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Spirulina allergy: causes, symptoms, diagnosis, and treatment methods

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Abstract

Research on spirulina is relevant because this microalga is widely used as a dietary supplement due to its high content of proteins, vitamins, and minerals. The aim of the study was to investigate allergic reactions to spirulina and to identify possible causes of their occurrence using clinical symptom analysis, skin tests, and laboratory investigations. The methodology included collection of medical history, performance of skin allergy tests, determination of specific immunoglobulin E antibody levels, and analysis of clinical cases of patients with suspected allergy. Elevated levels of specific immunoglobulin E antibodies were detected in 65% of patients, indicating an allergic reaction. The most common symptoms were skin manifestations (45%), respiratory symptoms (25%), and gastrointestinal disorders (20%), while anaphylaxis occurred in 10% of cases. Increased interleukin-4 levels were observed in 68% of patients, and interleukin-13 levels were 50% higher than baseline values. Elevated C-reactive protein levels were detected in 58% of patients, indicating a systemic inflammatory response. Treatment consisted of elimination of spirulina from the diet, antihistamines (87% effectiveness), corticosteroids (90% effectiveness), and epinephrine administration in 5% of cases with anaphylaxis. The findings emphasized the importance of quality control of spirulina products and preliminary assessment of allergenicity. The results contributed to improved diagnosis and prevention of spirulina-induced allergic reactions.

Keywords: algae; food additive; hypersensitivity; immunity; impurities; toxins

Introduction

The relevance of studying spirulina-related allergic reactions stems from its increasing use as a dietary supplement, raising concerns about potential adverse effects in sensitive individuals. Although spirulina is widely consumed for its nutritional benefits, this manuscript focuses on documented clinical cases of allergic responses rather than general health outcomes. Allergic reactions can range from mild symptoms, such as rash,

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itching, or nasal congestion, to severe manifestations, including nausea, vomiting, difficulty breathing, and anaphylaxis (Birinci *et al*., 2025; Rahimova *et al*., 2024).

Previous research has primarily evaluated spirulina in terms of its health benefits (Firdaus, 2025; Kolte *et al*., 2025; Wang *et al*., 2025; Banerjee and Naz, 2024). In contrast, this observational clinical study investigates its allergenic potential through a case series. The severity of allergic reactions depends on individual susceptibility, and special attention was given to identifying whether symptoms arise from spirulina proteins themselves or from contaminants introduced during cultivation or processing (Gromek *et al*., 2024; Kumar *et al*., 2021; Ibraimova *et al*., 2020; Serikbaeva *et al*., 2021).

The impact of different spirulina formulations – powder, tablets, or capsules – was also considered, as production methods may influence allergenicity. Abrams *et al*. (2024) demonstrated through skin prick testing that allergic responses are primarily associated with spirulina protein components.

Although this study is primarily observational, laboratory analyses were conducted to support the clinical observations. El-Tantawi and Abo-Zeid (2020) reported that low and moderate doses of spirulina did not cause significant organ damage, while high doses led to structural alterations in the liver, kidneys, heart, and spleen, along with increased oxidative stress markers. Additionally, microbiological contamination and cyanotoxin presence in commercial spirulina supplements have been documented (Rhoades *et al*., 2023), highlighting the importance of stringent quality control to minimize allergic and toxic risks.

Materials and Methods

The work was conducted between January 2023 and June 2024. This study was conducted in accordance with the ethical principles of research, including anonymity, confidentiality, and beneficence, and in compliance with the Declaration of Helsinki of the World Medical Association. Ethical approval was obtained from the Health Research Ethics Commission of the National Medical Institute of the Ministry of the Interior and Administration (Poland) under No. RA-524, approved on 15 March 2023, following protocol reference No. NMI-2023-AL-07.

This observational clinical study included 150 participants aged 18-65 years. Inclusion criteria were: history of allergic reactions potentially linked to dietary supplements, willingness to undergo laboratory testing, and absence of severe comorbidities. Exclusion criteria included pregnancy, ongoing immunotherapy, uncontrolled chronic diseases, or prior hypersensitivity to non-spirulina cyanobacteria.

