Selenium Supplement for Obesity and Diabetes

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Abstract

The beneficial effects of selenium (Se) as a trace element in chronic metabolic disease had been well reported in many studies. A change of Se level in human affects body metabolism significantly. The mechanism through which the Se improves diabetes, hyperglycemia and obesity is by relieving insulin resistance, reducing appetite and upregulating genes for fatty acid breakdown. The most important effect of Se is the regulation of the immune system. The present studies reveal that Se and Se-enriched products can be considered as promising candidates for the treatment of chronic metabolic diseases especially diabetes and obesity.

Keywords: Selenium; Diabetes; Obesity; Insulin resistance; Immune regulation; Gut microbiota

Abbreviations: T2D: Type 2 diabetes; Se: Selenium; IR: Insulin Resistance; HbA1c: Glycated Hemoglobin; FBG: Fasting Blood Glucose; FBW: Fasting Body Weight; IL: Inter Leukin; TNF: Tumor Necrosis Factor; HSPs: Heat Shock Proteins; FFA: Free Fatty Acids; Se-B. longum DD98: Selenium-enriched Bifidobacterium longum DD98; AST: Alanine Amino Transferase; ALT: Aspartate Amino Transferase; CPT1: Carnitine Palmitoyl Transferase-1; PPARα: Peroxisome Proliferator-Activated Receptor Alpha; FAS: Fatty Acid Synthase; IL: Lipo Protein Lipase; PPARγ: Peroxisome Proliferator Activated Receptor Gamma; NAFLD: Non-Alcoholic Fatty Liver Disease

Introduction

Obesity is one of the most common metabolic disorder diseases, which is caused by multiple factors including eating habits, environment, and genetics. It is stored in the form of fat when body’s energy intake exceeds consumption [1]. It is characterized by excessive accumulation and storage of fat in the body, which can accelerate the development of many chronic diseases and is a risk factor that causes diabetes. Diabetes is one of the global health problems, and type 2 diabetes (T2D), a chronic metabolic disease caused by the decrease of insulin receptor sensitivity and the increase of fasting blood glucose, accounts for about 90% of diabetes [2]. Selenium (Se) is an essential trace element in human diet. Previous studies had reported the effect of Se as a dietary supplement in yogurt [3]. Se exerts its bioactivities mainly through selenoproteins and the functions of selenoproteins strictly depend on the presence of selenocysteine, which is the 21st “naturally occurring” amino acid in the genetic code and is largely responsible for the health-promoting effects of Se. There are 25 selenoproteins in human body, and the physiological functions of some selenoproteins have been well-characterized [4]. Se plays an important role in human immune function, which is closely related to the development of obesity and T2D. Refer to the average dietary micronutrient requirements of Chinese residents, the proportions of men and women with insufficient selenium intake was 49.6% and 65.4%, respectively. Long-term Se deficiency significantly suppresses the immune response, reduces disease resistance, and increases the risk of chronic metabolic disease such as diabetes and obesity [5]. Additionally, selenoproteins are central for antioxidant system regulation in human body [6], and protects the human liver and other organs from oxidative stress injury caused by obesity and diabetes. Furthermore, Se also improves the chronic metabolic diseases via influencing the composition of gut microbiota [7]. Supplementation of Se is a good therapeutic strategy to regulate the immune system, relieve the oxidative stress and maintain the intestinal homeostasis, thereby improving the physiological functions of the host. This review mainly discusses about the beneficial effects of Se in chronic metabolic disease, especially in T2D and obesity.

Discussion

Se has been proved to have multiple biological functions in chronic metabolic disease, such as antioxidation, antitumor, improving the balance of lipid metabolism, and regulating the immune system [8,9]. In T2D, Se can directly reduce the symptoms of diabetes, especially the...
The gut microbiota is a complex ecosystem, which plays a vital role in regulating human physiological and metabolic functions. At present, the mechanism of intestinal flora to regulate diabetes and obesity mainly includes the following aspects. First of all, the type and proportion of intestinal flora can directly affect obesity or T2D [36]. Secondly, gut flora can relieve obesity by regulating host’s immune system [37]. Thirdly, Short-chain fatty acids secreted by...
intestinal microorganisms can improve metabolism and epithelial barrier integrity in many ways [36]. There are also other regulatory mechanisms of the intestinal flora, such as intestinal flora-hypothalamic-mechanism of obesity regulation and so on. Previous reports demonstrated that the composition of the gut microbiota in mice influenced the host Se levels, and that the Se levels also could alter the composition of the gut microbiota [38]. The diversity of the intestinal bacteria increased in animals fed with higher levels of Se. Se affects both the composition of the intestinal microbiota and the colonization of the gastrointestinal tract, which, in turn, influence the Se state and selenoproteome expression of the host [7]. Hence, Se and selenoproteins are closely related to gastrointestinal health and protective effects of Se in chronic metabolic disease could be mediated via a Se-gut microbiota pathway. Furthermore, studies have confirmed the synergistic effect of Se and probiotics in chronic metabolic diseases [32]. Our laboratory also developed a Se-enriched probiotic, Se-enriched Bifidobacterium longum DD98 (Se- Bifidobacterium longum DD98). Based on our results (data unpublished), Se- Bifidobacterium longum DD98 showed significant beneficial effects on obesity and T2D, and exhibited greater anti-diabetic and anti-obese effects compared with single Se or probiotics treatment. This superior function of Se-enriched probiotics could be attributed to the combination effects of Se and probiotics.

Conclusion

Many studies in animals and humans proved the important roles of Se in relieving chronic metabolic disease, such as T2D and obesity. The beneficial effects of Se are primarily mediated by suppressing inflammatory response, improving immune system, alleviating oxidative stress, and maintaining the intestinal hemostasis in the host. Se usually works as a dietary supplement or in combination with other substances, and Se-enriched probiotics could be considered as a promising candidate for the treatment of T2D and obesity. However, the application of Se in chronic metabolic diseases still requires more human trails to further confirm its therapeutic efficacy and toxicity.

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