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BIOTECHNOLOGICAL APPROACHES TO B-D-GALACTOSIDASE PRODUCTION FOR LACTOSE-FREE DAIRY PRODUCTS

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Lactose intolerance is a prevalent digestive disorder resulting from insufficient intestinal β-galactosidase activity, affecting a substantial proportion of the global population. In Ukraine, lactose malabsorption is estimated at approximately 61%, while clinically confirmed lactose intolerance occurs in 8.8% of individuals. These epidemiological data highlight the need for accessible and technologically advanced solutions enabling lactose reduction in dairy products. From a sustainable development perspective, the provision of safe and nutritionally adequate food for individuals with dietary restrictions is a key element of public health and food system resilience. The development of lactose-free dairy products contributes to United Nations Sustainable Development Goals (SDGs), particularly SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-being), and SDG 12 (Responsible Consumption and Production) (United Nations, 2015), by promoting resource-efficient bioprocessing and dietary inclusion.

Lactose intolerance is characterized by the inability to hydrolyze lactose due to reduced or absent endogenous β-galactosidase activity. In the colon, undigested lactose undergoes microbial fermentation, resulting in the production of fatty acids and gases, which cause gastrointestinal symptoms including bloating, abdominal pain, and diarrhea. Long-term restriction of dairy intake may lead to deficiencies in calcium and vitamin D, increasing the risk of osteoporosis and related metabolic disorders.

In this study, an original anonymous survey (n = 179) was conducted to assess consumer demand for lactose-free milk. The results demonstrated a significant and growing demand driven by both clinically determined intolerance and consumer preferences, thereby providing empirical justification for the development of enzymatic lactose hydrolysis technologies.

A comparative analysis of β-galactosidase production strategies was performed alongside a market assessment of lactose-free dairy products and enzyme-based dietary supplements. A techno-economic feasibility evaluation further confirmed the relevance of biotechnological approaches for industrial implementation. Among the investigated microbial producers, the yeast strain *Kluyveromyces marxianus* SLDY-005 exhibited the highest β-galactosidase activity (277 U/mL) (Afolabi et al., 2022), indicating strong potential for application in lactose-free dairy processing.

Future research will focus on developing an industrial-scale purification process for β-galactosidase from yeast cells and designing an immobilized enzyme system on a novel carrier to improve biocatalyst stability and reusability for scalable lactose-free dairy production.

References:

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