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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. ***Aspergillus oryzae*** is a well-established filamentous fungus 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 producing safe and nutrient-rich food products. In this study *A. oryzae* (MRI389) was inoculated onto cereal substrates and incubated at temperatures representative of local environmental conditions. Nutritional assessments were analyzed after 14 days with the determination of minerals, trace elements and *in vitro* digestibility.

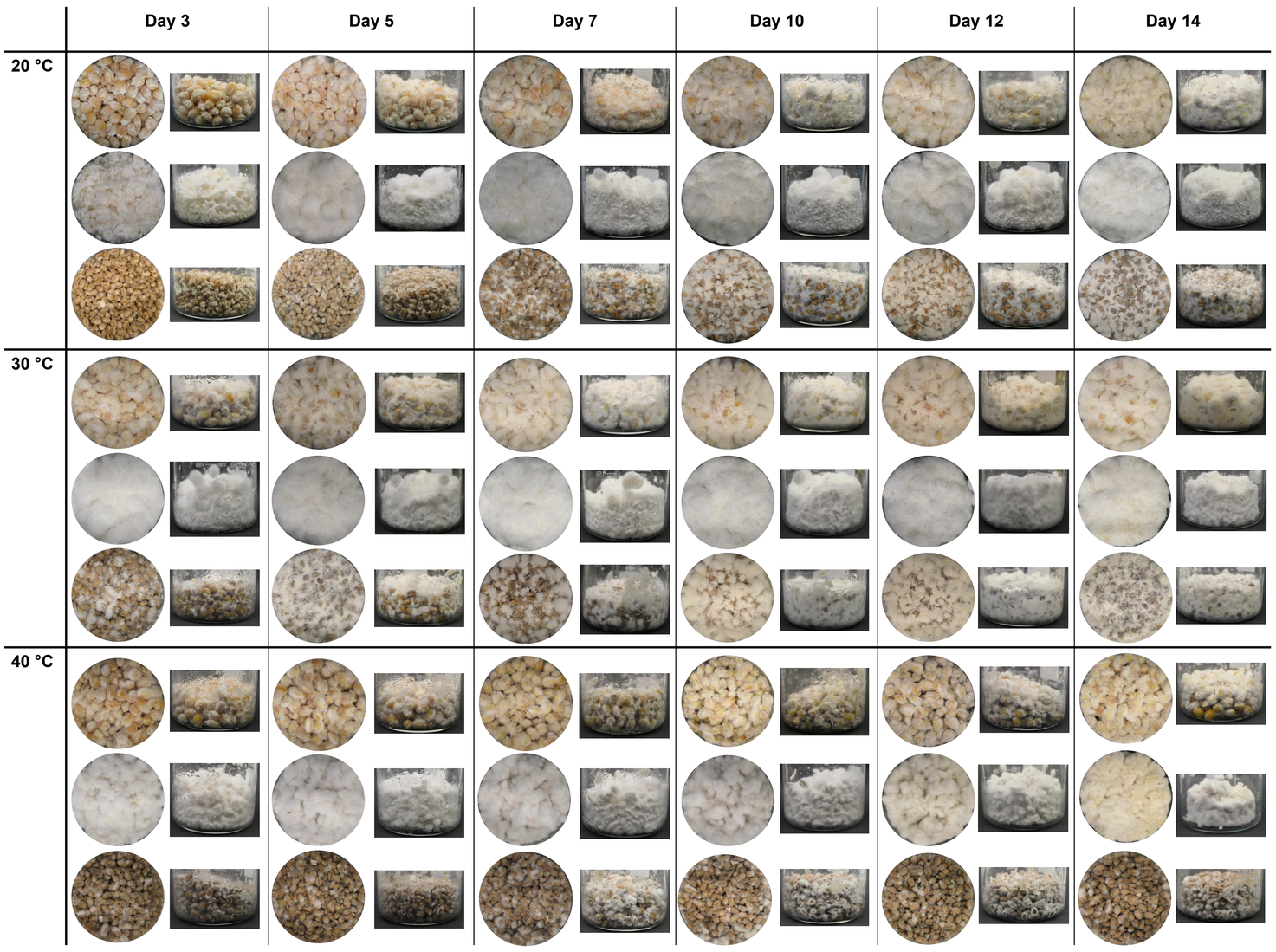

Table 1. Growth of MRI 389 *Aspergillus oryzae* on maize, rice, and wheat at 20 °C, 30 °C, and 40 °C. The days shown are 3, 5, 7, 10, 12, and 14. Each sample was replicated three times (not all are shown).

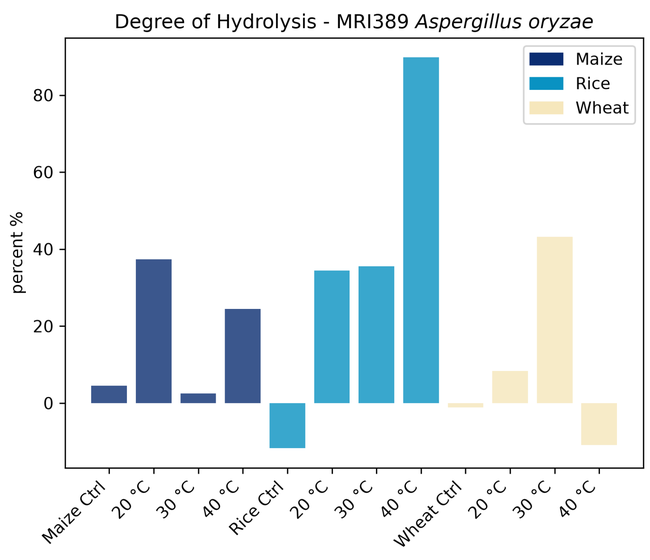

Figure 1. Degree of Hydrolysis (percentage of free amino acid groups) of fermentation products from maize, rice, and wheat fermented by *Aspergillus oryzae* strain MRI389 at 20 °C, 30 °C, and 40 °C for 14 days.

