In the comparison group, levels reached only 26.8 ng/mL, and in the control group, 24.5 ng/mL, both remaining in the insufficiency range. These data confirm that even under conditions of southern summer, natural insolation cannot fully compensate for vitamin D deficiency, especially in women who limit skin contact with sunlight. Previous studies among women wearing covered clothing have shown that their vitamin D levels in winter are significantly lower than those of women with uncovered clothing, and correction requires dosages exceeding standard preventive amounts (Lips *et al*., 2019; Lips *et al*., 2021; Al-Khaldy *et al*., 2023).

Equally significant were the results of iron deficiency correction. In the study group, ferritin levels increased from 22.5 to 48.3 µg/L, indicating replenishment of iron stores. In the comparison group, the dynamics were less pronounced, and in the control group, they were practically absent. Research shows that iron deficiency prevalence among young women reaches significant levels, and persistent deficiency often remains with standard therapy. Achieving target values in the study group after only two months of supplementation, and maintaining the result four months after course completion, indicates high bioavailability of the iron form used and synergistic action of the components (Finkelstein *et al*., 2024; Pantopoulos, 2024).

Improvement in *MFI-20* asthenia scale scores and increased spontaneous physical activity in most study group participants align with research data on the effects of iron deficiency correction on functional capacity. It has previously been shown that iron supplementation improves cardiovascular system adaptive capacity, recovery time after exertion, and overall physical performance (Man *et al*., 2022; Ebea-Ugwuanyi *et al*., 2024; Pengelly *et al*., 2025).

The choice of *Rhododendron adamsii* as the energy component was based on its unique properties. Experimental studies have established that its decoction increases creatine phosphate and macronutrient compound content in skeletal muscles and enhances physical endurance. Critically, unlike commercial energy drinks, it does not cause convulsions, hyperactivity, or aggression even in overdose. These effects are attributed to the presence of flavonoids, ascorbic acid, glycosides, and terpenes, which increase cell membrane permeability to glucose. Over one hundred seventy biologically active compounds have been identified in its leaves (Razgonova *et al*., 2020; Liu *et al*., 2024; Razgonova *et al*., 2025).

The inclusion of *Rhaponticum carthamoides* was intended to enhance the anabolic and fat-burning components. It has been experimentally proven that the ecdysteroids and flavonoids it contains increase muscle mass gain without negative metabolic effects (Skała *et al*., 2018; Todorova *et al*., 2021; Todorova *et al*., 2022). The anabolic action of phytoecdysones occurs without interaction with androgen receptors, through activation of protein synthesis, which eliminates the side effects characteristic of steroidal anabolics.

The synergistic action of the two adaptogens, combined with the correction of micronutrient deficiencies, produced a comprehensive result. *Rhododendron adamsii* increased energy levels and spontaneous activity, iron improved oxygen transport function, *Leuzea* phytoecdysones shifted metabolism toward utilization of fat reserves, and normalization of vitamin D, calcium, and magnesium optimized neuromuscular transmission.

The comparison group, which received the standard multivitamin complex, also showed positive dynamics, although they were significantly less pronounced and were not accompanied by substantial changes in anthropometric data or quality of life. This confirms that standard complexes, created without consideration of regional characteristics and lacking adaptogens, do not address the complex of problems affecting the female population of Southern Russia and the North Caucasus.

The division of the daily dose into morning and evening administration allowed consideration of chronobiological features: stimulating components in the morning capsule provided energy effects during the day, while sedative components and vitamin D in the evening capsule promoted normalization of nighttime rest and absorption of fat-soluble vitamins.

Conclusion

This study confirmed the efficacy and safety of *Caucasica Adaptogen Complex* in women of reproductive age living in Southern Russia and the North Caucasus. The two-component formulation, developed considering regional geochemical characteristics and cultural-religious traditions, achieved statistically significant improvement in key health parameters of the target group.

