IRTA Institute of Agrifood Research and Technology

Unlocking Nutritional and Functional Benefits of Fava Beans through Solid-State Fermentation: A Scientific approach

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INTRODUCTION

With the increase in the consumption of vegetable proteins, such as those from legumes, there is a growing need to innovate in their consumption. This entails not only novel preparation and cooking methods but also strategies to fully exploit their intrinsic nutrients. One promising approach could be fermentation [1]. Solid-state fermentation involves in inoculating the legume or legumes of interest with one or several microorganisms, among them fungi, yeasts and lactic acid bacteria. Koji (*Aspergillus oryzae*), Tempeh (*Rhizopus oligosporus*), and Oncom (*Neurospora sitophila*) are all traditional fermented foods that utilize fungi to enhance their nutritional value and flavor [2]. The fermentation process not only preserves the food but also boosts its nutritional content. Fungi increases the bioavailability of nutrients, adds beneficial compounds, and often reduces antinutritional factors [3], playing a crucial role in traditional diets and food culture.

OBJECTIVE

The present study focused on the characterization of the products obtained from the solid-state fermentation of fava beans with three different fungal strains. Ingredients resulting from the fermentation (Faba-based Tempeh, Faba-based Koji & Faba-based Oncom) were evaluated techno functionally and nutritionally.

The objective is to boost the nutritional contribution of traditional foods and also to benefit the local production of these products. In this way we encourage a responsible consumption of local resources with a touch of innovation and making the most of the nutritional contribution.

METHODOLOGY

Sofia fava bean (Vicia faba) variety from the Catalan region of Spain was inoculated with different strains of microorganisms for fermentation. Then were mixed with water in a 1:3 ratio, adjusted to pH 4.5 and left to soak for 24 hours. The skin was then removed, and beans were cooked in water at pH 4.5. Subsequently, they were dried at 30°C for one hour and inoculated according to the specifications of the provider (Kenshô, Tarragona, Spain) for each microorganism: *Aspergillus oryzae (Koji), Rhizopus oligosporus (Tempeh) and Neurospora sitophila (Oncom)*, incubating them at 30°C, on a controlled incubator, for at least 24 hours until a mycelial layer was observed. Products were divided into two batches: one was frozen for later freeze-drying and the other was dried at 70ºC for 24 hours, then grounded and subjected to techno-functional and nutritional analysis. Nutritional analyses of total polyphenol content (TPC) were carried out, as well as analyses to measure antioxidant capacity with two protocols: Ferric ion reducing antioxidant power (FRAP) and scavenging activity assay (ABTS).

RESULTS

As expected, the mycelial growth of the different fungi used, even under similar incubation conditions, was very different, as can be seen in Figure (1). Faba-based Tempeh (FB-T) showed greater dispersion and uniform coverage on the beans with a bright white color. While the Faba-based Oncom (FB-O), although with less dispersion, presented a characteristic orange-red color. Regarding techno-functional tests, Faba-based Koji (FB-K) presented better results for emulsifying capacity and water retention, while FB-T showed better results for oil retention (2). In nutritional terms, FB-K showed better results in terms of total phenolic content (3.50mg/g) (3) and antioxidant capacity in both FRAP and ABTS assays with almost 35 mg/100g and above 200 mg/100g for ABTS. In the ABTS analysis, the freeze-dried batch showed higher levels in antioxidant capacity in FB-K with almost 220 mg/100g (4). Protein levels were similar in all samples with different strains ranging from 32-35% (5).

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1. Growth of FB-k, FB-T & FB-O, and the samples grounded, respectively.