Participants were recruited via outpatient clinics and public advertisements, with screening performed using structured questionnaires. Case definitions for spirulina allergy were clearly established: patients with reproducible symptoms within 1-2 hours of spirulina ingestion and measurable increases in IgE or cytokine levels. Exposure confirmation included collection of product type, brand, dose, and batch information. The recruitment and enrolment process of study participants is summarized in Figure 1. Of approximately 200 individuals assessed for eligibility, 50 were excluded due to not meeting inclusion criteria, declining participation, or other reasons. A total of 150 participants were enrolled, all of whom completed the study and were included in the final analysis, along with a control group of 10 healthy individuals.

Primary and secondary endpoints were clearly defined. The primary endpoints of this study were the incidence and severity of allergic reactions following spirulina consumption, assessed through clinical evaluation and laboratory markers (serum IgE, IL-4, and IL-13 levels). Secondary endpoints included the association of allergic reactions with spirulina product characteristics (type, brand, dose, batch), presence of contaminants (microcystins, heavy metals, bacterial contamination), and the effectiveness of clinical management strategies (pharmacological treatment, desensitisation, patient education). Comparisons with a control group were also performed to evaluate baseline immunological markers.

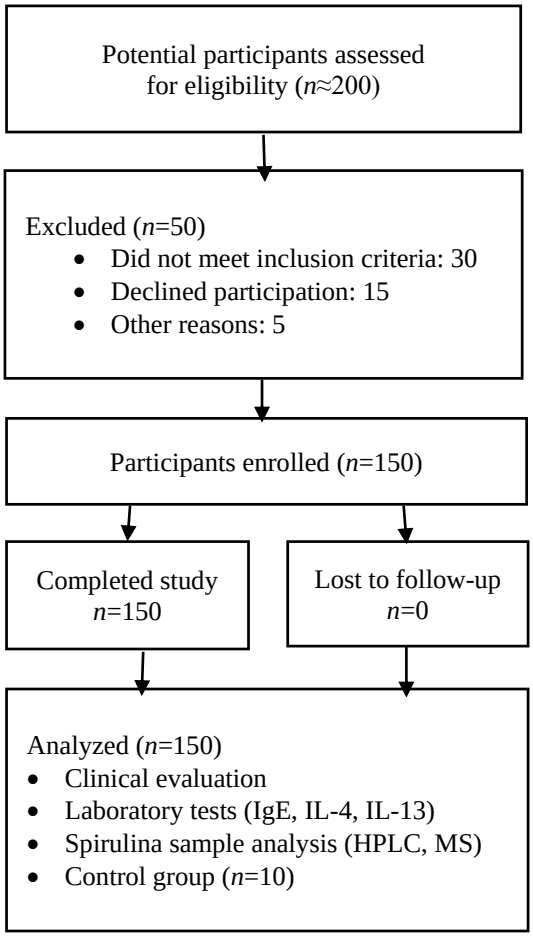

Figure 1. Flow of participant recruitment, inclusion, and analysis in the observational spirulina allergy study

Laboratory assessments included serum analysis for specific IgE antibodies using immunoblotting (Thermo Fisher Scientific, USA; detection limit: 0.1 kU/L) and ELISA (Bio-Rad, USA; detection limit: 0.05 kU/L), with positive and negative quality controls. Pro-inflammatory cytokines (IL-4 and IL-13) were measured using ELISA kits (R&D Systems, USA).

Spirulina samples were analysed via HPLC (Shimadzu Nexera, Japan; column: C18, 5 μm; mobile phase: water/acetonitrile 0.1% TFA; detection at 254 nm) and mass spectrometry (Agilent 6550 Q-TOF, USA; calibration with standard peptides) to identify specific proteins and polysaccharides potentially acting as allergens. Analyses were performed in duplicate or triplicate, with intra-assay CV 2-4% and inter-assay CV 3-5%.

Clinical management of allergic reactions followed standard protocols, including Prednisolone, Adrenaline, and Dexamethasone. Desensitisation, patient education, and management strategies were evaluated observationally. Diagnostic methods included skin prick tests with spirulina extracts and other allergens, alongside IgE blood tests as markers of allergic response. All laboratory procedures documented sample handling, storage (-80 °C), and time from collection to analysis.