The most important result was normalization of anthropometric parameters, manifested in a bidirectional effect. The proportion of participants with normal body weight increased from 55.0% to 67.5% due to a simultaneous reduction in the number of women with underweight, overweight, and obesity. Critically, these changes occurred without any dietary or exercise recommendations, solely through increased energy levels and spontaneous physical activity resulting from micronutrient status correction.

Laboratory studies confirmed effective replenishment of region-specific deficiencies. Vitamin D levels reached reference values, and ferritin, serum iron, selenium, and iodine levels normalized. No such changes were recorded in the comparison group receiving the standard multivitamin complex or in the control group. Even natural summer isolation and seasonal dietary enrichment failed to achieve optimal micronutrient levels without targeted pharmacological support.

Subjective quality of life parameters in the study group improved significantly. Asthenia scores on the *MFI-20* scale decreased by 29%, and physical and psychological health components on the *SF-36* questionnaire increased to levels exceeding average population values. Over 70% of participants reported increased spontaneous physical activity without external pressure.

Therefore, *Caucasica Adaptogen Complex* can be recommended for correcting micronutrient status, increasing energy levels, and normalizing body weight in women living in Southern Russia and the North Caucasus, particularly those with limited sun exposure due to wearing covered clothing. Future research perspectives include studying the efficacy of the preparation in other age groups and in the male population of the region.

Acknowledgments: None

Conflict of interest: None

Financial support: None

Ethics statement: The study was conducted in accordance with the ethical principles for medical research involving human subjects outlined in the Declaration of Helsinki. Written informed consent was obtained from all participants before enrollment. Each participant was informed about the study's purpose, procedures, potential benefits and risks, and her right to withdraw at any time without consequences for her education or medical care. The voluntary nature of participation was emphasized throughout the consent process. The study protocol was approved by the Ethics Committees of both participating universities: Ingush State University and Dagestan State Medical University.

References

Abdullah, N. A., Zulkifli, M. I., & Mohamed, A. S. (2025). Refinement of the 8th AJCC staging system for medullary thyroid cancer: Integrating tumor size and lymph node characteristics with SEER and multicenter validation. *Archives of International Journal of Cancer and Allied Sciences, 5*(2), 34–43. doi:10.51847/R1sIaONOms

Al-Khaldy, N. S., Al-Musharaf, S., Aljazairy, E. A., Hussain, S. D., Alnaami, A. M., Al-Daghri, N., & Aljuraiban, G. (2023). Serum vitamin D level and gut microbiota in women. *Healthcare (Basel), 11*(3), 351. doi:10.3390/healthcare11030351

Almelli, T. (2023). Distribution of Vitamin D Status in a Group from Syrian Society. *Jordan Journal of Pharmaceutical Sciences, 16*(4), 680–689. doi:10.35516/jjps.v16i4.786

Almoosawi, S., Vingeliene, S., Gachon, F., Voortman, T., Palla, L., Johnston, J. D., Van Dam, R. M., Darimont, C., & Karagounis, L. G. (2019). Chronotype: Implications for Epidemiologic Studies on Chrono-Nutrition and Cardiometabolic Health. *Advances in nutrition (Bethesda, Md.)*, *10*(1), 30–42. doi:10.1093/advances/nmy070

Al-Yatama, F. I., AlOtaibi, F., Al-Bader, M. D., & Al-Shoumer, K. A. (2019). The effect of clothing on vitamin D status, bone turnover markers, and bone mineral density in young Kuwaiti females. *International Journal of Endocrinology, 2019*, 6794837. doi:10.1155/2019/6794837

Bao, H., Huang, Y., Sun, Y., Chen, Y., Luo, Y., Yan, L., Man, S., Yu, C., Lv, J., Ge, M., et al. (2024). Prevalence of anemia of varying severity, geographic variations, and association with metabolic factors among women of reproductive age in China: A nationwide, population-based study. *Frontiers of Medicine, 18*(5), 850–861. doi:10.1007/s11684-024-1070-x

