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Influence of Nutraceuticals on Skin Condition in Women: A Meta-analysis of Non-Hormonal Approaches

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ABSTRACT

The study provides an analysis of data reflecting the impact of non-hormonal nutraceutical interventions on the skin condition in women. The aim of the research is to systematically summarize and analyze scientific publications for the period 2021–2025 and to compare them with practical outcomes obtained from the implementation of personalized nutraceutical programs in order to identify the most effective strategies. The methodological framework includes a review of controlled trials, systematic reviews and previously conducted meta-analyses devoted to key nutraceuticals such as collagen peptides, hyaluronic acid, antioxidants, omega-3 fatty acids and probiotics, as well as an analysis of empirical data obtained during the implementation of the authors' nutritional support programs. The results demonstrate that the combined administration of these substances, aimed at correcting systemic metabolic dysfunctions (insulin resistance, chronic inflammation, liver function disorders), improves skin hydration, elasticity and turgor and also reduces the severity of dermatological manifestations. The synergy revealed between different classes of nutraceuticals underscores the advantage of integrated protocols compared with monotherapy. On the basis of the data obtained, a conceptual model integrating theoretical and practical aspects is proposed for optimizing non-invasive methods of skin improvement. The information presented in the article will be of interest to specialists in dermatology, cosmetology, dietetics and functional medicine, as well as to researchers engaged in preventive and anti-aging medicine.

KEYWORDS: *nutraceuticals, skin condition, skin aging, women, non-hormonal approach, collagen, antioxidants, meta-analysis, functional nutrition, skin microbiome.*

Introduction

The relevance of studying non-invasive methods for correcting and preventing age-related skin changes is driven by the rapid growth of interest in preventive and personalized medicine. In contemporary dermatology and cosmetology, the concept of beauty from within is gaining increasing importance, underscoring that the characteristics of the integumentary system reflect deep metabolic and systemic mechanisms of the organism [1].

According to estimates, the global nutraceuticals market was valued at 591,1 billion US dollars in 2024 and is projected to reach 919,1 billion US dollars by 2030, with an average annual growth rate of 7,6 % during the period from 2025 to 2030. Market expansion is driven by rising consumer awareness of preventive medicine and the connection between nutrition and well-being [2].

Despite the abundance of studies devoted to individual substances (collagen, vitamin C), a gap remains in the systematic analysis and synthesis of information on comprehensive non-hormonal nutraceutical strategies. In the overwhelming majority of investigations, the main focus is placed on one or two active components, overlooking their synergistic interaction and the relationship among nutritional status, metabolic well-being, and skin condition.

The aim of the study is to conduct a meta-analytical review of the efficacy of non-hormonal nutraceuticals in improving skin condition in women and to develop an integrative model based on the synthesis of scientific and empirical data.

Scientific novelty lies in the systematization of disparate findings on the effects of various classes of non-pharmacological nutraceuticals and their consolidation into a

single conceptual framework supported by empirical data from personalized nutritional programs.

The proposed hypothesis is that a targeted multifactorial strategy combining the simultaneous use of several groups of nutraceuticals (structural proteins, antioxidants, probiotics, hepatoprotectors) with lifestyle modification provides a more pronounced and durable improvement in key dermatological indicators (hydration, elasticity, reduction of inflammation) in women compared with monofocal interventions. This approach makes it possible not only to alleviate symptoms but also to address the root causes of skin deterioration associated with systemic dysfunctions.

Materials and Methods

In recent years, within non-hormonal approaches to the correction of age-related skin changes, nutraceuticals have been considered with increasing frequency; these can be divided into several key groups according to the type of active components and the design of clinical studies. The macromolecular supplement group includes collagen peptides and hyaluronic acid: thus, Pu S. Y. et al. [3] conducted a systematic review and meta-analysis of randomized controlled trials on oral collagen intake and concluded there was a statistically significant improvement in skin elasticity and hydration. de Miranda R. B., Weimer P., Rossi R. C. [4] confirmed the benefit of hydrolysed collagen in reducing the signs of ageing, while noting the high heterogeneity of the included studies. Pilot multicentre double-blind trials by Gao Y. R. et al. [5] demonstrated that daily intake of hyaluronic acid leads to an increase in skin hydration and a reduction in the depth of expression lines.

