

Policy Brief:

Role of Biotechnology Strategies for Dietary Intervention in Multiple Sclerosis Patients

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Abstract

Background and Objective: Multiple sclerosis (MS) is a chronic autoimmune and neurodegenerative disease characterized by inflammation, demyelination, and progressive neurological dysfunction. Emerging evidence suggests that dietary patterns, gut microbiota composition, probiotics, and nutritional interventions may influence disease activity, symptom severity, and quality of life in patients with MS. This study aimed to evaluate the role of nutrition, probiotics, and biotechnology-based dietary approaches in MS management and to propose evidence-based policy recommendations for improving patient outcomes.

Methods: A narrative literature review was conducted using PubMed and Google Scholar databases to identify studies related to multiple sclerosis, nutrition, gut microbiota, probiotics, dietary interventions, and biotechnology-based therapeutic strategies. Relevant peer-reviewed articles and review papers were evaluated, and findings were synthesized to assess the potential impact of dietary and microbiome-targeted interventions on MS progression and patient well-being.

Results and Conclusion: Evidence indicates that probiotics and dietary interventions may reduce neuroinflammation, modulate immune responses, improve gut microbiota composition, and positively influence in patients with MS. Engineered probiotics, functional foods, and nutritional supplements including polyunsaturated fatty acids, vitamins, antioxidants, and microbial metabolites such as short-chain fatty acids have demonstrated potential benefits on physical, mental, and social health outcomes. Advances in biotechnology, including microbial engineering, bioinformatics, proteomics, and genome sequencing, may facilitate the development of safer and more effective nutrition-based interventions. Overall, nutritional and microbiome-targeted strategies represent promising complementary approaches for MS management and should be further investigated to support evidence-based healthcare policies.

Keywords: Multiple Sclerosis (MS), Gut Microbiota, Probiotics, Nutrition, Biotechnology

1. Introduction and Statement of the Problem

Multiple Sclerosis (MS) is an autoimmune disease which causes neuronal degeneration. It is estimated that a total of 1.89 million people live with MS (23.9 cases per 100,000 population) worldwide. The global prevalence of multiple sclerosis is increasing. In 2021, over 62,000 new cases diagnosed with MS. The mean age of the disease diagnosis is 30 years of age, with a female predominance.

The etiology of the multiple sclerosis is complex due to the various risk factors including genetic susceptibility and environmental factors like infections, smoking and, obesity [1]. Main clinical features of MS disease are inflammation, demyelination and, neurodegeneration. Most of MS lesions involve central nervous system (CNS). Neurodegeneration plays a major role in physical and cognitive disabilities [2].



Recent researches indicated that food intake and nutrition have a great impact on MS patient's clinical manifestations and quality of life. Low saturated fat dietary has beneficial effects on patients' nervous system. Food enriched with liver fish oil and vegetables oil decreased severity of the disease and improved neural functions. Moreover, it is emphasized that the gut microbiota interacts with the nervous system and affect the treatment outcome. So, it has been suggested that food and dietary interventions beside standard treatment protocols significantly improve clinical symptoms of MS patients [3].

Despite the recent advances in MS treatment, it is still causes a significant socioeconomical burden. Moreover, it is showed that lifestyle specially food and nutrition's intake have a great impact on diseases activity and severity. Various studies indicated that food intake pattern like saturated fat intake, alcohol or coffee consumption can worsen the MS pathological symptoms while dietary intake of fruits, vegetables, polyunsaturated fatty acids PUFAs have beneficial effects for MS patients. Besides, probiotics and supplements including vitamin D, vitamin A, B vitamins and, antioxidants can improve patients' wellness and play role as complementary treatment. So, with the help of biotechnology methods, dietary interventions and engineered probiotics could be a potential treatment approach for MS patients [4].

2. Methods

A narrative literature review was conducted using PubMed and Google Scholar databases to identify studies related to multiple sclerosis, nutrition, probiotics, gut microbiota, dietary interventions, and biotechnology-based therapeutic approaches. Relevant peer-reviewed articles, review papers, clinical studies, and experimental investigations were screened and evaluated for evidence regarding the effects of dietary patterns, probiotic supplementation, functional foods, and microbiome-targeted interventions on disease activity, neurological function, inflammation, and quality of life in patients with multiple sclerosis. Findings from the selected literature were synthesized to assess current evidence and to develop policy recommendations regarding the application of nutrition and biotechnology strategies in the management of multiple sclerosis.

3. Results

Probiotics and natural compounds combination therapy using biotechnology strategies boost the effectiveness of the treatment. Engineered probiotics from gut microbiota such as *Bifidobacterium* Sp., *Lactobacillus* Sp., *Bacillus subtilis*, and *Streptococcus thermophiles* modulate the immune system and decrease brain inflammation. In this regard, microbial screening and selection, isolation and metabolic

engineering approaches assist design and engineering of appropriate probiotic for MS patients. In addition, with the help of these techniques the quality of the dietary nutrition can be improved. In this regard functional food which contains specific compounds will be accessible for MS patients, refines patients' health, improves their quality of life and finally, decreases the costs [5]. Studies indicated that using probiotics decreased inflammatory mediators including cytokines and chemokines and inhibited migration of the pathogenic immune cells into the CNS. Such interventions also altered gut microbiome and modulate gut-brain axis which resulted in a significant positive impact on physical complications like fatigue, mental health, social dysfunction, anxiety and pain. Probiotics usually well tolerated and had no serious adverse effects. Moreover, it is suggested that microbiome inhibited and delayed MS progression, flare up and dampened intensity of symptoms as compared to the control groups. Probiotics derived metabolites especially short chain fatty acids (SCAFs) also caused intestine and blood-brain barrier (BBB) integrity, decreased inflammation and enhanced neurogenesis. Recent data showed that dietary interventions can boost the effects of the conventional treatments, decrease their adverse effects, enhance physical, mental and social function of the MS patients [6].