Belfiore, C. I., Galofaro, V., Cotroneo, D., Lopis, A., Tringali, I., Denaro, V., & Casu, M. (2024). Studying the Effect of Mindfulness, Dissociative Experiences, and Feelings of Loneliness in Predicting the Tendency to Use Substances in Nurses. *Journal of Integrative Nursing and Palliative Care, 5*, 1-7. doi:10.51847/LASijYayRi

Bhatt, V., Sendri, N., Swati, K., Devidas, S. B., & Bhandari, P. (2022). Identification and quantification of anthocyanins, flavonoids, and phenolic acids in flowers of *Rhododendron arboreum* and evaluation of their antioxidant potential. *Journal of Separation Science, 45*(14), 2555–2565. doi:10.1002/jssc.202200145

Bouillon, R., Marcocci, C., Carmeliet, G., Bikle, D., White, J. H., Dawson-Hughes, B., Lips, P., Munns, C. F., Lazaretti-Castro, M., Giustina, A., et al. (2019). Skeletal and extraskeletal actions of vitamin D: Current evidence and outstanding questions. *Endocrine Reviews, 40*(4), 1109–1151. doi:10.1210/er.2018-00126

Burns, J. L., Miller, C. H., Fontaine-Bisson, B., & Connor, K. L. (2025). Iron deficiency and iron deficiency anaemia in women of reproductive age: Sex- and gender-based risk factors and inequities. *Journal of trace elements in medicine and biology : organ of the Society for Minerals and Trace Elements (GMS)*, *90*, 127684. doi:10.1016/j.jtemb.2025.127684

Bushueva, T., Khubieva, M., Borovik, T., Skvortsova, V., Lukoyanova, O., Guseva, I., Chernikov, V., Komarova, O., Fisenko, A. (2025). Features of feeding young children in the regions of the North Caucasus Federal District. *Russian Pediatric Journal, 28*, 314–320. doi:10.46563/1560-9561-2025-28-5-314-320

Buyukuslu, N., Esin, K., Hizli, H., Sunal, N., Yigit, P., & Garipagaoglu, M. (2014). Clothing preference affects vitamin D status of young women. *Nutrition Research, 34*(8), 688–693. doi:10.1016/j.nutres.2014.07.012

Cheung, T. F., Cheuk, K. Y., Yu, F. W., Hung, V. W., Ho, C. S., Zhu, T. Y., Ng, B. K., Lee, K. M., Qin, L., Ho, S. S., et al. (2016). Prevalence of vitamin D insufficiency among adolescents and its correlation with bone parameters using high-resolution peripheral quantitative computed tomography. *Osteoporosis International, 27*(8), 2477–2488. doi:10.1007/s00198-016-3552-4

Clark, A., & Foster, H. (2025). Network pharmacology integration and experimental verification to elucidate the molecular mechanisms of triptolide in treating membranous nephropathy. *Pharmaceutical Sciences and Drug Design, 5*, 33–47. doi:10.51847/X9UVmVSJ4E

Csep, A. N., Voiţă-Mekereş, F., Tudoran, C., & Manole, F. (2024). Understanding and managing polypharmacy in the aging population. *Annals of Pharmacy Practice and Pharmacotherapy, 4*, 17–23. doi:10.51847/VdKr0egSln

Dyachenko, V. V., Shemanin, V. G., & Vishnevetskaya, V. V. (2023). The impact of technogenesis and aerosol geochemistry on the environment and public health in the south of Russia. *Geography, Natural Resources, 44*(4), 46–58. doi:10.15372/GIPR20230406

Ebea-Ugwuanyi, P. O., Vidyasagar, S., Connor, J. R., Frazer, D. M., Knutson, M. D., & Collins, J. F. (2024). Oral iron therapy: Current concepts and prospects for improving efficacy and outcomes. *British Journal of Haematology, 204*(3), 759–773. doi:10.1111/bjh.19268

