Valorization of Edible Mushroom Waste in Penne Pasta Production: Fermentation and Nutritional Enhancement

Ana Saldanha

Diogo Salvati, Laura Roman, Manuel A. Coimbra, Maria Inês Dias

July 2024

Introduction

Fermented foods are produced and consumed around the world, and the most common type of fermentation is based on **lactic acid bacteria.**

Fermented mushrooms are often a prized delicacy. Several species of fungi are fermented by lactofermentation by the Eastern Slavs, Estonians and Poles.

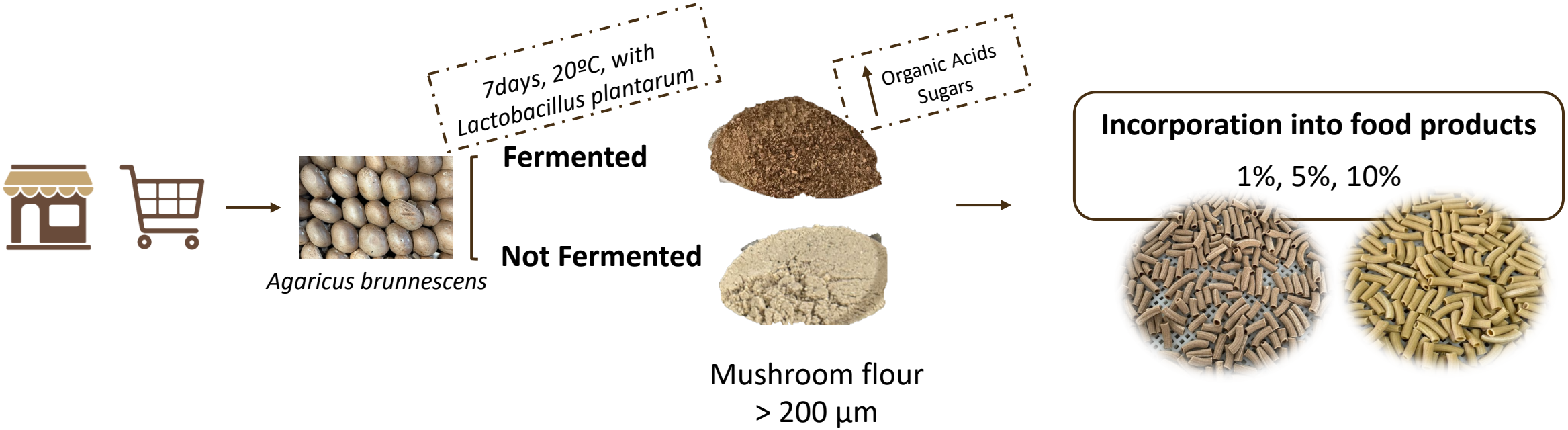
Change **nutritional**, **chemical**, **organoleptic** composition

↓ Waste and greenhouse gas emissions

Promoting responsible production

Food preservation

Introduction



- ✓ Increase in the nutritional composition of pasta;
- ✓ Increase conservation potential, through fermentation processes, without the need for chemical preservatives;
- ✓ Modification of the organoleptic properties of the pasta;
- ✓ Increase in new flavor options and use in various recipes, expanding gastronomic possibilities.

Objectives

- Use of edible mushroom waste to reduce waste and promote sustainability;
- Use of the lactic fermentation process to improve conservation and enhance the nutritional benefits of mushrooms;
- Development and evaluation of penne pasta enriched with fermented and non-fermented mushrooms, exploring their physicochemical and sensorial properties.

Materials and Methods

Flours Formulations

MHF: Fermented Mushroom Flour

MH: Not Fermented Mushroom Flour

DWS: Durum wheat semolina

Control: 100% DWS

Fermented

1%MHF 5%MHF 10%MHF

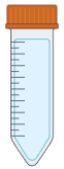
Not Fermented

1%MH 5%MH 10%MH

Color

Humidity

pH



Water Binding Capacity

Rapid Visco Analyze (RVA)

Materials and Methods

Penne Pasta Formulations

MHF: Fermented Mushroom Flour

MH: Not Fermented Mushroom Flour

DWS: Durum wheat semolina

Control: 100% DWS

Fermented

1%MHF

5%MHF

10%MHF

Not Fermented

1%MH

5%MH

10%MH

Humidity
(fresh and dry pasta)

