18.Medicinal Benefits of Deep Sea Water on Metabolic Disease : Anti-diabetes and Anti-obesity Effects

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Metabolic syndrome is a clustering of at least three of five of the following medical conditions: abdominal obesity, elevated blood pressure, elevated fasting plasma glucose, high serum triglycerides, and low high-density lipoprotein (HDL) levels. Recently, deep sea water (DSW) has been received much attention for its biological and clinical applications in the fields of health food, cosmetics, and medicine. Several studies suggest that DSW may prevent metabolic disease, including obesity and diabetes. In present study, we investigated effects of balanced deep-sea water (BDSW) on obesity and type 1, 2 diabetes in high fat diet (HFD) induced obese, type 2 diabetes and streptozotocin (STZ)-induced type 1 diabetes mouse. BDSW was prepared by mixing DSW mineral extracts and desalinated water to yield a final hardness of 1000–4000 ppm. Consequently, we found that HFD with BDSW fed group are lowered body weight and plasma glucose level compared to the HFD fed group and BDSW also inhibited hyperglycemia in STZ-induced group. Oral glucose tolerance tests (OGTT) and intraperitoneal glucose tolerance tests (IPGTT) showed that BDSW improves the impaired glucose tolerance in HFD fed group as well as STZ-induced diabetic group. In histopathological assay of liver, the HFD fed group showed severe steatohepatitis, while HFD with BDSW fed group were similar with ND fed group. In the pancreas, BDSW restored the morphology of the pancreatic islets of Langerhans and increases the secretion of insulin both HFD fed group and STZ-induced diabetic group. Moreover, triglyceride and total cholesterol levels in plasma and liver were lowered in HFD with BDSW fed group. Furthermore, quantitative RT-PCR results revealed that the expressions of lipogenic genes and glucose oxidation-related genes are suppressed, while the expressions of gene for glycogenolysis and for β-oxidation are increased in HFD with BDSW fed group. In addition to, the expression of hepatic genes involved in gluconeogenesis, glucose oxidation, and glycogenolysis was suppressed, while the expression of the genes involved in glucose uptake, β-oxidation, and glucose oxidation in muscle were increased in the STZ with BDSW group. In vitro, BDSW stimulated PI3-K, AMPK, and mTOR pathway-mediated glucose uptake in C2C12 myotubes and 3T3-L1 adipocytes. BDSW increased AMPK phosphorylation in both cell lines. In vivo, BDSW improved impaired AMPK phosphorylation in the muscles of HFD fed group and STZ-induced diabetic group. Taken together, these results suggest that BDSW has potentials as an anti-obesity and an anti-diabetic agent, owing to its ability to suppress increase of weight through decrease of adipose tissue weight, suppress hyperglycemia, and improve glucose intolerance by modulating glucose metabolism, recovering pancreatic islets of Langerhans and increasing glucose uptake. (This work was financially supported by the National R&D project of “Development of new application technology for deep seawater industry" supported by the Ministry of Oceans and Fisheries of the Republic of Korea.)

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