Figueroa-Valverde, L., Marcela, R., Alvarez-Ramirez, M., Lopez-Ramos, M., Mateu-Armand, V., & Emilio, A. (2024). Statistical data from 1979 to 2022 on prostate cancer in populations of Northern and Central Mexico. *Bulletin of Pioneer Research in Medical and Clinical Sciences, 4*(1), 24–30. doi:10.51847/snclnafVdg

Finkelstein, J. L., Cuthbert, A., Weeks, J., Venkatramanan, S., Larvie, D. Y., De-Regil, L. M., & Garcia-Casal, M. N. (2024). Daily oral iron supplementation during pregnancy. *Cochrane Database of Systematic Reviews, 8*(8), CD004736. doi:10.1002/14651858.CD004736.pub6

Franzago, M., Alessandrelli, E., Notarangelo, S., Stuppia, L., & Vitacolonna, E. (2023). Chrono-nutrition: Circadian rhythm and personalized nutrition. *International Journal of Molecular Sciences, 24*(3), 2571. doi:10.3390/ijms24032571

Ghiga, I., Pitchforth, E., Lundborg, C. S., & Machowska, A. (2024). Bacterial infections and antibiotic resistance in Romanian children: Insights from a hospital-based study. *Interdisciplinary Research in Medical Sciences Special, 4*(2), 1–8. doi:10.51847/pISlxaQJVu

Guzel, R., Kozanoglu, E., Guler-Uysal, F., Soyupak, S., & Sarpel, T. (2001). Vitamin D status and bone mineral density of veiled and unveiled Turkish women. *Journal of Women's Health & Gender-Based Medicine, 10*(8), 765–770. doi:10.1089/15246090152636523

Hendi, N. N., & Nemer, G. (2023). Epigenetic regulation of vitamin D deficiency. *Epigenomics, 15*(12), 653–655. doi:10.2217/epi-2023-0246

Hussain, A., Azam, S., Maqsood, R., Anwar, R., Akash, M. S. H., Hussain, H., Wang, D., Imran, M., Kotwica-Mojzych, K., Khan, S., et al. (2025). Chemistry, biosynthesis, and theranostics of antioxidant flavonoids and polyphenolics of genus *Rhododendron*: An overview. *Naunyn-Schmiedeberg's Archives of Pharmacology, 398*(2), 1171–1214. doi:10.1007/s00210-024-03428-6

Jagsi, R., Lee, J., Roselin, D., Ira, K., & Williams, J. (2025). Do

U.S. medical schools follow medical associations' recommendations on paid parental leave for faculty? *Annals of Pharmacy Education, Safety and Public Health Advocacy, 5*, 1–11. doi:10.51847/r117In8wdi

Jin, L. W., Tahir, N. A. M., Islahudin, F., & Chuen, L. S. (2024). Exploring treatment adherence and quality of life among patients with transfusion-dependent thalassemia. *Annals of Pharmacy Practice and Pharmacotherapy, 4*, 8–16. doi:10.51847/B8R85qakUv

Jing, L., Ma, H., Fan, P., Gao, R., & Jia, Z. (2015). Antioxidant potential, total phenolic and total flavonoid contents of *Rhododendron anthopogonoides* and its protective effect on hypoxia-induced injury in PC12 cells. *BMC Complementary and Alternative Medicine, 15*, 287. doi:10.1186/s12906-015-0820-3

Joungtrakul, J., & Smith, I. D. (2025). Exploring the path from organizational justice to organizational citizenship behavior: Job commitment as a mediator. *Annals of Organizational Culture, Communications and Conflict, 6*, 31–35. doi:10.51847/DBvez9u8O9

Karatas, K. S. (2024). First episode psychotic disorder and COVID-19: A case study. *Bulletin of Pioneer Research in Medical and Clinical Sciences, 4*(1), 19–23. doi:10.51847/VP5xOKglSX

Katanskaya, V. M., Vasilyeva, O. G., Khramova, E. P., Sazhina, N. N., Goncharuk, E. A., Nechaeva, T. L., Zubova, M. Y., Aksenova, M. A., Lapshin, P. V., & Zagoskina, N. V. (2025). Rhododendron Microshoot Culture as a Source of Phenolic Antioxidants for Biomedicine. *Molecules, 30*(14), 2949. doi:10.3390/molecules30142949