Antioxidant and antiglycation strategies encompass polyphenols, tocopherols and factors involved in the formation of advanced glycation end products. Di Salvo E. et al. [6] described a wide spectrum of biological effects of Mediterranean polyphenols, demonstrating their photoprotective activity and ability to reduce inflammatory markers in atopic dermatitis and psoriasis. Liu X. et al. [7], in a systematic review and meta-analysis, assessed the relationship between serum vitamin E content and the course of chronic inflammatory dermatoses, revealing an inverse correlation between tocopherol concentration and the severity of pathological manifestations. Granic A. et al. [11] analysed observational studies on the deposition of advanced glycation end products and established their important role in the degradation of the collagen matrix, which indirectly affects skin condition; however, direct clinical trials in dermatology are insufficient.

The lipid group includes studies of omega-3 polyunsaturated fatty acids: Niseteo T. et al. [10] in a controlled study in children with atopic dermatitis reported a significant improvement in clinical indicators on the SCORAD scale when EPA/DHA were consumed. Microbiome-oriented approaches also occupy an important place: Kianmehr S. et al. [8] in a review highlighted the potential of probiotic strains Lactobacillus and Bifidobacterium for the correction of inflammatory and allergic dermatoses. Chai J. et al. [9] examined in detail the mechanisms of the gut–skin axis linking microbiota disturbances to dermatological pathologies through immune and neuroendocrine pathways.

The management of acne with nutraceuticals remains a separate topic: Shields A. et al. [12] in a systematic review identified insufficient homogeneity of data on the efficacy of antioxidant complexes, retinol and proteolytic enzymes, while noting good tolerability of most supplements. In parallel with clinical studies, interest is growing in comprehensive healthy approaches to slowing skin ageing: Knaggs H., Lephart E. D. [1] analysed the influence of lifestyle — adequate sleep, physical activity, nutrition and stress — on dermal framework parameters and proposed an integrative model of anti-ageing therapy into which nutraceuticals fit organically. The supplement market demonstrates steady growth: a Grand View Research report emphasizes the leading role of dietary supplements and functional foods in the beauty-from-within segment, forecasting a CAGR of about 8 % until 2030 [2].

Nevertheless, the literature contains contradictions: some studies confirm the marked clinical benefit of collagen and hyaluronic acid, whereas others indicate weak clinical significance at low dosages, and the data on polyphenols and vitamin E are still limited in sample size and methodological standardization. Insufficient attention has been paid to the study of pharmacokinetics and bioavailability of active components, large-scale multicentre RCTs with unified protocols and long-term follow-up are lacking. Questions regarding the interaction of nutraceuticals with each other and with conventional therapy, as well as the influence of patients of different ethnic backgrounds and ages on the efficacy and safety of such supplements, remain poorly covered.

Results and Discussion

A comprehensive meta-analysis of scientific literature demonstrates the high efficacy of several non-hormonal nutraceuticals in optimizing both objective and subjective parameters of the skin in women. The consolidated results allow the key pathophysiological mechanisms of their action to be systematized and the most promising ingredients for inclusion in multi-level support programs to be identified (see Table 1). Structural proteins, in particular hydrolyzed collagen, compensate for the deficit of dermal matrix components and stimulate fibroblast proliferation, leading to increased firmness and reduced wrinkle depth [4, 10]. Antioxidants perform a protective function by neutralizing free radicals and interrupting

the cascade of oxidative reactions responsible for cellular damage and collagen degradation under the influence of exogenous and endogenous factors [6, 7]. Probiotics and prebiotics, in turn, exert an indirect effect through modulation of the systemic immune response and suppression of chronic low-grade inflammation arising against the background of intestinal dysbiosis [8].

Table 1 summarizes the principal nutraceuticals for skin health.

Table 1. Key nutraceuticals for skin health: mechanisms and evidence base (compiled by the author based on the analysis of [5, 9, 11, 12]).