Optimal Cooking Time

Solid Lost Weight gain

Texture
(cooked pasta)

Color
(fresh, dry and cooked pasta)

Results

Flours Formulations

pH

No significant difference in moisture

Fermented

Not Fermented

Control: 100% DWS

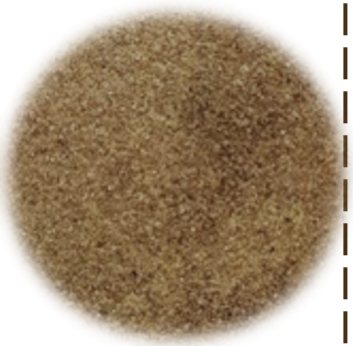
1%MHF

5%MHF

10%MHF

1%MH

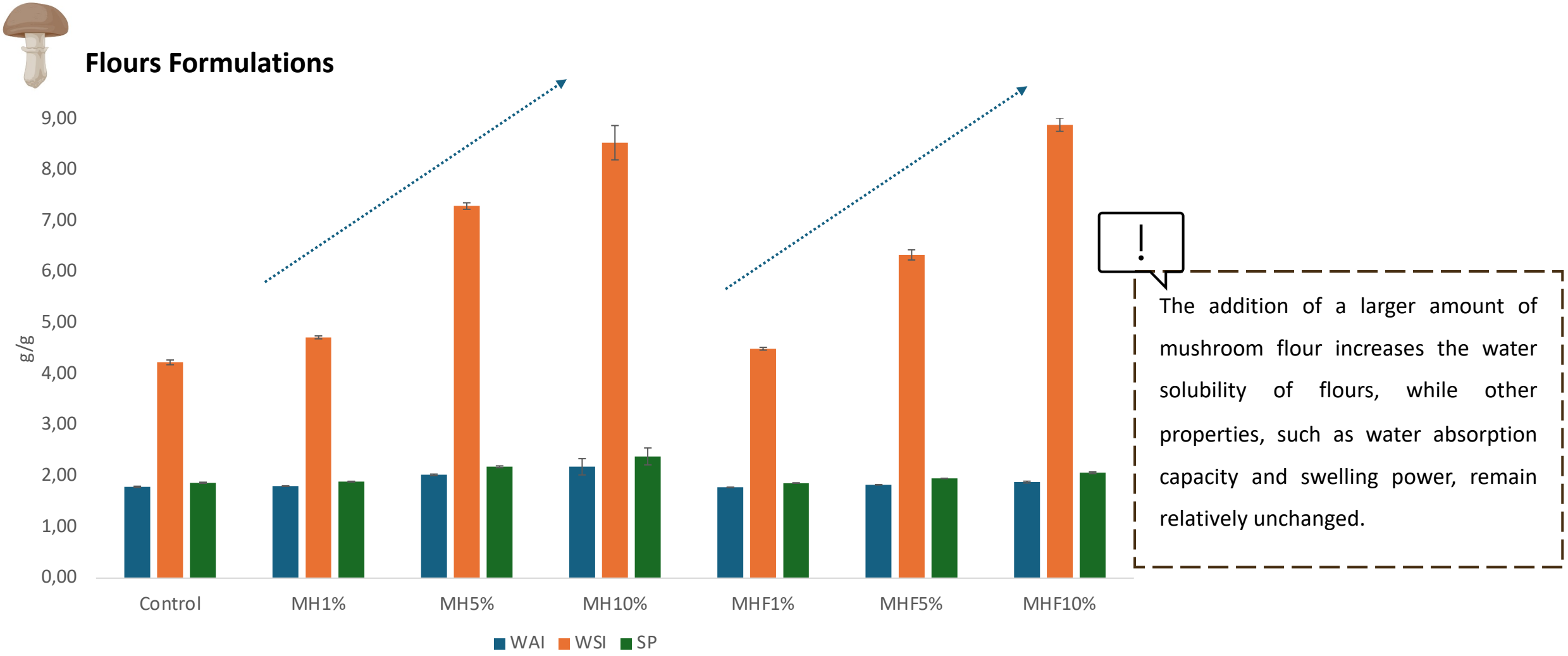
5%MH



10%MH

L*
b*

Results

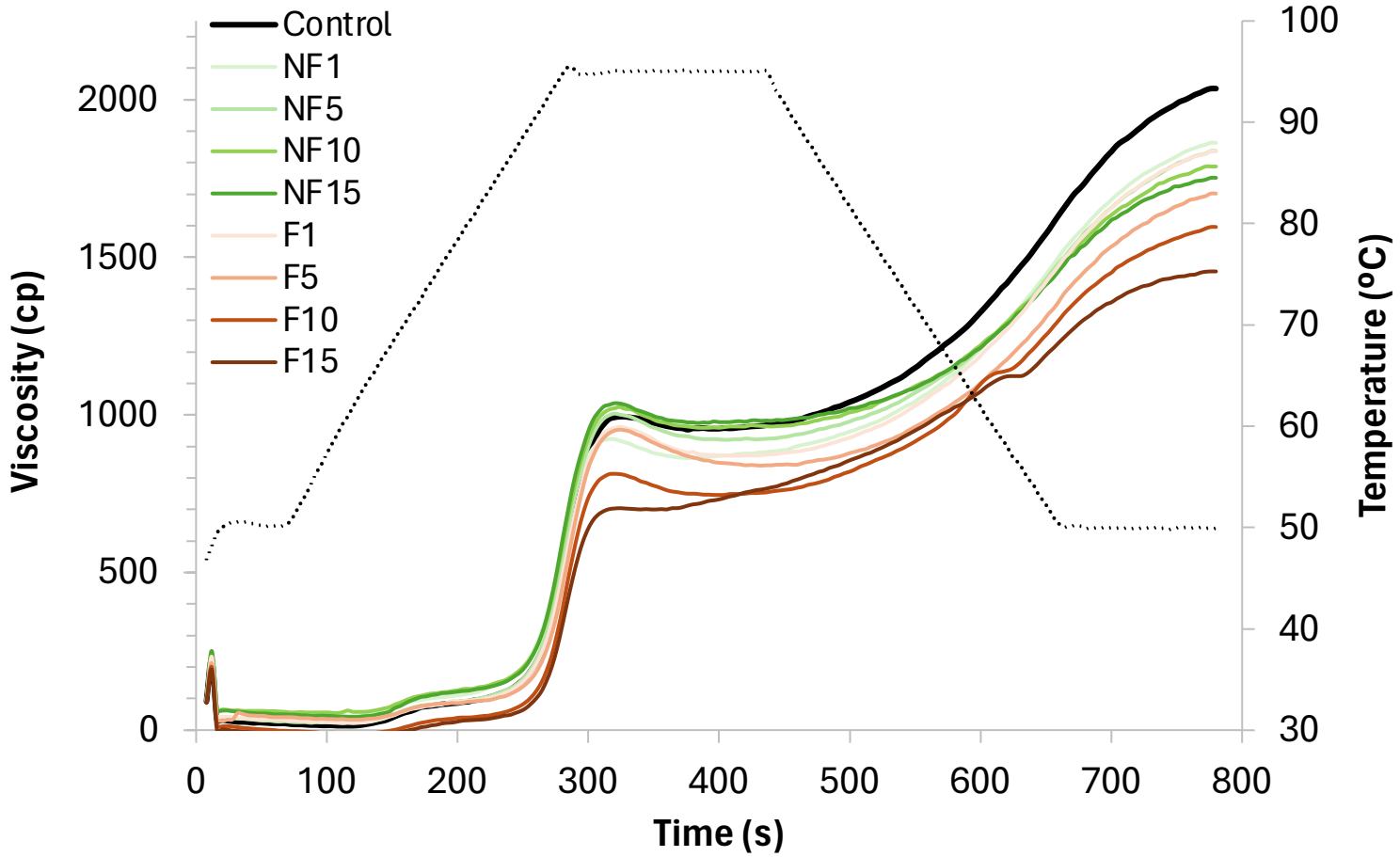


The addition of a larger amount of mushroom flour increases the water solubility of flours, while other properties, such as water absorption capacity and swelling power, remain relatively unchanged.

Figure 1. Functional properties of different flour formulations through the incorporation of fermented and not fermented mushrooms: Water Absorption Index (WAI; g/g), Water Solubility Index (WSI; g/g), Swelling Power (SP; g/g).

