Nutraceutical Approach for Appetite and Energy Homeostasis Regulation, MASLD Prevention, and Treatment: Future Opportunities for the Healthcare System in Bosnia and Herzegovina

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Life and health are intricately connected to food, eating behaviors, and normal digestive function. Emerging research highlights the complex interactions between the brain, the digestive system, and eating patterns, offering insights into the etiopathogenesis of obesity, insulin resistance, and metabolic dysfunction-associated steatotic liver disease (MASLD). Nutrients with diverse molecular structures interact with specific genes and receptors in the digestive system, influencing either health or disease (1, 2).

The term "nutraceutical," a hybrid of 'nutrition' and 'pharmaceutical,' refers to foods or components of foods with health-promoting benefits. Hippocrates, the father of modern medicine, emphasized the connection between food and health nearly 2,500 years ago, stating, "Let food be thy medicine and medicine be thy food" (3).

Nutraceutical strategies have gained traction in modern medicine only in recent decades, supported by scientific evidence demonstrating the health benefits of bioactive components in foods. These strategies include compounds such as dietary fiber, probiotics, polyunsaturated fatty acids, antioxidants, vitamins, polyphenols, and spices. The validated health benefits of these compounds have prompted the food and pharmaceutical industries to produce a wide range of products targeting chronic diseases like obesity and insulin resistance (1, 2).

MASLD is a growing global health concern, posing significant challenges in Bosnia and Herzegovina due to rising obesity rates, type 2 diabetes prevalence, and sedentary lifestyles. According to the World Obesity Federation's Global Obesity Observatory, Bosnia and Herzegovina has a national obesity risk score of 6.5 out of 10, indicating a moderate risk level. The prevalence of obesity among adults is projected to rise, with estimates suggesting that by 2025, 23.0% of men and 22.8% of women will be classified as obese. This upward trend in obesity rates is closely linked to the increasing incidence of MASLD, as excess body weight is a major risk factor for this liver condition. Addressing these risk factors through public health interventions is crucial to mitigating the impact of MASLD in the region (4)

Disruptions in appetite and energy homeostasis are central to MASLD pathophysiology. Nutraceuticals—bioactive compounds derived from natural sources—show potential in addressing these disruptions. Compounds such as catechins from green tea (Camellia sinensis), capsaicinoids from chili peppers (Capsicum annuum), and yerba mate (Ilex paraguariensis) have demonstrated mixed but promising results in clinical trials (5,6).

Bioactive phytochemicals, such as catechins from green tea and capsaicinoids from chili peppers, influence appetite-regulating hormones like GLP-1 and ghrelin. By delaying gastric emptying and enhancing thermogenesis, these compounds contribute to appetite suppression and increased satiety (5, 6).

Gengricin®, a nutraceutical formulation combining Cinchona bark and Chicory root, has shown effectiveness in reducing appetite and body weight in controlled trials, further validating the role of plant-derived compounds in energy regulation (5**).**

While many bioactive phytochemicals exhibit potential, their efficacy remains inconsistent across studies. For instance, green tea catechins show variable effects on hunger suppression, with some trials reporting significant benefits while others do not. Mild gastrointestinal side effects, such as bloating and discomfort, have been observed but are generally well-tolerated (6).

Integrating nutraceutical strategies into Bosnia and Herzegovina's healthcare system could leverage the region's rich tradition of herbal remedies and functional foods. Adapting these strategies to local dietary habits may enhance their efficacy and acceptance (1).

Nutraceuticals achieve clinical application only when backed by strong scientific evidence. Validated studies ensure their efficacy, safety, and therapeutic potential, allowing healthcare providers to confidently integrate them into practice. This evidence-based ap-

proach enhances patient trust and supports nutraceuticals as effective tools for preventing and managing conditions like obesity, insulin resistance, and MASLD. The Importance of Clinical and Scientific Evidence for the Application of Nutraceutical Strategies in Clinical Practice is Illustrated in Figure 1.

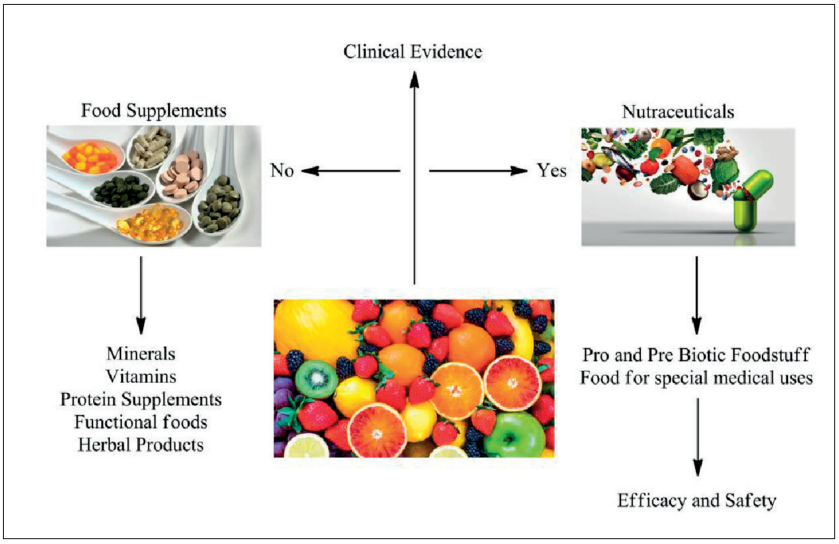

Figure 1. Nutraceuticals enter clinical application only with scientific evidence.

A systematic review of literature was conducted using databases such as PubMed, Scopus, and Web of Science to identify evidence-based nutraceuticals targeting appetite regulation and energy homeostasis. Studies prioritizing MASLD management were emphasized. Key nutraceuticals assessed included omega-3 fatty acids, polyphenols, prebiotics, probiotics, and plant-derived bioactives.

The primary outcomes included changes in appetite-regulating hormones (ghrelin, leptin), hepatic lipid content, and markers of metabolic health (2).

Nutraceuticals such as omega-3 fatty acids and polyphenols demonstrated significant benefits in appetite suppression, increased energy expenditure, and reductions in hepatic steatosis (1). Prebiotics and probiotics showed promise in modulating gut microbiota, thereby enhancing metabolic outcomes (3). Additionally, bioactive compounds such as berberine and curcumin were identified as effective in improving insulin sensitivity and reducing hepatic lipid accumulation (2).

Nutraceuticals provide a novel, cost-effective approach for MASLD prevention and treatment by addressing appetite dysregulation and energy imbalance. Their integration into public health strategies in Bosnia and Herzegovina could significantly alleviate the burden of metabolic disorders. Future efforts should prioritize localized research, regulatory policy development, and healthcare provider education to optimize implementation and improve patient outcomes.

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