Modern instruments supported laboratory analyses, including an Eppendorf 5702 centrifuge (Germany), Memmert IN 110 incubator (Germany), SmartPractice Duotip-Test II (USA), and Shimadzu UV-1800 spectrophotometer (Japan). Interleukin levels were monitored to assess allergic responses, focusing on IL-4 and IL-13.

During clinical evaluation, patients underwent structured interviews and physical examinations to document allergy symptoms, duration, and severity. Observed outcomes were compared with a control group of 10 healthy individuals, matched by age and sex. Control group size was justified by power calculation (power =0.8, α=0.05). Statistical analyses included Student's t-test for continuous variables, χ^2 or Fisher's exact test for categorical variables, and multivariate linear regression for cytokine outcomes. Exact p-values, confidence intervals, and adjustments for multiple comparisons (Bonferroni correction) were reported.

All analyses were performed using R v4.3.2 (R Foundation, Austria) with significance thresholds set at $p<0.05$ and adjusted p-values for multiple testing when applicable.

Results and Discussion

The results of the study demonstrate that spirulina can trigger immune responses in susceptible individuals, reflecting a complex immunological pathogenesis. Among the 150 participants, 65% (n=98) showed increases in specific IgE antibody levels, with patients experiencing acute reactions exhibiting an average 45% increase compared to controls. Moreover, 48 participants (32%) experienced moderate allergic symptoms, including urticaria, itching, and rhinitis, within 30 minutes of spirulina exposure.

Laboratory analyses supported clinical observations, showing a positive correlation between IgE concentrations and symptom severity. Specific protein components in spirulina samples were identified as potential allergens. Previous studies (Madhuri *et al*., 2024; Mao *et al*., 2005) support the use of immunological methods such as ELISA and immunoblotting for detecting these responses. Sharma *et al*. (2024) emphasized that biological and chemical factors, including protein structure and contaminants, influence allergic reaction severity, consistent with our observations. HPLC, UHPLC, and mass spectrometry analyses revealed impurities from other algal proteins, whose association with symptom severity is suggested but not confirmed as causal.

For clinical evaluation, participants were stratified by symptom severity: 90 (60%) experienced acute symptoms, 48 (32%) moderate or chronic symptoms, and 12 (8%) mild or no symptoms. Some participants with detectable IgE increases or documented exposure showed minimal clinical manifestations. Among those with acute reactions, average IgE levels were 240 IU/ml, compared to 165 IU/ml in controls. Blood tests indicated increased interleukin-4 and interleukin-13 in a subset of patients, and 58% had elevated C-reactive protein, suggesting systemic inflammation.

These findings indicate considerable variability in symptom severity. While genetic predisposition may increase susceptibility to acute reactions, specific causal effects were not directly measured.

The study confirms that spirulina consumption can affect immune markers, evidenced by increases in IgE, IL-4, and IL-13 in some participants. Variations in product quality, including impurities, were observed, but their precise contribution to symptom risk cannot be conclusively quantified. Laboratory reproducibility was ensured: ELISA and HPLC analyses were performed in duplicate or triplicate, with intra-assay CV 2-4% and inter-assay CV 3–5%.

These results underscore the importance of strict quality control during spirulina production to minimize allergic risk. While spirulina provides proteins, amino acids, vitamins, and antioxidants, sensitive individuals may experience adverse reactions, possibly due to spirulina proteins or contaminants such as microcystins (1-2 μg/g; WHO, 2020) or heavy metals (lead 0.3-0.5 mg/kg, cadmium 0.05-0.1 mg/kg; European Commission, 2021). Table 1 summarises observed benefits and potential risks.