Kebe, I. A., Kahl, C., & Liu, Y. (2025). The role of transformational leadership in enhancing employee performance: A study of the Vietnamese banking industry. *Annals of Organizational Culture, Communications and Conflict, 6*, 21–30. doi:10.51847/g7jtt7Qgxk

Kęska, M., & Suchy, W. (2024). Cardiovascular risk and systemic inflammation in rheumatoid arthritis: A comparative analysis with psoriatic arthritis. *Journal of Medical Sciences and Interdisciplinary Research, 4*(2), 30–40. doi:10.51847/PvcqitKMgB

Kounatidis, D., Dalamaga, M., Grivakou, E., Karampela, I., Koufopoulos, P., Dalopoulos, V., Adamidis, N., Mylona, E., Kaziani, A., Vallianou, N. G., et al. (2024). Evaluation of blood-aqueous barrier permeability in response to tetracycline antibiotics under normal and pathological conditions. *Interdisciplinary Research in Medical Sciences Special, 4*(2), 9–17. doi:10.51847/wu4fOEjgDv

Lee, M. J., & Ferreira, J. (2024). COVID-19 and children as an afterthought: Establishing an ethical framework for pandemic policy that includes children. *Asian Journal of Ethics in Health and Medicine, 4*, 1–19. doi:10.51847/haLKYCQorD

Lips, P., Cashman, K. D., Lamberg-Allardt, C., Bischoff-Ferrari, H. A., Obermayer-Pietsch, B., Bianchi, M. L., Stepan, J., El-Hajj Fuleihan, G., & Bouillon, R. (2019). Current vitamin D status in European and Middle East countries and strategies to prevent vitamin D deficiency: a position statement of the European Calcified Tissue Society. *European Journal of Endocrinology*, *180*(4), P23–P54. doi:10.1530/EJE-18-0736

Lips, P., de Jongh, R. T., & van Schoor, N. M. (2021). Trends in vitamin D status around the world. *JBMR Plus, 5*(12), e10585. doi:10.1002/jbm4.10585

Liu, X. J., Su, H. G., Peng, X. R., Bi, H. C., & Qiu, M. H. (2024). An updated review of the genus *Rhododendron* since 2010: Traditional uses, phytochemistry, and pharmacology. *Phytochemistry, 217*, 113899. doi:10.1016/j.phytochem.2023.113899

Man, Y., Xu, T., Adhikari, B., Zhou, C., Wang, Y., & Wang, B. (2022). Iron supplementation and iron-fortified foods: A review. *Critical Reviews in Food Science and Nutrition, 62*(16), 4504–4525. doi:10.1080/10408398.2021.1876623

Mukabenova, R., Mandzhieva, S., Rajput, V. D., Buluktaev, A., Zamulina, I., Adyanova, A., Dzhimbeev, N., Sayanov, V., Shende, S. S., Barakhov, A., et al. (2024). Assessment of soil properties and trace element accumulation in arid regions: A case study of Kalmykia's central dry steppe zone, Russia. *Eurasian Journal of Soil Science, 13*(1), 10–19. doi:10.18393/ejss.1365149

Musa, K., Noor, O., Ibrahim, M., & Saleh, A. (2025). A validated whole-body PBPK model of dextromethorphan and its metabolites for genotype-based prediction of CYP2D6 phenotype and urinary metabolic ratio. *Special Journal of Pharmacognosy, Phytochemistry and Biotechnology, 5*, 50–76. doi:10.51847/xbESBJHHcx

Musazadeh, V., Keramati, M., Ghalichi, F., Kavyani, Z., Ghoreishi, Z., Alras, K. A., Albadawi, N., Salem, A., Albadawi, M. I., Salem, R., et al. (2023). Vitamin D protects against depression: Evidence from an umbrella meta-analysis on interventional and observational meta-analyses. *Pharmacological Research, 187*, 106605. doi:10.1016/j.phrs.2022.106605