Results

Flours Formulations



- Flours with a higher percentage of mushrooms tend to exhibit higher viscosity and more complex behavior during heating and cooling, which suggests greater interaction of the mushroom components with the flour matrix.

Fermentation appears to modify the viscosity response of flours, possibly due to changes in the chemical and structural composition of the mushrooms and the flour matrix.

Figure 2. Viscosity profile of different flour formulations with fermented and not fermented mushrooms.

Results

Penne Pasta

No significant difference in moisture

Cooked

Control: 100% DWS

Fermented

1%MHF 5%MHF 10%MHF

Not Fermented

1%MH 5%MH 10%MH

Not Cooked

Control: 100% DWS

Fermented

1%MHF 5%MHF 10%MHF

Not Fermented

1%MH 5%MH 10%MH

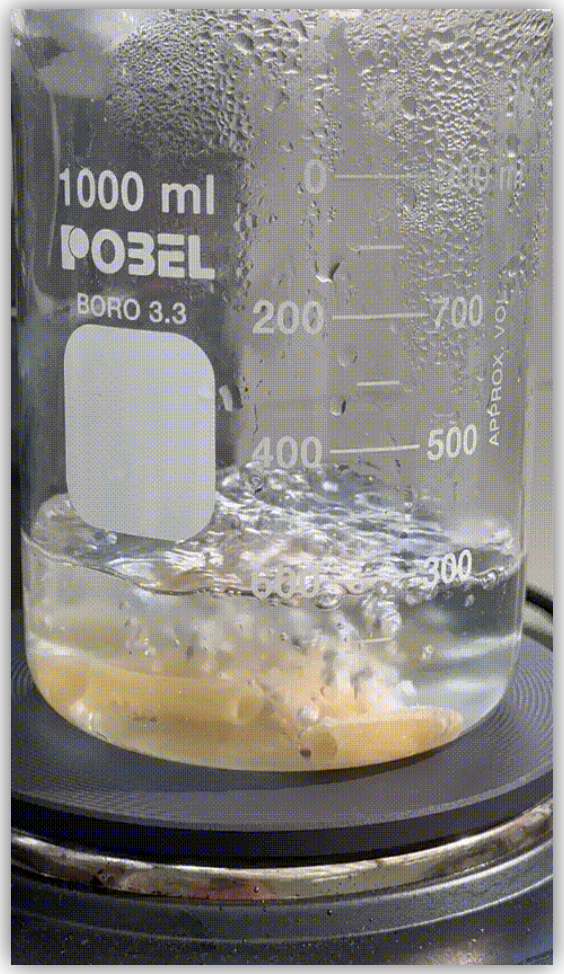
L*
b*

Results

Penne Pasta – Optimal Coooking Time

Table 1. Optimum cooking time (min) values for different formulations of penne pasta with fermented and not fermented mushrooms**.**

Samples	8 min	9 min	10 min
 Control: 100% DWS	X		
 1%MH		X	
 5%MH 10%MH 1%MHF 5%MHF 10%MHF			X



The shorter cooking time increased significantly with increasing mushroom powder supplementation.

