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From grain to greater nutrition: Solid-state fermentation with *Aspergillus oryzae* enhances nutrient bioavailability and digestibility of cereals – A research contribution conducted within the SoLFOOD project

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Abstract

Solid-state fermentation (SSF) using filamentous fungi represents a versatile, sustainable approach for producing nutrient-dense, minimally processed whole foods. By colonizing solid substrates such as cereals, filamentous fungi can improve protein quality, enhance nutrient bioavailability, and reduce anti-nutritional factors through their enzymatic activities. *Aspergillus oryzae* (Koji mold) is a well-established filamentous fungus that has been used for centuries in the production of fermented foods and is classified "Generally Recognized as Safe" (GRAS).

Within the SoLFOOD project, which aims to reduce food losses associated with mycotoxin contamination among Kenyan smallholder farmers, SFF was investigated as a low-cost and locally applicable strategy for producing safe and nutrient-rich food products. To assess the feasibility of household-scale fermentation, freeze-dried *A. oryzae* (MRI389) was inoculated onto pre-steamed cereal substrates (maize, rice, and wheat) and incubated at temperatures representative of local environmental conditions (20, 30 and 40 °C). Fungal growth was monitored by ergosterol analysis after 3, 5, 7, 10, 12, and 14 days of fermentation. Nutritional assessments were conducted after 7 and 14 days and included the determination of phytate content, proximate nutrient composition, and *in vitro* digestibility.

Preliminary results demonstrated successful colonisation of all cereal substrates by *A. oryzae*. Fermentation resulted in improved *in vitro* digestibility and reduced phytate concentrations compared with unfermented controls. These changes indicate enhanced nutrient accessibility and underscore the potential of SFF as a simple, low-technology intervention for improving the nutritional quality of staple cereals in resource-limited settings.

Although SFF has demonstrated considerable potential for improving the nutritional quality and functionality of food products, most studies have been conducted under controlled laboratory conditions that are difficult to reproduce in resource-limited settings. Therefore, this study evaluated the performance of *A. oryzae* under simplified fermentation conditions designed to reflect those encountered in rural households. The results indicate that SFF using *A. oryzae* represents a promising and cost-effective strategy for enhancing

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the nutritional value of staple foods, supporting circular food systems, reducing post-harvest losses, and contributing to food security in resource-constrained environments.

Keywords: Aspergillus oryzae, food security, improved dietary quality, rural households, solid-state fermentation (SSF), sustainability