

## Probiotic Action: Activating Autophagy in the Management of Diabetes Mellitus

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Type 2 Diabetes mellitus (T2M) is one of the multifactorial disorders leading causes of death across the world. Numerous pathophysiological studies proposed several risk factors of T2D, caused by genetic, epigenetic, environmental and lifestyle-related factors resulting in development of diabetic complications such as  $\beta$ -cell dysfunction, hyperglycemia, hypercholesterolemia, adiposity, dyslipidaemia, metabolic endotoxemia, systemic inflammation, intestinal permeability, defective incretin secretion, ectopic fat storage and oxidative stress [1]. From T2D, it is also an established major independent risk factor for several chronic diseases such as ischemic heart disease and stroke [2]. Both pharmacologic and non-pharmacologic interventions can reduce the levels of glucose [3-5]. Previous studies have also found that dietary constituents and supplements such as green tea and garlic can improve glucose [6,7].

Recently, the health benefits of probiotics have attracted increased attention. Probiotics are defined as live microorganisms which play an important role in health and disease. The beneficial effects of probiotics are suggested to be due to a number of factors including regulation of intestinal microbial homeostasis, maintenance of the gastrointestinal barrier for adherence of pathogens, interference from colonization of pathogens, changes the enzymatic activity in the colon, adjustment the availability of nutrients and finally modulation of immune responses [8]. It has also been demonstrated that probiotics can decrease the blood glucose through improved inflammation and prevented  $\beta$ -cell destruction in animal models [9]. However, several clinical trials of probiotics have outcome in mixed results, with some reports have no effect [10], while the others have established a powerful glucose diminishing effect [11].

Diabetes mellitus has also been associated with dysbiosis and one of the possible routes to restore a healthy gut microbiota is by the regular ingestion of probiotics which can control glucose level. Probiotics are live microorganisms that promote gut health and regulate a number of factors including intestinal microbial homeostasis and modulation of immune responses [12]. Although the mechanisms to regulate these works by probiotics is remaining investigated, one of the pathways involves the induction of cell survival. However, probiotics might induce autophagy. Autophagy, lysosomal degradation pathway, is important for cell survival, proliferation, differentiation and finally homeostasis. Autophagy has an important action in maintaining cell survival under stressful conditions and cleared preferentially intracellular pathogenic microorganisms. Polymorphisms in autophagy genes have recently been linked to increased risk of human IBD (probiotics is also effective in the treatment of IBS) [12]. This evidence indicates that bioactive products of probiotics and commensal bacteria can activate autophagy in the epithelial cells of gut. The association of autophagy may provide sequential beneficial clinical consequences attributed to a hygienic enteric microbiota. It is mentioned that probiotics lower blood sugar level, relieve inflammation and prevent  $\beta$ -cell destruction. Therefore, the mechanistic effects of probiotics on glycemic control, lipid profile, inflammation, oxidative stress and short chain fatty acids in diabetes mellitus remains under considerations.

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