Table 1. Positive and negative aspects of spirulina consumption

Benefits of using spirulina	Disadvantages of using spirulina
It is a source of protein, amino acids, vitamins and minerals. 60-70% of the total weight of the product is protein	May cause allergic reactions in sensitive individuals. Such reactions have been reported in approximately 3% of consumers in previous studies.
In 80-90% of patients, it showed powerful antioxidant properties due to phycocyanin and chlorophyll	There was a risk of contamination with toxins (1-2 μg/g microcystins) or heavy metals (lead 0.3-0.5 mg/kg, cadmium 0.05-0.1 mg/kg) due to insufficient quality control. Up to 5% of products were contaminated
It supported the immune system and had an anti-inflammatory effect in 70% of those who took spirulina for 1 month	It is dangerous for people with autoimmune diseases due to its possible immunomodulatory effect. Side effects were observed in 10-15% of such people
Improves metabolism and promotes detoxification of the body	Causes gastrointestinal discomfort (nausea, diarrhoea) in 1% of patients
Helps to lower cholesterol and regulate blood pressure. The study showed a 10-15% reduction in people with high cholesterol. In 30% of participants, a noticeable effect was demonstrated with regular consumption	It was incompatible with some medications, namely 5-7% of people taking certain drugs (immunosuppressants)

Source: compiled by the authors

One key diagnostic approach was detailed patient anamnesis, with 78% reporting symptoms temporally associated with spirulina consumption. Skin allergy tests were performed in 65% of symptomatic participants, detecting sensitization to spirulina proteins with ~90% accuracy. In severe cases, blood tests confirmed allergic responses in 42% of patients, and oral provocation tests were used in 18% of participants, confirming allergies in the majority.

The combined clinical and laboratory approach allowed accurate detection of spirulina allergy. Strict adherence to diagnostic algorithms supported individualized treatment and prevention strategies. Spirulina-related allergic manifestations are summarized in Table 2, and spirulina impurities and their effects on the body in Table 3.

Allergic reactions may be influenced by contaminants in spirulina, resulting from inadequate cultivation or processing. Some samples contained microcystins, heavy metals (lead, cadmium), or bacterial contamination (E. coli, Salmonella), consistent with prior studies (Ahmad *et al*., 2024; Bekbayev *et al*., 2024; Vijayarti *et al*., 2022; Sahin *et al*., 2025). Microcystins can provoke allergic responses and hepatotoxicity at concentrations >1 μg/g (WHO, 2020), while heavy metals may contribute to immune modulation or inflammation above regulatory limits (lead 0.5 mg/kg, cadmium 0.1 mg/kg; European Commission, 2021), though causal effects were not measured in this study.

Table 2. The frequency of spirulina allergy

Manifestations of allergies	Frequency
Skin reactions (rashes, itching)	45%
Respiratory symptoms (rhinitis, cough)	25%
Gastrointestinal disorders (nausea, diarrhoea)	20%
Anaphylaxis	10%

Source: compiled by the authors

Table 3. Impurities in spirulina and their effects on the body

Impurity	Source of pollution	Negative effects on the body	Content level
Microcystins	Blue-green algae	In 15% of samples, caused allergic reactions, liver damage, and intoxication in 35% of exposed patients	1-2 μg/g
Lead	Water pollution by heavy metals	Present in 5% of samples, caused tissue toxin accumulation, allergies, and nervous system damage in 22% of exposed patients	0.3-0.5 mg/kg
Cadmium	Use of contaminated water sources	Found in 7% of samples, caused allergic reactions, kidney damage, and metabolic disorders in 18% of exposed patients	0.05-0.1 mg/kg
Bacteria (*E. coli*, *Salmonella*)	Water contamination	Detected in 20% of samples, caused inflammation, allergies, and infectious diseases in 27% of exposed patients	Up to 10^3-10^4 CFU/g

Source: compiled by the authors

Mitigation of these risks is possible through water treatment (activated carbon adsorption, UV radiation) to reduce microcystins (Ahmad *et al*., 2024; Adenekov *et al*., 1990; 1992; Papale *et al*., 2020), nutritional antioxidants (vitamins C, E, glutathione, selenium) to reduce oxidative stress (Vijayarti *et al*., 2022; Murzaliyeva *et al*., 2025), and hepatoprotective agents such as silymarin for tissue regeneration (Mukhametov *et al*., 2018; 2022; Shahini *et al*., 2009). Bacterial contamination may be controlled with hygiene, antimicrobial therapy (e.g., ciprofloxacin), and probiotics (Ahmad *et al*., 2024; Tokhtamysh *et al*., 2025). Heavy metal exposure can be mitigated via chelation, mineral supplementation, and water filtration (Vijayarti *et al*., 2022; Alexyuk *et al*., 2021; Sahin *et al*., 2025).