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Sample	Oil Retention (%)	Water Retention (%)	Emulsifying Capacity (%)
Freeze-dried FB-T	87.13	297.06	20.80
Freeze-dried FB-K	75.86	247.39	22.21
FB-T	89.31	256.20	31.70
FB-K	67.87	263.13	33.79

Techno-Functional Properties

2. Most Relevant techno-functional results in both dried and freeze-dried fermented products.

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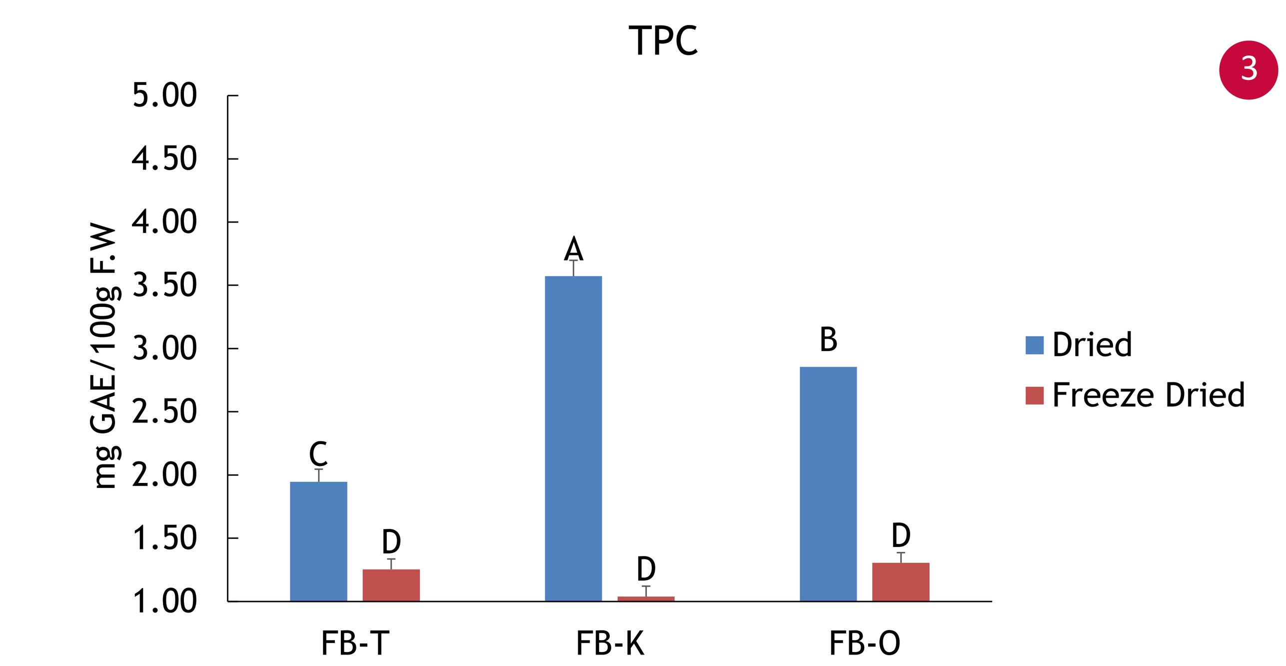

