

Characterization and application of enzyme-stable trehalose analogs derived from actinomycetes

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Nonreducing disaccharide trehalose is used as a stabilizer and humectant in various products including cosmetics and skincare products. However, its use has some problems. Trehalose is hydrolyzed by trehalase, a widely expressed enzyme in multiple organisms including microbes on the skin and environment. When trehalose is hydrolyzed, two glucose molecules are released, and it can be a nutrient of the microbes and promote their growth. It may disturb the microbial flora on the skin and may be a cause of the deterioration and putrefaction of products containing it. The released glucose can glycate proteins and lipids in the skin cells and accelerate the aging of the skin. New trehalose analogs that have adequate moisture retention and protective activities and cannot be hydrolyzed and digested by trehalase and microbes are expected. More than 40 trehalose analogs were prepared including microbial metabolites and synthetic compounds. Among them, a mass-producible metabolite of an actinomycete 4-trehalosamine and its derivative detergent compounds IMCTA-Cns (n=8-15) were selected to be analyzed their properties in this study. Compared with trehalose, 4-trehalosamine exhibited better or comparable protective activities on a starch, proteins, and microbial cells. 4-Trehalosamine also exhibited a high buffer capacity around the neutral pH. 4-Trehalosamine was biologically stable that was not assimilated by microbes and not hydrolyzed by mammalian trehalases. While IMCTA-Cn detergents could be effectively used in membrane protein extraction without the denaturing activity, long-chain detergents IMCTA-C13 – IMCTA-C15 showed 1000–3000-fold stronger autophagy-inducing activity in cultured cells than trehalose and are expected to become a drug lead and research reagent. These results indicate that 4-trehalosamine and the derivative detergents are potential trehalose substitute for various purposes. They can be useful ingredient of cosmetics and skincare products.