Enzymatic production of wax esters from spent coffee grounds' oil and evaluation of their oleogelation properties

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Abstract

Coffee is nowadays considered as the most popular beverage worldwide, and its consumption is constantly increasing. Hence, unavoidable, significant quantities of spent coffee grounds (SCG) are obtained from the coffee brewing process. SCG contain around 15% (w/w) lipids, mainly consisted of palmitic and linoleic acid. In this context, the present study aimed to valorise the SCG oil for the enzymatic synthesis of wax esters, which were subsequently applied as oleogelator agents for gels production. Wax esters were synthesized by lipase Novozyme 435 using SCG oil and fatty alcohols at a molar ratio of 1:3. Experiments included the utilisation of two fatty alcohols, namely behenyl and cetyl alcohol, and the reactions were performed for 24 h under solvent-free conditions at different temperatures, depending on the melting point of each alcohol. Subsequently, olive oil and the produced wax esters (at concentrations 5-10% w/w) were mixed for oleogels production, which were stored at 10 °C for at least 24 h prior to analysis. Results showed that high conversion yields were achieved when cetyl and behenyl alcohols were applied under solvent free conditions. More specifically, the obtained conversion yields were 90.3% (at 50 °C) and 91.7% (at 70 °C), respectively. The conversion yield in both cases reached its maximum at around 4-6 h, which was subsequently not significantly increased until the end of the reaction (24 h). Oleogels production using behenyl and cetyl wax esters showed that oleogelation was effective only at high concentrations (10% w/w) of both wax esters. Firmness values during texture analysis were around 0.3-0.9N, whereas their oil bind capacity ranged from 60% to 70%. Rheological analysis of oleogels showed that storage (G′) and loss modulus (G′′) were independent to stain values in the range of 0.001-1% (around G′ = 10^5 Pa and G′′ = 10^4 Pa). Also, G′ and G′′ values were increased as concentration of wax esters increased, indicating that a stronger oleogel was formulated at higher wax esters concentrations. Conclusively, the present study demonstrated that food waste, such as SCG, can be effectively valorised towards food additives (wax esters) and food products (oleogels) through a biotechnological approach and within the context of Circular Economy.

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