3. Total Polyphenols Content in FB-T, FB-K and FB-O for both dried and Freeze-dried simples.

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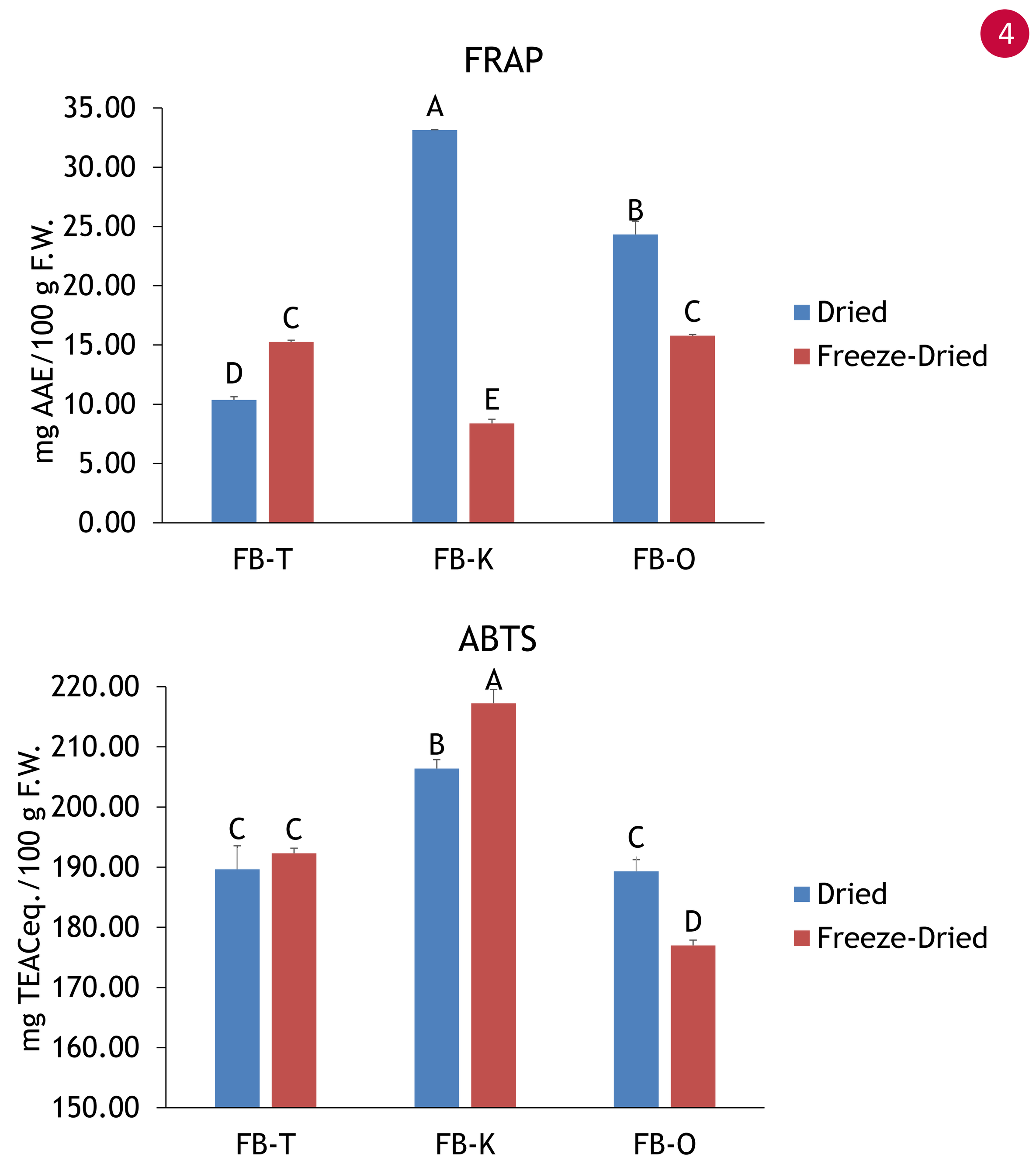

4. Antioxidant Capacity results for FRAP & ABST assays in both dried and freeze-dried Faba-Bean samples.

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Kjeldahl

Samples	Protein (%)
Faba bean (Not Fermented)	27.55
FB-T	35.87
FB-K	35.68
FB-O	33.58
FD FB-T	35.46
FD FB-K	36.08
FD FB-O	32.85

5. Protein content percentages for both dried and Freeze-dried (FD) samples.

CONCLUSIONS

The results obtained seem promising, not only for the nutritional capacity of the beans, but also for the added contribution of the fungal strains used, the advantage in antioxidant capacity and the contribution in phenolic compounds is remarkable. Although there is no significant difference in the protein content, beans continue to be a source of high-quality green protein. In subsequent trials, the capacity of absorption of these nutrients by humans will be analyzed.

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