Nagdalian, A. A., Rzhepakovsky, I. V., Siddiqui, S. A., Povetkin, S. N., Verevkina, M. N., & Simonov, A. N. (2023). Analysis of the impact of zinc deficiency on the morphology of rat small intestine enterocytes. *Veterinary World, 16*(5), 1012–1021. doi:10.14202/vetworld.2023.1012-1021

Negreiros, A. B., & Ory, M. G. (2024). Navigating uncertain outcomes: Returning genomic results in children with developmental delays. *Asian Journal of Ethics in Health and Medicine, 4*, 20–27. doi:10.51847/grOfZd8oyo

Njoroge, E., & Odhiambo, S. (2025). Elucidating the therapeutic mechanisms of *Agrimonia pilosa* Ledeb. extract for acute myocardial infarction via network pharmacology and experimental validation. *Pharmaceutical Sciences and Drug Design, 5*, 48–63. doi:10.51847/eZOWCUj80m

Noor, H., Sabău, D., Coțe, A., Mihetiu, A. F., Pirvut, V., & Mălinescu, B. (2024). Advancements in esophageal stricture treatment: The role of stents in benign and malignant conditions. *Journal of Medical Sciences and Interdisciplinary Research, 4*(2), 47–52. doi:10.51847/LtuxAzRl0M

Olennikov, D. N., Nikolaev, V. M., & Chirikova, N. K. (2021). Sagan Dalya Tea, a new "old" probable adaptogenic drug: Metabolic characterization and bioactivity potentials of *Rhododendron adamsii* leaves. *Antioxidants, 10*(6), 863.

doi:10.3390/antiox10060863

Osluf, A. S. H., Shoukeer, M., & Almarzoog, N. A. (2024). Case report on persistent fetal vasculature accompanied by congenital hydrocephalus. *Asian Journal of Current Research in Clinical Cancer, 4*(1), 25–30. doi:10.51847/0gjOEudJNr

Pantopoulos, K. (2024). Oral iron supplementation: New formulations, old questions. *Haematologica, 109*(9), 2790–2801. doi:10.3324/haematol.2024.284967

Pengelly, M., Pumpa, K., Pyne, D. B., & Etxebarria, N. (2025). Iron deficiency, supplementation, and sports performance in female athletes: A systematic review. *Journal of Sport and Health Science, 14*, 101009. doi:10.1016/j.jshs.2024.101009

Petronis, Z., Golubevas, R., Rokicki, J. P., Guzeviciene, V., Sakavicius, D., & Lukosiunas, A. (2025). A systematic review and meta-analysis on trigeminal neuralgia linked to neurovascular compression using MRI analysis. *Journal of Current Research in Oral Surgery, 5*, 17–24. doi:10.51847/sptZWIrWeo

Qureshi, G., Khemissa, M., Amr, G., & Bhat, R. (2024). The non-conventional effects of hypovitaminosis D: A pandemic even in sunlight-rich countries. *Cureus, 16*(4), e59267. doi:10.7759/cureus.59267

Raza, S., Khan, A., Mehmood, F., & Farooq, U. (2025). Nationwide implementation of essential pharmacogenomic testing in the Netherlands: A decision-analytic model of lives saved and cost-effectiveness. *Special Journal of Pharmacognosy, Phytochemistry and Biotechnology, 5*, 39–49. doi:10.51847/PUWEymkYkk

Razgonova, M. P., Zakharenko, A. M., & Golokhvast, K. S. (2025). Supercritical CO2 extraction and tandem mass spectrometry of the medicinal plant Sagan Dalya (*Rhododendron adamsii*). *Pharmaceuticals (Basel), 18*(12), 1823. doi:10.3390/ph18121823

