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ЕКОЛОГІЧНА БЕЗПЕКА СІЛЬСЬКОГО ГОСПОДАРСТВА, ТЕРИТОРІЙ ТА АКВАТОРІЙ

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Nadiia Adamchuk-Chala, Ph.D. Research associate,
Yelyzaveta Chala, graduate student,
McGill University, School of Human Nutrition, Montreal, Canada

EXPLORING THE ENVIRONMENTAL IMPACT AND NUTRIOTIONAL BENEFITS OF KOMBUCHA PRODUCTION FOR SPORTS AND WORK IN EXTERE CONDITIONS

Abstract. *This paper explores the nutritional benefits of kombucha, especially for people aged 20-40 who exercise intensely or work in extreme conditions. Underlining the rich composition of kombucha in antioxidants, organic acids, and probiotics, the paper discusses its potential to improve athletic performance, promote early recovery, and improve overall health. The research results show the perspectives of introducing kombucha into the diet of active people not only as a healthy alternative to sugary drinks but also as a strategic choice to promote physical and mental well-being in a challenging environment. The paper calls for further clinical trials to fill the existing knowledge gaps and ensure the safe and effective use of kombucha as a dietary supplement.*

Key words: kombucha, probiotics, SCOBY, extreme environments, space exploration, dietary supplement.

Kombucha is a valuable supplement to the diet of people with an active lifestyle and intense physical activity. Its high content of antioxidants, organic acids, probiotics, and low sugar content can help improve athletic performance, accelerate recovery, and improve overall health (Selvaraj & Gurumurthy, 2023).

The use of probiotics, probiotic products, and concern for our gut microbiota is a popular topic of current nutrition discussions. Nowadays, probiotics are considered to have a barrier effect, a kind of protection of the microflora from colonization by foreign pathogenic bacteria.

Kombucha is gaining popularity today as a healthy alternative to sugary drinks and sports supplements. However, it can also be a powerful ally for athletes, extreme athletes, and even astronauts and cosmonauts looking to maximize their performance and recovery. The objective of this paper is to analyze the literature on the nutritional value of kombucha products.

Kombucha is a fermented beverage of historical Manchurian origin, derived from fermented tea using a microbial combination consisting of several bacteria and yeast. Traditionally, it is made by combining sweetened black or green tea with a symbiotic culture of bacteria and yeast (SCOBY). This mixture forms a powerful symbiosis that can inhibit the growth of potentially contaminating bacteria. SCOBY initiates the fermentation process, converting the sugar in the tea into various compounds. The fermentation process also leads to the formation of a polymeric cellulose film due to the activity of certain strains of Acetobacter sp. This fermentation results in a spicy, fizzy drink with a distinctive flavor (Abacı et al., 2022).

It has been shown that the process of tea fermentation using a microbial combination enhances certain biological activities although there is little information available on the characterization of its active components and their transformation during fermentation. Probiotic properties of Kombucha are reported in the literature due to the presence of beneficial bacteria and yeast, and it may contain organic acids, vitamins, and other bioactive compounds, which are very useful functional foods for extreme athletes, and space mission specialists who work outside the Earth (Podolich et al., 2016). Authors offered a new experimental model, a kombucha multi-microbial culture, to assess the structural integrity of a widespread microbial polymer – cellulose – as a biosignature of bacteria-producers for the multipurpose international project "BIOlogical and Mars Experiment (BIOMEX)", which aims to study the vitality of pro- and eukaryotic organisms and the stability of organic biomolecules in contact with minerals to analyze the detectability of life markers in the context of a planetary background. In this work, from a broader perspective, extracellular vesicles or nano globules are intriguing objects in astrobiological discussions about the origin of life and lithopanspermia. This idea has been supported by other authors (Kebukawa et al. 2009; De Gregorio et al. 2013).

