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Short Communication

The Impact of Functional Food on the Intestinal Microbiota in Relation to Chronic Noncommunicable Diseases

Introduction

The World Health Organization (WHO) states that obesity is characterized as a positive energy balance that favors the accumulation of fat, associated with metabolic complications related to health risks such as high cholesterol and triglyceride levels, high blood pressure, and resistance to insulin [1].

These obesity-related alterations, such as high systemic blood pressure, dyslipidemia, high fasting glycemia, and central obesity, are the main characteristics of Metabolic Syndrome (MS), according to the International Diabetes Federation. MS is defined as the combination of physiological, biochemical, clinical, and metabolic factors associated with increased cardiovascular risk and the risk of type II diabetes mellitus [2].

Dietary recommendations are used as important tools in the prevention of cardiovascular diseases and include: increased intake of fibers derived from fruit, vegetables, nuts, and whole grains, such as oatmeal; reduced consumption of products made from refined flour; substituting trans and saturated fatty acids for unsaturated and non-hydrogenated fatty acids; and increased consumption of series n-3 polyunsaturated fatty acids (PUFAs), also known as omega-3, through the consumption of linseed oil, fish, and other vegetable sources [3], and increased consumption of proteins that can be obtained from meet, but also from the consumption of vegetable sources such as textured soy protein (TSP). Moreover, studies have highlighted the role of diet by measuring intestinal microbiota during the development of obesity and MS [4]. Although the main cause of obesity is excess caloric consumption compared with expenditure, differences in intestinal microbiota ecology between humans can be an important factor that affects energy homeostasis [5]. Thus, this paper is important in demonstrating the effectiveness of foods with functional claims, when united in a single dietary compound, by measuring lipid serums and intestinal microbiota.

Results

Fibers are present in dietary components and are defined as non-digestible carbohydrates that resist digestion and absorption in the small intestine and undergo partial fermentation in the large intestine. Examples of soluble fibers include beta-glucans, which are present in high quantities in oat and barley bran and form viscous solutions and are pseudoplastic [6]. Fibers known as beta-glucans promote increased bolus viscosity and delay nutrient absorption [7]. The presence of beta glucan in the diet can reduce postprandial glycemic peaks and can significantly reduce the quantity of LDL cholesterol in blood plasma.

Linseed (*Linum usitatissimum*) oil, which is a widely consumed oilseed, stands out for its rich α-linolenic content (18:3 *cis* Δ9,12,15) [8], which confers important properties for dietary application. The use of linseed oil has received considerable attention due to the seed's functional properties, as previously mentioned, and it presents health benefits [9]. Soy (*Glycine max* L.) grain belongs to the oilseed group and is a functional food that presents important characteristics due to it containing isoflavones and lignans, which form one class of polyphenols [10]. The main phytochemicals are isoflavanes (daidzein and genistein). Soy-based products are related to atherosclerosis prevention, given that they perform an antioxidant action over lipids circulating in the plasma and also due to the presence of soluble fibers that act in reducing total and LDL cholesterol, as well as exerting an antiplatelet aggregation effect, thus reducing triglyceride levels and raising HDL cholesterol levels [11].

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For this purpose, the Bioactive Food Blend (BFB) produced from oat bran, linseed oil, and textured soy protein (TSP) was elaborated by this group [12-14], with low atherogenicity (0,20) and thrombogenicity (0,13) indices, an adequate hypercholesterolemia/hypocholesterolemia ratio (6,11), ω6:ω3 (1,05), PUFA/SFA (2,61), which leads to a product with high nutritional value aimed at controlling raised levels of total cholesterol, LDL-cholesterol, triglycerides, and glucose, and which is effective especially in controlling serum lipids and triglycerides. The BFB contained higher protein (24.27%), fat (13.37%) and fiber (7.98%) content and lower carbohydrate (50.39%) levels [13]. A patent application was filed for the proposed BFB at the Brazilian National Institute of Industrial Property (INPI - BR 10 2013 018002 5) and was published on August 8, 2015, by the Ministry for Development, Industry, and Foreign Trade.

Thus, studies have identified that dietary fibers and lipids modulate the composition of the intestinal microbiota [15,16]. In particular, variations of *Bacteroides* spp. have been associated with the intake of polyunsaturated fatty acids (PUFAs) [17].

Correlation analyses have revealed that there is a positive relationship between an abundant presence of *Bacteroides* spp. and the consumption of lipids derived from vegetable and animal sources [18]. Not only the quantity, but also the the type of fatty acid determines the impact of lipid intake on intestinal microbiota and its clinical consequences [19].

In an experimental study carried out by the Czech Republic Faculty of Medicine, a significant reduction was found in the fecal coliform count in rats fed with the *Lactobacillus plantarum* probiotic in addition to 40 g/kg of linseed oil, thus demonstrating that the combination of the probiotic element with the PUFAs present in the linseed oil displayed antimicrobial properties against pathogenic bacteria. This is due to the important role of PUFAs in enhancing probiotic effects, with them increasing in number and promoting their adhesion to the epithelium, as well as having an influence on the size of bacterial colonies [20].

Intestinal microbiota plays an important role in human health, given that it has high metabolic potential, it is located together with the intestinal mucus, and is intimately related with the underlying immune system. It is therefore associated with a wide variety of intestinal and systemic diseases, varying from inflammatory intestinal disease to metabolic syndrome and allergies [21].

It is observed that the concentration and normal spatial distribution of bacteria along the intestinal tract of humans is characterized by Escherichia spp., Bacteroides spp., Clostridium cluster spp., Lactobacillus spp., Streptococcus spp., Veillonella spp., Bifidobacterium spp. Eubacterium spp., Ruminococcus spp., Roseburia spp., at the concentration of 10^{7} - 10^{11} bacteria mL^{-1} [22].

Modulating intestinal microbiota via dietary interventions is becoming a promising strategy for verifying the cause of chronic inflammation involved in obesity and metabolic syndrome.-

Conclusion

Functional foods, besides reducing serum lipids, which, when high, cause metabolic disorders such as obesity, increased fasting glycemia, and systemic inflammations, act directly in mediating intestinal microbiota. The purpose of this paper was to show that bioactive dietary compounds, when used daily, promote important benefits, especially in serum lipoproteins, due to their hypolipidemic effect and their effect on metabolic syndrome.

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