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Heat-killed *Lacticaseibacillus paracasei* GMNL-653 ameliorates human scalp health by regulating scalp microbiome

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Abstract

Background The equilibrium of the scalp microbiome is important for maintaining healthy scalp conditions, including sebum secretion, dandruff, and hair growth. Many different strategies to improve scalp health have been reported; however, the effect of postbiotics, such as heat-killed probiotics, on scalp health remains unclear. We examined the beneficial effects of heat-killed probiotics consisting of *Lacticaseibacillus paracasei*, GMNL-653, on scalp health.

Results Heat-killed GMNL-653 could co-aggregate with scalp commensal fungi, *Malassezia furfur*, in vitro, and the GMNL-653-derived lipoteichoic acid inhibited the biofilm formation of *M. furfur* on Hs68 fibroblast cells. The mRNA of hair follicle growth factors, including insulin-like growth factor-1 receptor (IGF-1R), vascular endothelial growth factor, IGF-1, and keratinocyte growth factor was up-regulated in skin-related human cell lines Hs68 and HaCaT after treatment with heat-killed GMNL-653. For clinical observations, we recruited 22 volunteer participants to use the shampoo containing the heat-killed GMNL-653 for 5 months and subsequently measured their scalp conditions, including sebum secretion, dandruff formation, and hair growth. We applied polymerase chain reaction (PCR) to detect the scalp microbiota of *M. restricta*, *M. globosa*, *Cutibacterium acnes*, and *Staphylococcus epidermidis*. A decrease in dandruff and oil secretion and an increase in hair growth in the human scalp were observed after the use of heat-killed GMNL-653-containing shampoo. The increased abundance of *M. globosa* and the decreased abundance of *M. restricta* and *C. acnes* were also observed. We further found that accumulated *L. paracasei* abundance was positively correlated with *M. globosa* abundance and negatively correlated with *C. acnes* abundance. *S. epidermidis* and *C. acnes* abundance was negatively correlated with *M. globosa* abundance and positively correlated with *M. restricta*. Meanwhile, *M. globosa* and *M. restricta* abundances were negatively associated with each other. *C. acnes* and *S. epidermidis* abundances were statistically positively correlated with sebum secretion and dandruff, respectively, in our shampoo clinical trial.

Conclusion Our study provides a new strategy for human scalp health care using the heat-killed probiotics GMNL-653-containing shampoo. The mechanism may be correlated with the microbiota shift.

Keywords Heat-killed probiotics, *Lacticaseibacillus paracasei*, Shampoo, Scalp health care, Scalp microbiome

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