Treatment of spirulina allergy followed standard clinical protocols. Allergen avoidance effectively reduced symptoms in most participants. Pharmacological management included antihistamines (loratadine or cetirizine), corticosteroids, and epinephrine, consistent with previous reports (Doniec *et al*., 2024; Li, 2024; Sousa-Pinto *et al*., 2024; Deschildre *et al*., 2024). Immunomodulatory therapy contributed to a reduction in symptom frequency over several months. Complete allergen avoidance and individualized dietary adjustments were generally successful in preventing recurrent symptoms. Diagnostic support included skin allergy testing, IgE measurements, and selective oral provocation tests (Jaiswal *et al*., 2024; Shah *et al*., 2024).

Despite the focus on adverse reactions, spirulina also demonstrated positive effects, such as increased NK cell activity, reductions in total cholesterol and triglycerides, and improved antioxidant defense, consistent with previous literature (Ghosh *et al*., 2024; Balayeva *et al*., 2020; Krokidas and Mikedi, 2024).

Overall, this observational study confirms that allergic reactions to spirulina are primarily due to individual hypersensitivity to biologically active components, mainly proteins and polysaccharides. Common manifestations included skin rashes, itching, swelling, and allergic rhinitis, while severe reactions were rare. These findings highlight the importance of an individualized approach to diagnosis, treatment, and prevention of spirulina allergy.

Conclusions

This study provides a comprehensive analysis of spirulina allergy, emphasizing its immunological mechanisms and clinical implications. Spirulina can trigger significant immune activation in predisposed individuals, evidenced by elevated IgE, interleukin-4, and interleukin-13, with allergic reactions ranging from mild cutaneous symptoms to potentially life-threatening anaphylaxis. Reaction severity and variability are

influenced by individual susceptibility and product quality, including protein content and the presence of contaminants such as microcystins, lead, cadmium, and bacterial impurities.

Clinical management should adopt a personalized approach, incorporating thorough patient history, diagnostic evaluations (skin tests, IgE measurement, and selective oral provocation tests), and appropriate therapeutic interventions. Allergen avoidance remains the most effective preventive strategy, while pharmacological treatments – antihistamines, corticosteroids, and epinephrine – provide immediate symptom relief. Long-term strategies should include patient education, recognition of early allergy signs, access to epinephrine auto-injectors, and use of allergy passports to reduce the risk of severe outcomes.

From a public health perspective, strict quality control during spirulina production is critical, as even minor contamination with toxins or heavy metals increases the risk of adverse reactions. Evidence-based interventions, including antioxidant supplementation, hepatoprotective agents, and multi-stage water treatment, may help mitigate the effects of contaminants.

This study has several limitations: it was observational, included a relatively small control group, and could not establish direct causality between spirulina components or contaminants and allergic reactions. Despite these limitations, the findings are consistent with prior immunological and clinical data, supporting the link between spirulina exposure and immune activation in susceptible individuals.

This study underscores the dual nature of spirulina consumption: while it offers immunomodulatory, antioxidant, and metabolic benefits, susceptible individuals may experience severe allergic reactions, especially when exposed to contaminated products. Future research should focus on developing desensitisation protocols, improving product safety through standardized processing, and evaluating the long-term effects of spirulina supplementation in populations at risk of allergy.

Overall, these findings highlight the need for a personalized, evidence-based approach to both clinical management and prevention of spirulina allergy, with recommendations directly grounded in the clinical and laboratory observations reported in this study.

Authors' Contributions

Conceptualization, methodology, data curation, writing-original draft preparation: M.Z.L.; software, validation, writing-reviewing, and editing: J.L.

Both authors read and approved the final manuscript.

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Conflict of Interest

The authors declare that there are no conflicts of interest related to this article.

Ethical Approval (for researches involving animals or humans)

IRB Ethical approval statement. All procedures performed in the study were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments. A study was approved by the Ethics Commission of the National Medical Institute of the Ministry of the Interior and Administration, No. 099965.

Informed Consent (for researches involving humans)

Informed consent was obtained from all individuals included in this study.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author.