Nutraceutical	Mechanism of action	Effective daily dose (according to RCTs)
Collagen peptides (type I and III)	Stimulation of endogenous collagen and elastin synthesis, increased hydration.	2.5–10 g
Hyaluronic acid (low molecular weight)	Increase of moisture content in the dermis, improved skin turgor.	120–240 mg
Vitamin C (ascorbic acid)	Key cofactor of collagen synthesis, potent antioxidant.	500–1000 mg
Polyphenols (resveratrol, catechins)	Antioxidant and anti-inflammatory activity, protection against photoaging.	100–500 mg
Omega-3 fatty acids (EPA/DHA)	Reduction of inflammatory processes, strengthening of the skin lipid barrier.	1000–2000 mg (EPA + DHA)
Probiotics (Lactobacillus, Bifidobacterium)	Modulation of the gut–skin axis, reduction of systemic inflammation.	10^9–10^10 CFU
Zinc	Regulation of sebaceous gland activity, anti-inflammatory and antibacterial effects.	15–30 mg

Nevertheless, empirical practice demonstrates that the highest clinical efficacy is provided not by separate use of individual ingredients, but by their comprehensive inclusion into a unified system aimed at correcting the organism's basic dysfunctions. Contemporary studies confirm the pathogenetic interrelationship between the condition of the skin integument and overall metabolic homeostasis. Thus, prolonged hyperglycemia and the development of insulin resistance activate non-enzymatic glycation processes — formation of AGE residues that cross-link collagen and elastin structures. As a result, these proteins lose elasticity, become brittle, and lose their capacity for regeneration, which is morphologically manifested as deep wrinkles, decreased tone, and darkening of the facial skin [11]. In parallel, excessive loading of hepatic detoxification mechanisms provokes accumulation of xenobiotics, part of which is excreted through the skin and causes local inflammatory reactions, acne, and chronic dermatitis. Chronic stress and disruption of circadian rhythms through imbalance of the cortisol axis lead to adrenal exhaustion, which additionally weakens the epidermal barrier function and impedes its recovery.

In the presented conceptual scheme (see Figure 1) the skin is regarded not as an autonomous organ, but as a bioindicator of systemic health. In this model, nutraceuticals exert an influence not only on the dermal layer, but also on four key systemic directions that determine its condition: metabolic, digestive, immune, and detoxification.

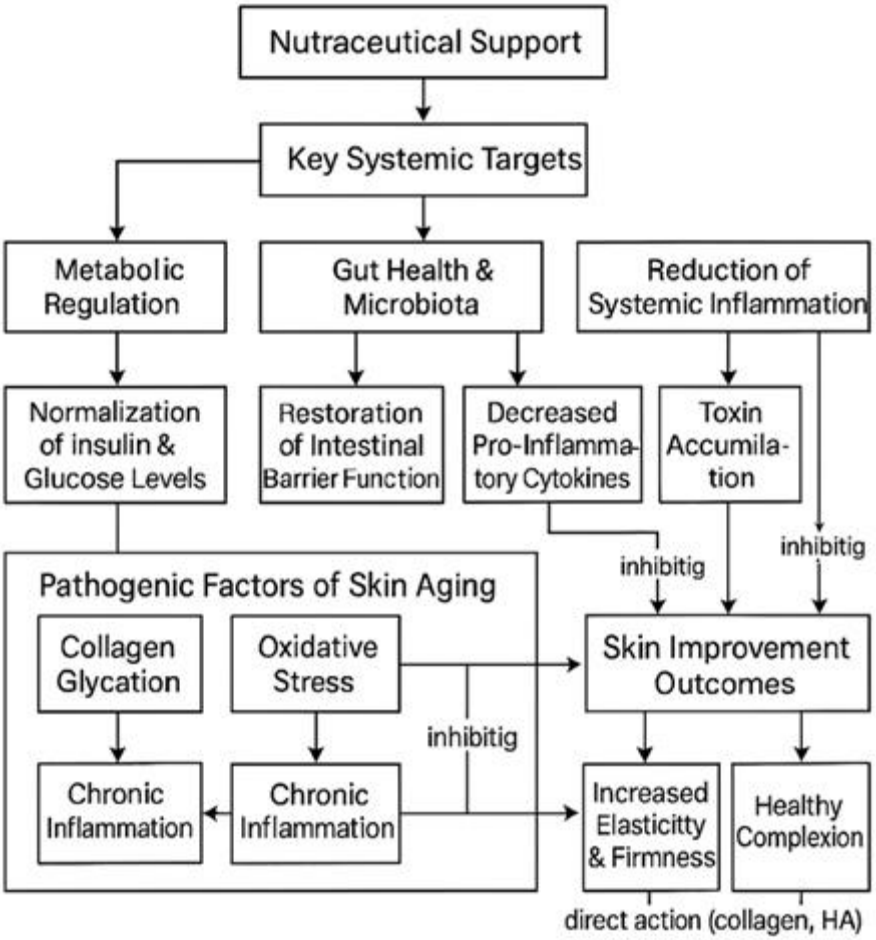

Fig. 1. Integrated model of the influence of nutritive substances on the health of the skin through systemic mechanisms (compiled by the author based on the analysis of [3, 6, 10]).