The hybrid products were hydrolyzed using a drying oven hydrolysis (acid hydrolysis) and in vitro digestion, which allowed the degree of hydrolysis to be determined. After hydrolysis, the level of free amino groups was measured photometrically using ninhydrin. A single determination was performed for this purpose.

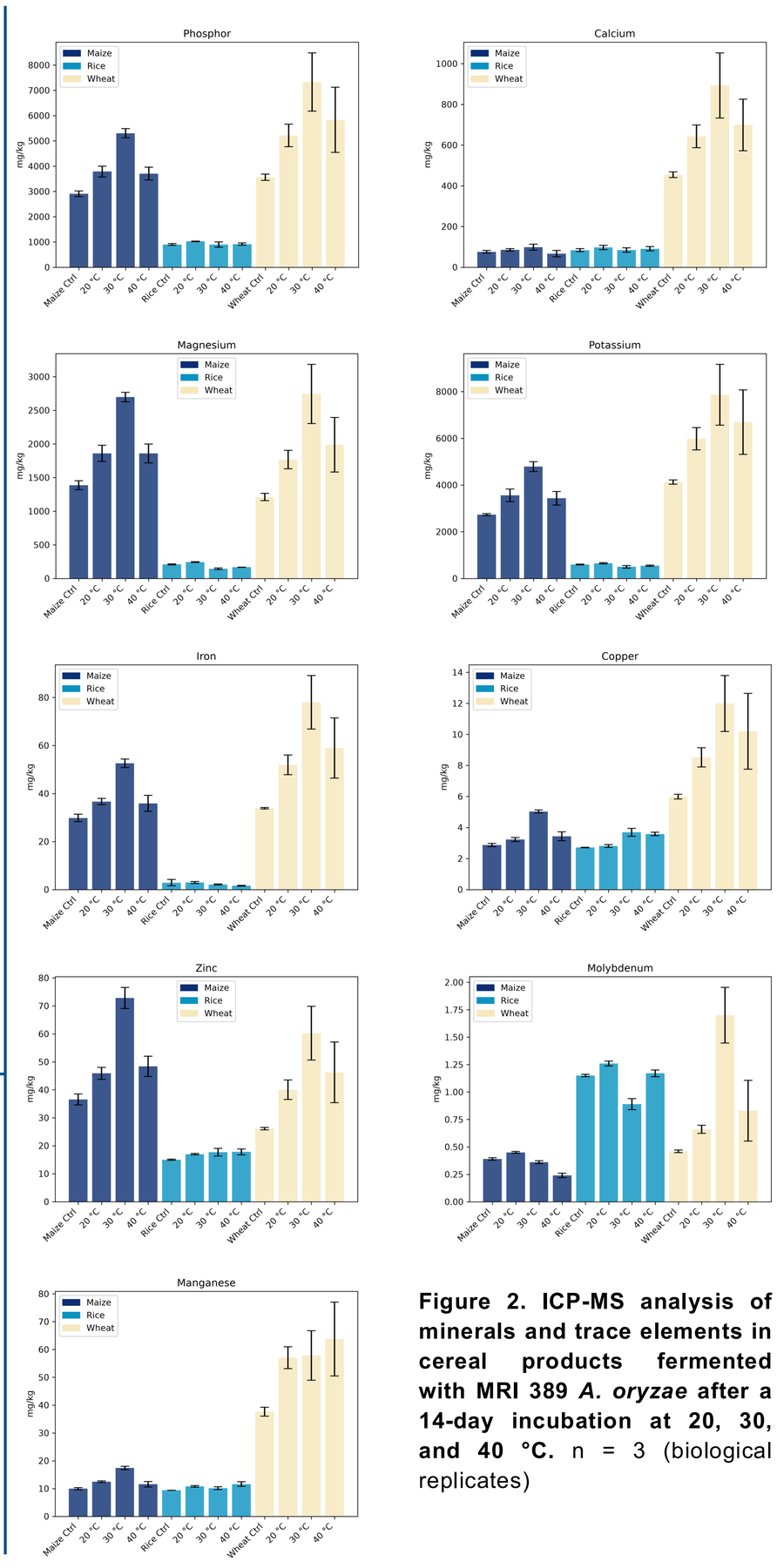

Figure 2. ICP-MS analysis of minerals and trace elements in cereal products fermented with MRI 389 *A. oryzae* after a 14-day incubation at 20, 30, and 40 °C. n = 3 (biological replicates)

Conclusion and Outlook

Preliminary results demonstrated successful colonization of all cereal substrates by MRI389 *A. oryzae*. In most cases, the degree of hydrolysis increased, suggesting improved digestibility. The ICP-MS analyses show an increase in minerals and trace elements, particularly in wheat. A similar trend can be observed in maize.
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. This study evaluated the performance of *A. oryzae* under simplified fermentation conditions designed to reflect those encountered in rural households and the results indicate that SFF using *A. oryzae* represents a promising and cost-effective strategy for enhancing the nutritional value of staple foods.

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References:
Gerber et al. Advancing solid-state fermentation with culinary fungi for nutrient-dense, minimally processed, whole foods and resilient food systems – a narrative review. Front. Nutr. 2026; 13: 1798618.

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