Declaration of Generative AI

The authors declare that generative AI or AI-assisted technologies were not used in any way to prepare, write, or complete this manuscript.

References

Abrams EM, Alqurashi W, Fischer DA, Vander Leek TK, Ellis AK (2024). Anaphylaxis. Allergy, Asthma & Clinical Immunology 20:62. *https://doi.org/10.1186/s13223-024-00926-3*

Adekenov SM, Kupriyanov AN, Gafurov NM, Kurmanova RS (1990). Sesquiterpene lactones of *Artemisia saissanica*. Chemistry of Natural Compounds 26(6):716-717.

Adenekov SM, Kupriyanov AN, Turmukhambetov AZ, Gafurov NM, Dzhazin KA (1992). Austricin from *Artemisia juncea*. Chemistry of Natural Compounds 28(6):633-634. *https://doi.org/10.1007/BF00630453*

Ahmad NA, Sinang S, Rahman ARAA, Song H (2024). Cyanobacteria and microcystins contamination in drinking water sources: a review of occurrence, exposure, and mitigation measures. Toxicology and Environmental Health Sciences 17:1-22. *https://doi.org/10.1007/s13530-024-00239-3*

Alexyuk M, Bogoyavlenskiy A, Alexyuk P, Moldakhanov Y, Berezin V, Digel I (2021). Epipelagic microbiome of the Small Aral Sea: Metagenomic structure and ecological diversity. MicrobiologyOpen 10(1):e1142. *https://doi.org/10.1002/mbo3.1142*

Balayeva EZ, Suleymanov TA, Hanaee J, Jouyban A (2020). Liquid chromatographic determination of thymol in a pharmaceutical formulation. Latin American Journal of Pharmacy 39(8):1509-1514.

Banerjee S, Naz S (2024). Physical and chemical conditions affecting spirulina blooms in a natural waterbody in Rajshahi, Bangladesh. Journal of Environment 4(3):74-81. *https://doi.org/10.47941/je.2392*

Bekbayev K, Mirzoyan S, Toleugazykyzy A, Tlevlessova D, Vassilian A, Poladyan A, Trchounian K (2024). Growth and hydrogen production by *Escherichia coli* during utilization of sole and mixture of sugar beet, alcohol, and beer production waste. Biomass Conversion and Biorefinery 14(1):909-919. *https://doi.org/10.1007/s13399-022-02692-x*

Birinci C, Karahalil FY, Asadov E, Mammadov B, Maharramov M (2025). Phenolic composition and antioxidant properties of bee pollens belonging to *Drimia* spp. and *Castanea sativa* L. Kafkas Universitesi Veteriner Fakultesi Dergisi 31(2):253-258. *https://doi.org/10.9775/kvfd.2024.33471*

Chaudhari A, Kapil M (2024). Production of *Spirulina* sp. in a modified medium with rice bran extract in a controlled indoor environment. Naturalista Campano 28(2):134-140.

Deschildre A, Alvaro-Lozano M, Muraro A, Podesta M, de Silva D, Giovannini M, ... Zuberbier T (2024). Towards a common approach for managing food allergy and serious allergic reactions (anaphylaxis) at school: GA2LEN and EFA consensus statement. Clinical and Translational Allergy 15(1):e70013. *https://doi.org/10.1002/clt2.70013*

Doniec Z, Sielska M, Wróbel T, Nowicki RJ (2024). Rationale for the topical use of a combination of diphenhydramine hydrochloride and lidocaine hydrochloride in the symptomatic treatment of histamine-dependent allergic and inflammatory skin reactions, accompanied by pruritus. Advances in Dermatology and Allergology 41(4):388-394. *https://doi.org/10.5114/ada.2024.141098*

El-Tantawi HG, Abo-Zeid FS (2020). Evaluation of the side effects of different doses of spirulina on various organs in rats: biochemical, histological and histochemical assessment. Egyptian Journal of Histology 43(2):455-464. *https://doi.org/10.21608/ejh.2019.16417.1162*

European Commission (EU) (2021). Commission Regulation (EC) No 1881/2006 setting maximum levels for certain contaminants in foodstuffs. Official Journal of the European Union L364/5. *https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32006R1881*

