



Individualized Dietary Supplements Enriched with Microbial Propionic Acid for Athletes and the Elderly with Benefits on Gut Microbiota [†]

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Abstract: Personalized dietary supplements adapted to the individual needs of athletes and the elderly enriched with microbial propionic acid were produced in form of a powder, ready to be mixed in drinks such as orange juices. Studies have shown that fresh and pasteurized orange juices have a positive influence on gut microbiota, and exhibit selective prebiotic activity, particularly in terms of gut microbiota, by increasing *Lactobacillus* spp., *Enterococcus* spp., *Bifidobacterium* spp., and *Clostridium* spp., and reducing Enterobacteria. Besides, studies have reported the effect of the combined use of probiotics and organic salts, such as propionic acid salts, on the in vitro inhibition of microorganisms. Additionally, the short chain fatty acid propionic acid influences the gut-mediated immune regulation of people, reduces lipogenesis, and inhibits serum cholesterol synthesis.

Keywords: personalization; nutrition; propionic acid; athletes; elderly

1. Introduction

Nutritional requirements are required for human health, and the research is still ongoing to describe their function at the cellular and molecular level [1].

The diet influences the composition and activity of the microbiota, and this is more important for health than has long been assumed. Microbiota research over the past ten years has provided insights into the mechanisms. A typical Western diet rich in fat and protein, with lots of meat and fast food, stimulates the growth of bacteria that contain lipopolysaccharides in their cell membrane. These in turn promote inflammation and destabilize the intestinal barrier. Fibers and dietary proteins are the key to healthy microbiota [1]. Dietary proteins, from alternative sources extracted implementing environmentally friendly process from industry side streams, are of high importance nowadays due to the high demand for proteins for human and animal consumption.

Depending on the state of health, dysbiosis can also occur in old age. Fragility, inflammation, and malnutrition lead to unfavorable changes in the microbiota. The number and diversity of bacterial strains decrease, the main strains shift in favor of pathobionts, and at the expense of protective anaerobes. The main cause is probably a one-sided diet with less fiber and micronutrients. Healthy seniors, on the other hand, have a stable intestinal microbiota up to the age of 80. However, the immune system ages in everyone, whether frail or not. At the same time, the susceptibility to infection increases and inflammation occurs—a chronic, subclinical inflammation. In every second

senior, the inflammation parameters such as C-reactive proteins (CRPs) are slightly increased, which are associated with an increased risk of cardiovascular events such as heart attacks and strokes. In addition, folic acid and vitamin B12 levels decrease with age [2].

Propionic acid, together with acetic acid and butyric acid, are the most abundant short chain fatty acids (SCFA), representing 90–95% of the SCFA present in the colon. SCFA as postbiotics have distinct physiological effects which contribute to shaping the gut environment and influencing the physiology of the colon. SCFA can be used as energy sources by host cells and the intestinal microbiota [3–5].

Food-grade propionic acid (E280) can be used as a preservative in food, and is listed in Commission Regulation (EU) No 231/2012 as an authorized food additive and categorized in “Additives other than colors and sweeteners”. It can be used to produce its salts: sodium propionate (E281), calcium propionate (E282) and potassium propionate (E283), with the maximum permitted levels (MPLs) from 1000 to 3000 mg/kg in foods [6,7].

Studies have shown that fresh and pasteurized orange juices have a positive influence on gut microbiota, and exhibit selective prebiotic activity, particularly in terms of gut microbiota, by increasing *Lactobacillus* spp., *Enterococcus* spp., *Bifidobacterium* spp., and *Clostridium* spp., and reducing Enterobacteria. Due to its nutrients, orange juice is at least as healthy as the numerous trendy smoothies, keeps us mentally fit, and is also cheaper [8].

A study by the renowned Harvard University has now even shown that orange juice can prevent dementia. Regular consumption of orange juice increased the efficiency of the brain in 47 percent of the study participants. The reason is the high proportion of antioxidants and other nutrients that have a preventive effect against dementia. Those who drink orange juice every day can protect themselves from the molecules that cause dementia. Regular consumption of the fruit juice is important for its effectiveness, therefore in subjects who only drank orange juice once a month, the drink had no beneficial effects on the brain. Orange juice, with immune system-boosting vitamin C and phytonutrients, is not a muscle building substance per se, but in certain situations it can work wonders—especially after training and in the right combination. Earlier studies have provided evidence of an immune-modulating effect of prebiotics and postbiotics in athletes and elderly people [9].

2. Materials and Methods

The microbial propionic acid was produced from lignocellulosic biomass, in form of a powder, free or encapsulated as presented in a previous study [10–12]. Personalized dietary supplements (containing fibers, protein from alternative sources, minerals, and vitamins) adapted to the individual needs of athletes and elderly has been developed in previous research projects [13–18]. Fresh and pasteurized orange juices were purchased commercially.

3. Results

The objective was the preparation of a novel fruit beverage product fortified with dietary fibers (soluble fibers), macro- and micronutrients using the microbial propionic acid, which has been produced in the form of a powder (free and encapsulated). Developed novel fruit beverage products prepared will be tested to evaluate their sensory attributes. Great solubility and a powder free of color, and no odor and taste or modified consistency was noticed when it incorporated microbial propionic acid at 0.1 g/L to serve as a postbiotic in the final product.

Further chemical properties to check their quality and safety during storage and to evaluate stability of used functional compounds will be performed.

4. Conclusions

The results support the current trend in the development of feasible, sustainable, or future-oriented nutritional concepts and provides the basis for conscious eating behavior.

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