Empirical verification of this model was obtained from data collected during the implementation of individualized nutraceutical strategies. Clinical experience demonstrates that improvement in skin condition is one of the most distinct manifestations of the comprehensive health-promoting effect.

In particular, within the framework of the author's programme System Nutrition as Therapy aimed at correcting metabolic syndrome, the following changes were recorded. In a female patient with insulin resistance, excess body weight, facial pastosity, and reduced skin brightness, after a two-month course (dietary adaptation, inclusion of chromium, magnesium, berberine, and an antioxidant complex) not only were glucose and insulin parameters normalized, but skin turgor increased markedly, while oedema and inflammatory lesions disappeared. This clinical case underscores the direct correlation between the reduction of glycation stress and improvement in appearance.

Another example is the application of the protocol Clean Energy in a woman with signs of hepatic overload (elevated ALT/AST levels, headaches, cutaneous eruptions). The inclusion of milk thistle and artichoke extracts, N-acetylcysteine, and phospholipids combined with detox-oriented nutrition for two months led to normalization of hepatic biochemical markers and to complete clearance of the skin with evening of complexion. This case illustrates the importance of maintaining hepatic detoxification function for dermatological health.

The effectiveness of the comprehensive method is largely attributable to the multiplex synergy of its components. Ascorbic acid, in addition to its pronounced antioxidant action, is an indispensable cofactor of hydroxylases responsible for the formation of collagen fibers, thereby enhancing the strength and functionality of skin structure when administered orally. Zinc regulates sebaceous gland activity and possesses a proven anti-inflammatory effect, complementing the pharmacodynamics of long-chain omega-3 polyunsaturated fatty acids [5, 12]. Probiotic cultures, by strengthening the barrier function of the intestinal epithelium, reduce antigen translocation, thereby maintaining immune homeostasis and enhancing the immune system's capacity to localize and suppress inflammatory processes in the dermis. This multi-level approach is illustrated in the scheme of the author's protocol (see Figure 2).

