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Brewers' Spent Grain Protein as a Novel Pickering Emulsion Stabilizer

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Abstract

Beer is a widely consumed and popular alcoholic beverage. However, its production requires high concentrations of raw materials, such as malted barley, which is discarded after mashing. This by-product, usually referred to as brewer's spent grain (BSG), represents a novel source of valuable compounds such as proteins, fiber, and bioactive compounds. Proteins are widely used as emulsifiers to facilitate the fabrication of stable emulsions such as Pickering emulsions (PEs). PEs have recently attracted significant attention due to their safe, long-term stability. In this study, protein was extracted from BSG and used to stabilize oil-in-water (o/w) PEs. Protein was initially extracted using NaOH solution at a 1:15 (w/v) ratio for 1.5 h, followed by precipitation at the isoelectric point and freeze-drying. Next, the BSG protein was solubilized in water at four different concentrations (0.25, 0.5, 0.75, and 1 % w/v). The solutions were stirred, filtered to remove undissolved large particles, and used as stabilizers to prepare PEs by mixing the aqueous phase (containing the protein) with the oil phase (30% or 40% sunflower oil) using an Ultra turrax for 5 min at 10.000 rpm. The obtained emulsions were characterized using a Mastersizer to determine droplet size, a LUMiSizer to compare physical stability among different emulsions, and a ζ-potential analyzer to determine their stability. Results showed that the Sauter mean diameter (d3,2) was 58.6 ± 30.6 µm, 149.66 ± 30.5 µm, 218.5 ± 26.16 µm, 150.33 ± 33.29 µm for emulsion samples prepared with different protein concentrations (i.e 0.25, 0.5, and 0.75 and 1 % w/v) and 30 % oil contents, and 157.67 ± 35.50 µm, 188.0 ± 18.38 µm, 177.33 ± 32.62 µm, 181.5 ± 12.02 µm for these samples having 40% oil contents, respectively. Similarly, ζ-potential values, i.e., -48.61 ± 7.46 mV, -47.42 ± 4.96 mV, -25.76 ± 3.58 mV, -43.54 ± 1.42 mV for the samples having different protein concentrations and 30% oils, and for the samples with 40% -43.85 ± 3.80 mV, -34.88 ± 1.42 mV, -32.16 ± 1.65 mV, -43.35 ± 2.37 mV respectively indicated the stable nature of the prepared emulsions. Among all these samples, the emulsion prepared with protein concentration of 0.25 % (w/v) with 30 % oil contents showed better stability as evaluated by measuring the instability index using LUMiSizer, where the instability index for this sample was 0.699 while it was 1.06, 0.976, 1.00, 0.946, 0.984, 0.997 and 0.955 for the samples containing different protein concentrations and oil contents (i.e. 30 and 40%) respectively. It can be concluded that protein derived from BSG can be effectively extracted and upcycled into high-value, sustainable ingredients, including novel stabilizers for PEs, which have a wide range of potential applications in food, cosmetics, and pharmaceutical industries.

Keywords: brewer's spent grain, protein, application, stabilization, pickering emulsion

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