A review by (Cubas et al., 2023) deserves special attention. The authors noted that in recent years, several researchers have focused their studies on the development of sustainable biomaterials using renewable sources, including the incorporation of living biological systems. One of the best biomaterials is bacterial cellulose (BC). There are several ways to produce BC, from using a pure strain to producing the fermented drink kombucha, which has a symbiotic culture of bacteria and yeasts (SCOBY). Studies have shown that the use of agricultural waste can be a low-cost and sustainable way to create BC. This article conducts a literature review to analyze issues related to the creation of BC through kombucha production. The databases used were ScienceDirect, Scopus, Web of Science, and SpringerLink. A total of 42 articles, dated from 2018 to 2022, were referenced to write this review.

Especially, safe, and robust probiotics are needed for long-term expeditions, outposts, and extraterrestrial permanently manned bases, where humans are exposed to adverse environmental factors. Kombucha beverage is a Symbiotic Culture of Bacteria and Yeast (SCOBY) and is associated with health-promoting effects. Kombucha tea/mat has been in use in human living for millennia as a probiotic drink for healing and health prophylaxis effects, however, new research opportunities promise its «renaissance », going to be used pharmacologically (Kozyrovska et al., 2012).

Kombucha has been the subject of many biomedical studies, which have revealed microorganisms synthesized substances that are beneficial to humans.

It is worth noting that the kombucha sample demonstrated high protein content (3.31 μg/ml), significant phenol content (290.4 mg/100 ml) and low sugar content (glucose: 1.87 g/l; sucrose: 1.11 g/l; fructose: 0.05 g/l) compared to green tea. The diverse microbial community combined with the proven health benefits is indicative of the potent probiotic nature of kombucha. These findings not only contribute to a more complete understanding of kombucha, but also have significant implications for increasing its commercial value and unlocking its promising prospects for human health (Kaashyap et al., 2021).

None of the clinical trials have demonstrated any undesirable side effects of kombucha. The available data are treated as case reports. It was believed to be a combination of poor diet, kombucha consumption, and consumption of other supplements that leads to reduced niacin absorption.

Although the study acknowledges existing knowledge gaps and calls for additional clinical trials, it provides valuable insights into the multiple effects of kombucha, paving the way for further exploration of its role as a probiotic-rich functional drink.

Probiotics, when ingested, interact with intestinal immune cells to enhance immune homeostasis and function in the host. Despite advances in the field, further research is needed to better understand the relationship between immune cells and probiotics to further explain the well-documented and established immune system boosting by probiotics.

Kombucha naturally contains several organic acids, including acetic, lactic, and gluconic acids, which improve the body's ability to utilize energy and delay fatigue during exercise.

In studies on both mice and humans, obese patients have an altered ratio of bacteroides to firmicutes. In particular, the main finding is an increase in the number of bacteroides compared to firmicutes (DeGruttola et al., 2016). Knowing this, the Western population is increasingly looking for ways to maintain a healthy microflora and prevent dysbiosis, preferring to use probiotics for health benefits including vitamin synthesis, enzymatic activity, strengthening of the intestinal barrier, competitive exclusion of pathogens, resistance to colonization, production of acid and short-chain fatty acids (SCFAs).

Finally, kombucha is low in sugar and calories, making it a great substitute for sports drinks that can be loaded with sugar and artificial ingredients. It can help athletes maintain a healthy weight and avoid the harmful effects of excessive sugar consumption, such as an increased risk of developing type 2 diabetes (Aloulou et al., 2012).

Many personal experiences and testimonials of kombucha tea drinkers are available throughout the world on the ability of kombucha tea to protect against a vast number of metabolic and infectious diseases, but very little clinical evidence (randomized controlled trials and cohort studies) is available that validates the beneficial effects of kombucha.

Conclusions. Kombucha is a potentially beneficial supplement for athletes aged 20-40 who lead an active lifestyle or work in extreme conditions. Its unique composition is

rich in antioxidants and organic acids, which can contribute to improved energy performance, reduced fatigue, and increased endurance during exercise. In addition, the probiotic properties of kombucha support the health of the gut microbiome, which is important for optimal nutrient absorption, immune system support, and mental health.

Therefore, the addition of kombucha to the diet can significantly improve the health and athletic performance of active people aged 20-40 who work in high-stress environments, including athletes, extreme sports enthusiasts, and space travelers such as astronauts and cosmonauts who seek to maximize their performance and restore vitality.

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