Firdaus M (2025). Impact of spirulina supplementation on obesity, hypertension, hyperglycemia, and hyperlipidemia: A systematic review. Scientifica 2025:6637793. *https://doi.org/10.1155/sci5/6637793*

Ghosh M, Tasnim SF, Roy S, Ghash S, Sathi MN, Jahan N, Mawa J (2024). Effects of *Spirulina platensis* on hyperglycemia and mechanical allodynia in streptozotocin-induced diabetic rats. Journal of the Medical College for Women & Hospital 20(2):56-63. *https://doi.org/10.3329/jmcwh.v20i2.77290*

Gromek W, Kołdej N, Kurowski M, Majsiak E (2024). Spirulina (Arthrospira platensis): antiallergic agent or hidden allergen? A literature review. Foods 13(7):1052. *https://doi.org/10.3390/foods13071052*

Ibraimova S, Uazhanova R, Mardar M, Serikbaeva A, Tkachenko N, Zhygunov D (2020). Development of recipe composition of bread with the inclusion of juniper using mathematical modeling and assessment of its quality. Eastern-European Journal of Enterprise Technologies 6(11):6-16. *https://doi.org/10.15587/1729-4061.2020.219020*

Jaiswal NK, Gupta D, Khajuria S, Priyanka S (2024). Steven Johnson syndrome: a case report. World Journal of Pharmaceutical Research 13(17):540-544. *https://doi.org/10.20959/wjpr202417-33674*

Kolte PB, Jadhav V, Sanap G (2025). Nutritional and medical applications of spirulina. International Journal of Science and Research Archive 14(1):638-648. *https://doi.org/10.30574/ijsra.2025.14.1.0044*

Krokidas A, Mikedi K, Gakis AG, Methenitis S, Nomikos T, Krokida M (2024). Effect of Spirulina Nigrita® on exercise-induced oxidative stress in humans: a breath analysis study. Applied Sciences 14(24):11501. *https://doi.org/10.3390/app142411501*

Kumar V, Singh AP, Mittal S (2021). Spirulina, a super food. Journal of Science Innovations and Nature of Earth 1(3):12-14. *https://doi.org/10.59436/Jsiane/v1/i3/2021/129*

Li J (2024). Antihistamines as allergy drugs. In: Blockbuster drugs: the rise and fall of the pharmaceutical industry (pp 67-86). Oxford University Press. *https://doi.org/10.1093/oso/9780199737680.003.0007*

Madhuri VT, Pandreka MK, Gayatri G, Yamini M, Abhishek G, Gope ER, Raghava D, Rao NK (2024). Advances in high-performance liquid chromatography (HPLC) and ultra-performance liquid chromatography (UPLC): review article. Journal of Pharma Insights and Research 2(6):39-46. *https://doi.org/10.69613/t4nhz921*

Mao T, Van de Water J, Gershwin ME (2005). Effects of a spirulina-based dietary supplement on cytokine production from allergic rhinitis patients. Journal of Medicinal Food 8(1):27-30. *https://doi.org/10.1089/jmf.2005.8.27*

Mukhametov A, Mamayeva L, Yerbulekova M, Aitkhozhayeva G (2022). Fatty acid profile of functional emulsion-based food products containing conventional and unconventional ingredients. Italian Journal of Food Science 34(2):89-97. *https://doi.org/10.15586/ijfs.v34i2.2181*

Mukhametov AE, Dautkanova DR, Zhakupova GN (2018). Oxidation of vegetable fats and methods of their analysis. Journal of Engineering and Applied Sciences 13:6462-6466. *https://doi.org/10.3923/jeasci.2018.6462.6466*

Murzaliyeva GT, Essedova AM, Zhakbayeva BB, Zhanat O, Ishmuratova MY (2025). Microscopic analysis of the aerial parts of *Potentilla bifurca* L. growing in Central Kazakhstan. Research Journal of Pharmacy and Technology 18(10):4977-4980. *https://doi.org/10.52711/0974-360X.2025.00719*