4. Health Policy Framework and Recommendation

The following highlighted points are the recommended opinions to find a suitable protocol to approve the MS patient's health aspects:

A: Targeting gut using probiotics, antibiotics and, dietary nutrition as a potential complementary treatment for MS patients via a mixture of two or more bacteria strains such as mixture of *Lactobacillus*, *Bifidobacterium*, and *Streptococcus* Sp. [7].

B: Since dietary patterns can shape or alter the gut microbial composition, therefore, matching dietary style with gut microbiota is a significant point in MS patients' health improvement.

C: To achieve the safer composition of gut microbiota and increment of nutrition uptake in MS patients, development of the related biotechnology and microbiological, genetic, and toxicological analysis related to the engineered probiotics should be considered.

5. Declarations

5.1. Acknowledgement

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5.2. Conflict of Interest

All authors declare no conflict of interest.

5.3. Using chatbots

No chatbot tool was used in the preparation, writing, analysis, or revision of this manuscript

5.4. Authors' Contributions

The all authors contributed to literature review, policy recommendation development, manuscript writing, revision, and final approval of the manuscript

6. References

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خلاصه سیاستی:

نقش استراتژی‌های بیوتکنولوژی برای مداخله غذایی در بیماران مبتلا به مولتیپل اسکلروزیس

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سابقه و هدف: بیماری مولتیپل اسکلروزیس (MS) یک بیماری خودایمنی و نورودژنراتیو مزمن است که با التهاب، دمیالیناسیون و اختلال عملکرد عصبی پیشرونده مشخص می‌شود. شواهد نوظهور نشان می‌دهد که الگوهای غذایی، ترکیب میکروبیوتای روده، پروبیوتیک‌ها و مداخلات تغذیه‌ای ممکن است بر فعالیت بیماری، شدت علائم و کیفیت زندگی در بیماران مبتلا به MS تأثیر بگذارند. این مطالعه با هدف ارزیابی نقش تغذیه، پروبیوتیک‌ها و رویکردهای غذایی مبتنی بر بیوتکنولوژی در مدیریت MS و ارائه توصیه‌های سیاستی مبتنی بر شواهد برای بهبود پیامدهای بیمار انجام شد.

مواد و روش‌ها: یک بررسی‌ها با استفاده از پایگاه‌های داده PubMed و Google Scholar برای شناسایی مطالعات مرتبط با مولتیپل اسکلروزیس، تغذیه، میکروبیوتای روده، پروبیوتیک‌ها، مداخلات غذایی و استراتژی‌های درمانی مبتنی بر بیوتکنولوژی صورت گرفت. مقالات و مقالات مروری مرتبط با داوری هم‌تا ارزیابی شدند و یافته‌ها برای ارزیابی تأثیر بالقوه مداخلات غذایی و میکروبیوم محور بر پیشرفت MS و رفاه بیمار ترکیب شدند.

یافته‌ها و نتیجه‌گیری: شواهد نشان می‌دهد که پروبیوتیک‌ها و مداخلات غذایی ممکن است التهاب عصبی را کاهش دهند، پاسخ‌های ایمنی را تعدیل کنند، ترکیب میکروبیوتای روده را بهبود بخشند و تأثیر مثبتی بر بیماران مبتلا به MS داشته باشند. پروبیوتیک‌های مهندسی‌شده، غذاهای کاربردی و مکمل‌های غذایی شامل اسیدهای چرب غیراشباع چندگانه، ویتامین‌ها، آنتی‌اکسیدان‌ها و متابولیت‌های میکروبی مانند اسیدهای چرب زنجیره کوتاه، مزایای بالقوه‌ای بر پیامدهای سلامت جسمی، روانی و اجتماعی نشان داده‌اند. پیشرفت‌ها در بیوتکنولوژی، از جمله مهندسی میکروبی، بیوانفورماتیک، پروتئومیکس و توالی‌یابی ژنوم، ممکن است توسعه مداخلات مبتنی بر تغذیه ایمن‌تر و مؤثرتر را تسهیل کنند. به طور کلی، استراتژی‌های تغذیه‌ای و میکروبیوم‌محور، رویکردهای مکمل امیدوارکننده‌ای برای مدیریت MS هستند و باید برای پشتیبانی از سیاست‌های مراقبت‌های بهداشتی مبتنی بر شواهد، بیشتر مورد بررسی قرار گیرند.

واژگان کلیدی: مولتیپل اسکلروزیس (MS)، میکروبیوتای روده، پروبیوتیک‌ها، تغذیه، بیوتکنولوژی