Razgonova, M., Zakharenko, A., Ercisli, S., Grudev, V., & Golokhvast, K. (2020). Comparative analysis of Far East Sikhotinsky Rhododendron (*Rh. sichotense*) and East Siberian Rhododendron (*Rh. adamsii*) using supercritical CO2-extraction and HPLC-ESI-MS/MS spectrometry. *Molecules, 25*(17), 3774. doi:10.3390/molecules25173774

Razzaque, M. A., Karim, M. N., Biswas, R. S. R., Islam, N., & Mallick, S. (2019). AB0917 pattern of serum cholecalciferol (vitamin D3) level among females in relation to clothing. *Annals of the Rheumatic Diseases, 78*(Suppl 2), 1925. doi:10.1136/annrheumdis-2019-eular.4866

Richards, J. D., Cori, H., Rahn, M., Finn, K., Bárcena, J., Kanellopoulos, A. K., Péter, S., & Spooren, A. (2025). Micronutrient bioavailability: concepts, influencing factors, and strategies for improvement. *Frontiers in Nutrition*, *12*, 1646750. doi:10.3389/fnut.2025.1646750

Rypel, J., Kubacka, P., Mykała-Cieśla, J., Pająk, J., & Bulska-Będkowska, W. (2024). Case presentation of breast adenoid cystic carcinoma. *Asian Journal of Current Research in Clinical Cancer, 4*(1), 18–24. doi:10.51847/6eOqq2KFjp

Schneider, T. L., & Krüger, B. E. (2025). Breast cancer-specific mortality in stage IV patients with small tumors: Insights from a population-based cohort. *Archives of International Journal of Cancer and Allied Sciences, 5*(2), 1–12. doi:10.51847/b9vFcweAVg

Semenkov, I., Konyushkova, M., Heidari, A., Nukhimovskaya, Y., & Klink, G. (2020). Data on the soilscape and vegetation properties at the key site in the NW Caspian Sea coast, Russia. *Data in Brief, 31*, 105714. doi:10.1016/j.dib.2020.105714

Shuvalov, O., Kirdeeva, Y., Fefilova, E., Daks, A., Fedorova, O., Parfenyev, S., Nazarov, A., Vlasova, Y., Krasnov, G. S., & Barlev, N. A. (2024). 20-Hydroxyecdysone boosts energy production and biosynthetic processes in non-transformed mouse cells. *Antioxidants, 13*(11), 1349. doi:10.3390/antiox13111349

Silva, T. D. B. D., Vieira, G. M. M., Fraga, L. T. S., Fernandes, W. D., Sakane, E. N., & Maeda, S. S. (2025). Supplements for bone health. *Archives of Endocrinology and Metabolism, 70*(Spe1), e20250374. doi:10.20945/2359-4292-2025-0374

Skała, E., Toma, M., Kowalczyk, T., Śliwiński, T., & Sitarek, P. (2018). *Rhaponticum carthamoides* transformed root extract inhibits human glioma cells viability, induces double-strand DNA damage, H2A.X phosphorylation, and PARP1 cleavage. *Cytotechnology, 70*(6), 1585–1594. doi:10.1007/s10616-018-0251-3

Soorya, M., Suganya, S., Elayarajan, M., Davamani, V., & Chitra, P. (2024). Nutrient nexus: Linking soil, plants, animals and humans. *Plant Science Today, 11*(sp4). doi:10.14719/pst.4562

Todorova, V., & Ivanov, K. (2021). Comparison between the biological active compounds in plants with adaptogenic properties (*Rhaponticum carthamoides, Lepidium meyenii, Eleutherococcus senticosus, and Panax ginseng*). *Plants (Basel), 11*(1), 64. doi:10.3390/plants11010064

Todorova, V., Ivanov, K., Delattre, C., Nalbantova, V., & Karcheva-Bahchevanska, D. (2021). Plant adaptogens—History and future perspectives. *Nutrients, 13*(8), 2861. doi:10.3390/nu13082861