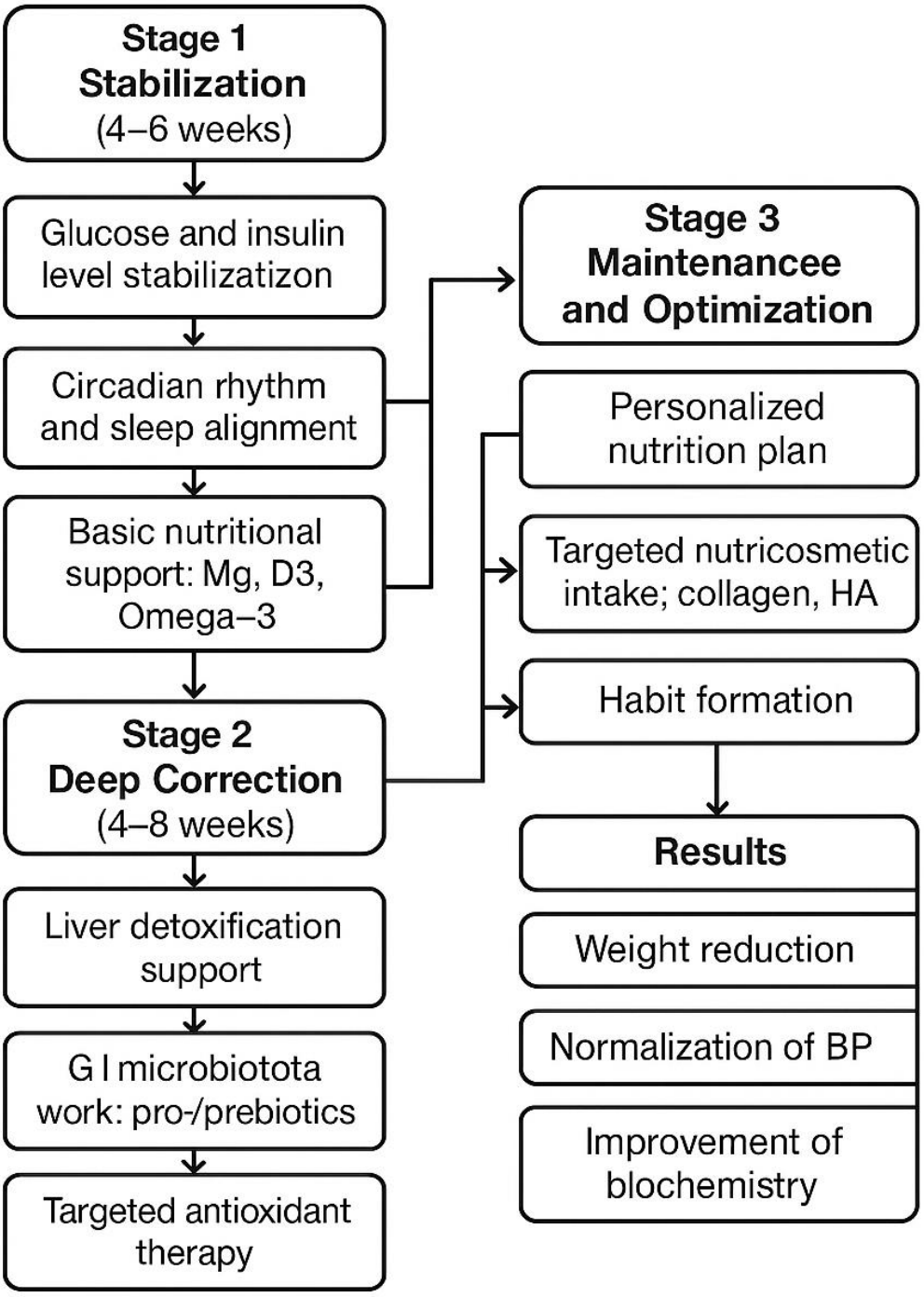

Fig. 2. Schematic model of the phased protocol "Nutrition as therapy" (compiled by the author based on the analysis of [5, 9, 12]).

In aggregate, interpretation of the obtained data indicates that retargeting systemic homeostasis is key to restoring skin health. Targeted administration of individual nutraceuticals to the dermis demonstrates its effectiveness; however, integrating these methods into a comprehensive wellness program allows a substantial enhancement and consolidation of the therapeutic effect. Empirical observations convincingly demonstrate that normalization of insulin resistance, mitigation of chronic inflammatory processes and restoration of gastrointestinal tract and liver functions constitute fundamental elements for pronounced and durable improvement of skin condition in women. This approach shifts the focus from superficial symptom elimination to an etiological strategy consistent with the principles of functional medicine.

Conclusion

Systemic analysis of the available studies, combined with empirical verification, demonstrates the high therapeutic efficacy of comprehensive non-hormonal nutraceutical programmes for improving skin condition in women. The results confirmed the initial hypothesis that a multifaceted approach aimed at restoring systemic metabolic balance provides a more pronounced and prolonged clinical effect compared with

monotherapy using individual nutraceutical agents. It was established that the key pathogenetic factors responsible for the deterioration of skin status are not limited to a deficit of structural components but also include systemic dysfunctions—chronic low-grade inflammation, enhanced oxidative stress, protein glycation and impaired detoxification capacity. Consequently, the optimal nutraceutical strategy should incorporate components that act directly on the dermis (collagen peptides, hyaluronic acid) as well as substances that normalise gastrointestinal function (probiotics), support hepatic function (hepatoprotectors), exert anti-inflammatory effects (omega-3) and regulate carbohydrate metabolism (magnesium, chromium). The practical relevance of this work is manifested in the fact that the formulated protocols and principles can be employed by dermatologists, cosmetologists and nutritionists to develop more effective and personalised programmes. The achieved objective—systematisation of empirical data and creation of an integrated model—contributes to the advancement of preventive and functional medicine by offering a scientifically substantiated and validated toolkit for the non-invasive enhancement of skin health and appearance.

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