Results

Penne Pasta

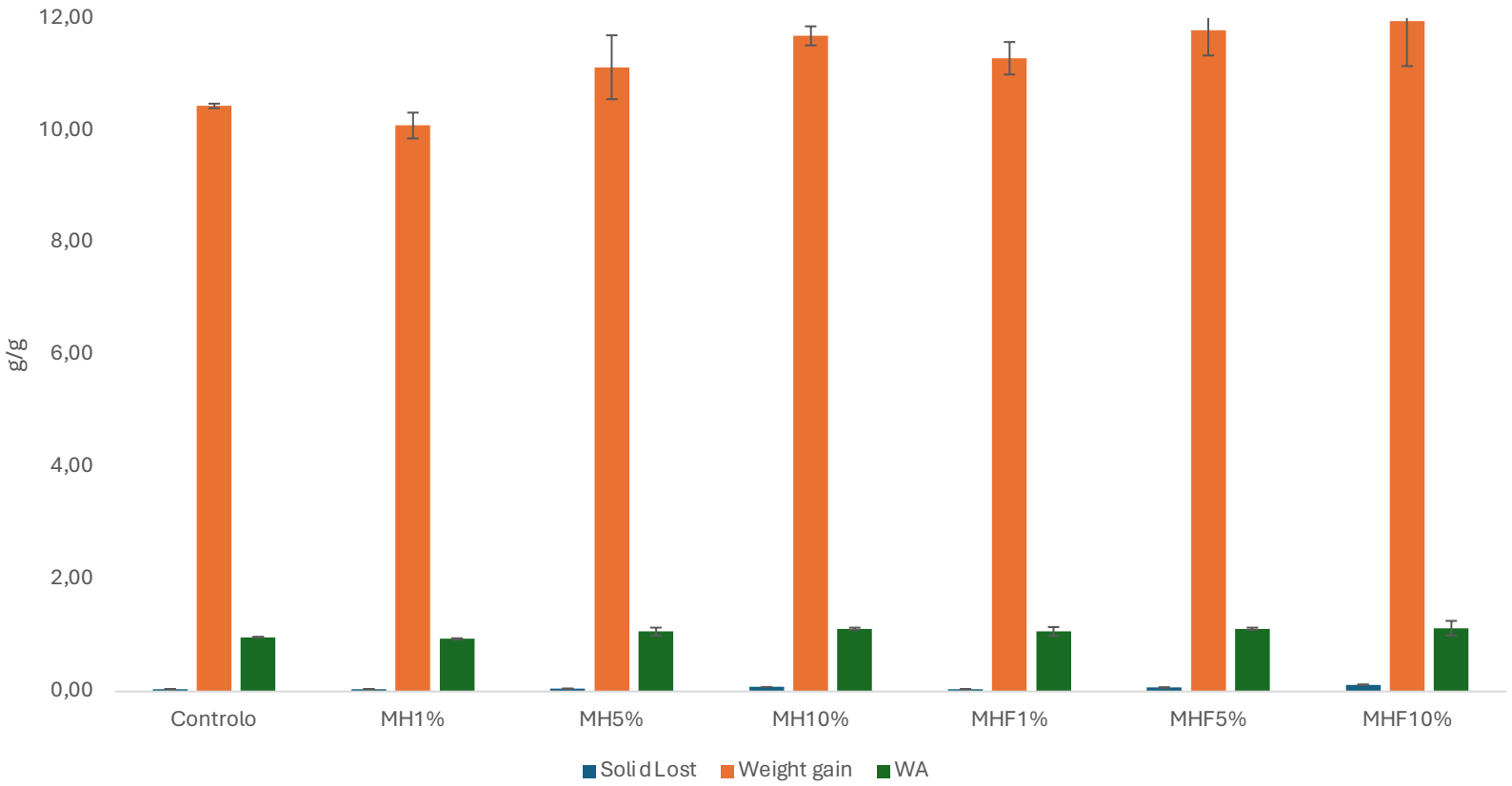


Figure 3. Physical properties of different penne paste formulations: Solids lost; Weight gain; Water Absortion.

!

- All samples showed significant weight gain after cooking;
- The loss of solids is minimal, and water absorption is similar in all samples, indicating that the addition of mushrooms does not significantly alter this aspect.

