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ECO-FRIENDLY MEAT ADDITIVES: FUNGAL FERMENTATION OF COFFEE SILVERSKIN AS A SUSTAINABLE ALTERNATIVE

Wendy Alejandra Atondo-Echeagaray[1], Brisa del Mar Torres-Martínez[1], Gastón R. Torrescano-Urrutia[1], Nelson Huerta-Leidenz[2], Félix J. Ibarra-Arias[3], Rey David Vargas-Sánchez[1], Armida Sánchez-Escalante[1*],

[1] Centro de Investigación en Alimentación y Desarrollo, Coordinación de Tecnología de Alimentos de Origen Animal, Hermosillo, México.

[2] Texas Tech University, Department of Animal and Food Sciences, Lubbock, USA.

[3] Alta Tecnología Industrial para la Salud Animal, Guadalajara, México.

*Corresponding author email: armida-sanchez@ciad.mx

I. INTRODUCTION

In several research has been used conventional methods to extract preservatives from natural sources. However, fungal fermentation of agro-industrial by-products emerges as an innovative strategy for recovering new additives [1,2]. Coffee silverskin, a waste with a high content of bioactive compounds [3], has been explored little in meat applications. This study evaluates the potential of the fungal fermentation of coffee silverskin (CSS) as a source of natural additives with antimicrobial and antioxidant properties. It is hypothesized that biotransformation by fungal fermentation will increase the extraction of the bioactive compounds, favoring their application in the meat industry.

II. MATERIALS AND METHODS

Coffee silverskin residues were procured from a local commercial supplier (CAFFENIO®; Hermosillo, Mexico). *Pleurotus ostreatus* mycelium was grown under-submerged fermentation (150 rpm/29 °C/10 d/under dark), using a sterilized medium (pH 5.4) composed of glucose (20 g/L), yeast extract (5 g/L), KH_2PO_4 (1 g/L), $MgSO_4$ $7H_2O$ (0.5 g/L), and ascorbic acid (0.05 g/L). The medium (100 mL) was inoculated with mycelium (1 cm^2 of covered surface in PDA). Treatments were as follows: T1, medium without CSS; T2 and T3, medium with 1 and 2% CSS, respectively). After fermentation, the resultant solution was filtered (with Whatman 1 paper), concentrated (150 rpm/60°C), and dried (20 Pa/-80°C/48 h). The obtained aqueous extracts were assessed for total carbohydrate, phenolic, and chlorogenic acid content (TCC, TPC, and CGA, respectively) and antioxidant effect (radical DPPH and ABTS inhibition). BHT was used as a positive control, and the radical solution was used as a negative control. Also, the antimicrobial effect against *Staphylococcus aureus* and *Escherichia coli* was evaluated. Gentamicin was used as a positive control, and BHI as a negative control [4]. Results are presented as mean ± standard deviation (n=6). Data were subjected to a one-way analysis of variance and the Tukey mean separation test ($P<0.05$).

III. RESULTS AND DISCUSSION

The metabolite content of aqueous extracts was affected by the addition level of CSS fermented with *P. ostreatus* mycelium (Table 1). T1 shows the highest TCC content, while T3 shows the highest TPHC and CGA contents.

Table 1 – Polyphenol content of fermented coffee silverskin extract.

Treatment	TCC (Abs 517 nm)	TPHC (Abs 730 nm)	CGA (Abs 517 nm)
T1	1.677 ± 0.052^{b}	0.020 ± 0.001^{a}	0.040 ± 0.001^{a}
T2	1.504 ± 0.050^{a}	0.021 ± 0.001^{a}	0.044 ± 0.002^{b}
T3	1.561 ± 0.049^{a}	0.025 ± 0.001^{b}	0.052 ± 0.001^{c}

Abs, absorbance.

The antioxidant and antimicrobial activity of aqueous extracts were affected by the addition level of coffee silverskin fermented with *P. ostreatus* mycelium (Table 2). Regarding antioxidant activity, T3 shows the lowest DPPH and ABTS absorbances, which indicates more significant radical inhibition. T3 shows the lowest *S. aureus* and *E. coli* absorbances concerning antimicrobial activity, suggesting more significant bacterial inhibition.

Table 2 – Antioxidant and antimicrobial activity of fermented coffee silverskin extract.

Treatment	DPPH (Abs 517 nm)	ABTS (Abs 700 nm)	*S. aureus* (Abs 630 nm)	*E. coli* (Abs 630 nm)
T1	0.556 ± 0.001^{d}	0.381 ± 0.010^{c}	0.625 ± 0.006^{c}	0.448 ± 0.004^{d}
T2	0.524 ± 0.002^{c}	0.329 ± 0.009^{b}	0.613 ± 0.010^{c}	0.396 ± 0.017^{c}
T3	0.459 ± 0.007^{b}	0.280 ± 0.008^{a}	0.571 ± 0.013^{b}	0.363 ± 0.001^{b}
Control (-)	0.574 ± 0.006^{e}	0.775 ± 0.004^{d}	0.774 ± 0.011^{d}	0.471 ± 0.018^{e}
Control (+)	0.044 ± 0.001^{a}	0.272 ± 0.006^{a}	0.169 ± 0.021^{a}	0.095 ± 0.002^{a}

Abs, absorbance.

It was reported that the aqueous extract obtained by submerged fermentation with *Pleurotus pulmonarius* mycelium and residual coffee beans presented a high content of metabolites, where the presence of carbohydrates, phenols, flavonoids, and chlorogenic acid were highlighted, depending on the concentration of the residue. Furthermore, this extract displayed antioxidant activity by inhibiting DPPH and ABTS radicals, reducing lipid oxidation, and improving reducing power [4]. Another study determined the effect of the aqueous extract obtained by maceration and fungal fermentation (using *P. pulmonarius* mycelium) of CSS on the metabolite content and bioactivity (antioxidant and antimicrobial activity). Regarding the metabolite content and bioactivity, the results showed a decrease in the carbohydrate content of the extracts obtained by fungal fermentation, as well as an increase in the contents of phenols, flavonoids, and caffeoylquinic acid, depending on the concentration of the residue used. Moreover, an increase in the free-radical and radical cation scavenging activity was observed, as well as a decrease in microbial growth values of the extracts obtained by fermentation [5].

IV. CONCLUSION

These results suggest that fermenting coffee silverskin with *P. ostreatus* may be an effective process to enhance its functional properties, opening new application possibilities in the formulation of ingredients with antioxidant and antimicrobial properties for the food and nutraceutical industries.

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