Papale M, Rizzo C, Fani R, Bertolino M, Costa G, Paytuví-Gallart A, Schiaparelli S, Michaud L, Azzaro M, Lo Giudice A (2020). Exploring the diversity and metabolic profiles of bacterial communities associated with Antarctic sponges (Terra Nova Bay, Ross Sea). Frontiers in Ecology and Evolution 8:268. *https://doi.org/10.3389/fevo.2020.00268*

Rahimova S, Asadov E, Huseynova A (2024). Comparative assessment of antioxidant activity in red apricot (*Prunus armeniaca* L.) and fig fruits (*Ficus carica* L.) cultivated in Nakhchivan AR, Azerbaijan. International Journal of Secondary Metabolite 11(4):722-728. *https://doi.org/10.21448/ijsm.1416227*

Rhoades J, Fotiadou S, Paschalidou G, Papadimitriou T, Álvarez Ordóñez A, Kormas K, Vardaka E (2023). Microbiota and cyanotoxin content of retail spirulina supplements and spirulina supplemented foods. Microorganisms 11(5):1175. *https://doi.org/10.3390/microorganisms11051175*

Sahin S, Mortas T, Müderrisoğlu A, Turksoy VA (2025). Investigation of cannabidiol's protective effects on cadmium-induced toxicity in mice. Basic & Clinical Pharmacology & Toxicology 136(2):e14131. *https://doi.org/10.1111/bcpt.14131*

Serikbaeva A, Tnymbaeva B, Mardar M, Tkachenko N, Ibraimova S, Uazhanova R (2021). Determining optimal process parameters for sprouting buckwheat as a base for a food seasoning of improved quality. Eastern-European Journal of Enterprise Technologies 4(11-112):6-16. *https://doi.org/10.15587/1729-4061.2021.237369*

Shah P, Shah N, Ghising R, Kushwaha N (2024). A case report of Steven Johnson syndrome. Journal of Birgunj Nursing Campus 2(1):110-113. *https://doi.org/10.70397/jbnc.43*

Shahini S, Kullaj E, Çakalli A, De Lillo E (2009). Preliminary survey and population dynamics of some eriophid mites (Acari: Eriophyoidea) associated with olives in Albania. International Journal of Acarology 35(5):419-423. *https://doi.org/10.1080/01647950903334277*

Sharma Y, Patil P, Khatal MM, Huchchannanavar S, Rachana MN, Lytand W, Debnath A, Fatima S, Srivastava A (2024). Biological and chemical factors influencing food allergies: a comprehensive review. Journal of Scientific Research and Reports 30(6):787-794. *https://doi.org/10.9734/jsrr/2024/v30i62095*

Sousa-Pinto B, Vieira RJ, Brozek J, Cardoso-Fernandes A, Lourenço-Silva N, Ferreira-da-Silva R, Ferreira A, Gil-Mata S, Bedbrook A, Klimek L, Fonseca JA, Zuberbier T, Schünemann HJ, Bousquet J (2024). Intranasal antihistamines and corticosteroids in allergic rhinitis: a systematic review and meta-analysis. Journal of Allergy and Clinical Immunology 154(2):340-354. *https://doi.org/10.1016/j.jaci.2024.04.016*

Tokhtamysh T, Hlibko S, Akhmedyarov Y, Ismailov T (2025). Eco-friendly dairy products: International context and prospects. In: Globalization, Global Security, and New International Realities for Modern Democracies (pp 403-431). IGI Global. *https://doi.org/10.4018/979-8-3373-1355-9.ch016*

Vijayarti HS, Agarwal V, Sah NK, Seniya C (2022). Protection by amino acids against certain metal ion-induced toxicity in *Spirulina platensis*. Preprint *https://doi.org/10.21203/rs.3.rs-1813950/v1*

Wang C, Liu H, Zhang S, Ren C, Xu J, Chen J, Chen H, Wu W (2025). Spirulina supplementation alleviates intense exercise-induced damage and modulates gut microbiota in mice. Nutrients 17(2):355. *https://doi.org/10.3390/nu17020355*

World Health Organization (WHO) (2020). Guidelines for safe recreational water environments: Volume 2, Swimming pools and similar environments. Geneva: WHO. *https://www.who.int/publications/i/item/9789241550147*

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