Results

Penne Pasta

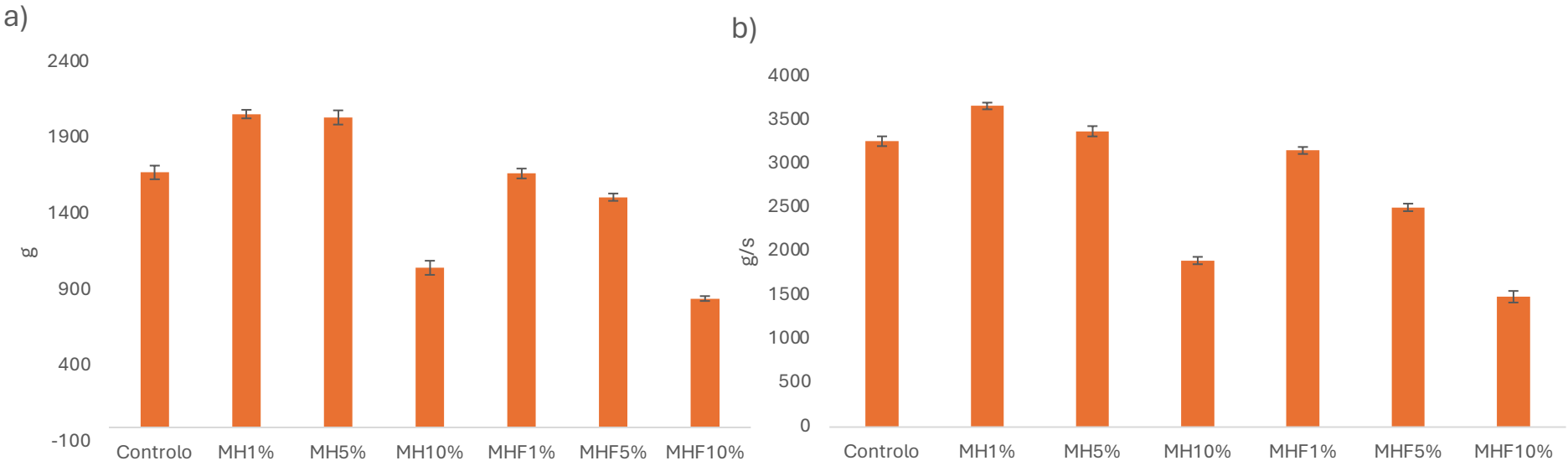
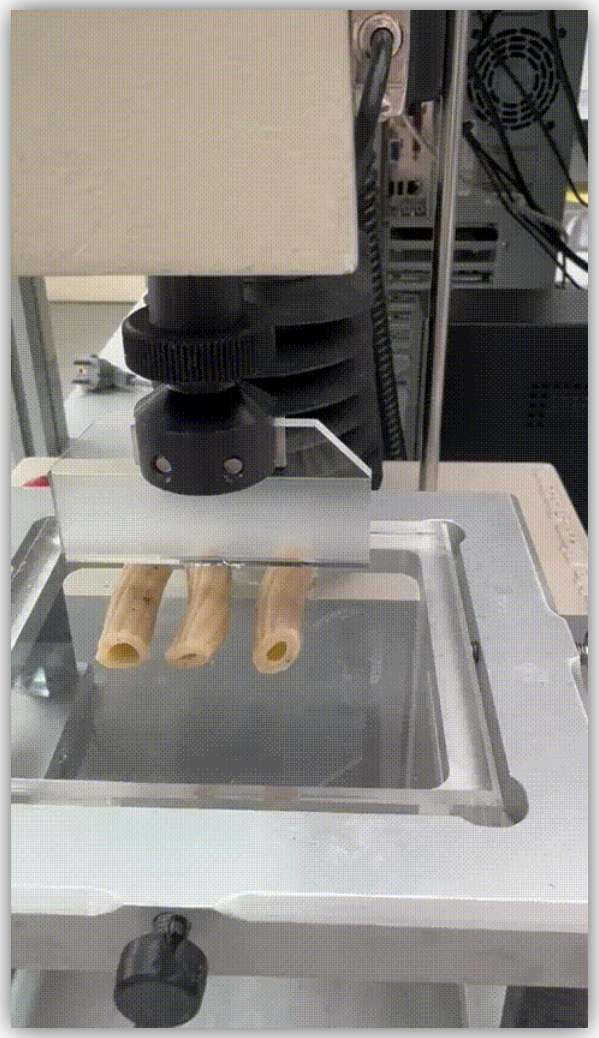


Figure 4. Instrumental physical properties of different penne paste formulations with fermented and not fermented mushrooms: a) Firmness; b) Cutting force.



The addition of mushrooms, especially in higher percentages, tends to reduce the firmness of penne pasta, which translates into a decrease in cutting force.

Conclusion

The potential of using edible mushroom residues to improve the nutritional and functional properties of penne pasta through fermentation was verified;

Increased substitution of mushroom flour led to darker doughs with reduced hardness, longer cooking times, lower pH, higher fiber and protein content, and similar swelling;

Fermented mushroom flour can be a useful component in the production of creative, nutrient-dense food products that serve health- and sustainability-conscious consumers;

This project enhances penne pasta with fermented mushroom waste, promoting food security and healthy diets (SDGs 2 and 3), technological innovation (SDG 9), waste reduction, lower emissions (SDG 13), and responsible production (SDG 12).

Thank you for your attention!