Todorova, V., Ivanova, S., Georgieva, Y., Nalbantova, V., Karcheva-Bahchevanska, D., Benbassat, N., Savova, M. S., Georgiev, M. I., & Ivanov, K. (2022). Chemical composition and histochemical localization of essential oil from wild and cultivated *Rhaponticum carthamoides* roots and rhizomes. *Plants, 11*(15), 2061. doi:10.3390/plants11152061

Todorova, V., Savova, M. S., Ivanova, S., Ivanov, K., & Georgiev, M. I. (2023). Anti-adipogenic activity of *Rhaponticum carthamoides* and its secondary metabolites. *Nutrients, 15*(13), 3061. doi:10.3390/nu15133061

Tsiaras, W. G., & Weinstock, M. A. (2011). Factors influencing vitamin D status. *Acta Dermato-Venereologica, 91*(2), 115–124. doi:10.2340/00015555-0980

Ware, J. E., Jr. (2025). Improved items for estimating SF-36 profile and summary component scores: Construction and validation of an 8-item QOL General (QGEN) survey. *Medical Care, 63*(4), 300–310. doi:10.1097/MLR.0000000000002122

Webb, A. R., Kline, L., & Holick, M. F. (1988). Influence of season and latitude on the cutaneous synthesis of vitamin D3: Exposure to winter sunlight in Boston and Edmonton will not promote vitamin D3 synthesis in human skin. *Journal of Clinical Endocrinology & Metabolism, 67*(2), 373–378. doi:10.1210/jcem-67-2-373

Westenberger, A., Nöhre, M., Brähler, E., Morfeld, M., & de Zwaan, M. (2022). Psychometric properties, factor structure, and German population norms of the multidimensional fatigue inventory (MFI-20). *Frontiers in Psychiatry, 13*, 1062426. doi:10.3389/fpsyt.2022.1062426

Wimalawansa, S. J. (2024). Physiology of vitamin D: Focusing on disease prevention. *Nutrients, 16*(11), 1666. doi:10.3390/nu16111666

Wolderslund, M., Kofoed, P., & Ammentorp, J. (2024). Investigating the effectiveness of communication skills training on nurses' self-efficacy and quality of care. *Journal of Integrative Nursing and Palliative Care, 5*, 14–20. doi:10.51847/55M0sHLo3Z

Wong, Y., Lin, S., Cheng, H., Hsieh, T., Hsiue, T., Chung, H., Tsai, M., & Wang, M. (2025). Understanding the Impact of Medical Humanities on Internship Training and Performance. *Annals of Pharmacy Education, Safety, and Public Health Advocacy, 5*, 12-21. doi:10.51847/Z1fogzPksy

Xi, Z., Chen, C., Zhu, D., Zhu, H., & Liang, K. (2025). Selenium biofortification: A dual-edged sword of nutrition and contamination risk. *Comprehensive Reviews in Food Science and Food Safety, 24*(6), e70045. doi:10.1111/1541-4337.70045

Yu, M., Ma, Y., Han, F., & Gao, X. (2025). Effectiveness of mandibular advancement splint in treating obstructive sleep apnea: A systematic review. *Journal of Current Research in Oral Surgery, 5*, 25–32. doi:10.51847/AInSXrD9rc

Zheng, Z., Xian, Y., Jin, Z., Yao, F., Liu, Y., Deng, Y., Wang, B., Chen, D., Yang, J., Ren, L., et al. (2022). *Rhaponticum carthamoides* improved energy metabolism and oxidative stress through the SIRT6/Nrf2 pathway to ameliorate myocardial injury. *Phytomedicine, 105*, 154197. doi:10.1016/j.phymed.2022.154197

Zhetishev, R. A., Arkhestova, D. R., Beradji, B., Zhetisheva, I. S., & Klimov, L. Ya. (2022). Comparative characteristics of iron deficiency states in children of Nepal and the North Caucasus, taking into account the adherence to traditional nutrition and vegetarianism. *Medical News of North Caucasus, 17*(2), 149–153. doi:10.14300/mnnc.2022.17036