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The Effect of Nitrogen Fertilization on the Protein Content and Functionality of Lyophilized Opuntia ficus-indica Mucilage

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Abstract

Mucilage is a slimy green liquid found in the cladodes of Opuntia ficus-indica. The mucilage can be freeze-dried into a powder and this powder holds potential to be a commercial hydrocolloid in the food industry because it exhibits good functional properties, especially concerning emulsification. The main objective of this study was to investigate whether nitrogen fertilization had an effect on the yield and protein content of Opuntia ficus-indica (L.) Mill 'Morado' mucilage. Nitrogen fertilizers from three nitrogen sources (urea, limestone ammonium nitrate and ammonium sulphate) were applied at four application levels (0, 60, 120 and 240 kg ha^{-1}). The objective was further extended to investigate whether an increased protein content would increase the functionality of 'Morado' freeze-dried mucilage in terms of emulsification capacity and stability, as well as foaming capacity and stability. The functionality of mucilage was also compared to high-protein commercial products known to have good emulsification and foaming potential. Of the parameters tested, the freeze-dried mucilage content, the protein content, the foam stability, the oil holding capacity and the oil absorption capacity of the mucilage were significantly affected by nitrogen fertilization. Limestone ammonium nitrate applied at 120 kg ha^{-1} was the best nitrogen source and level for optimal protein content in freeze-dried mucilage. Ammonium sulphate applied at 60 kg ha^{-1} was the nitrogen source and level that promoted the best functionality of the mucilage for most of the parameters measured. However, the freeze-dried mucilage of the ammonium sulphate 60 kg ha^{-1} sample exhibited a lower protein content compared to the other samples from high application-level fertilizer sources. The protein content was only weakly positively correlated to the oil holding capacity of the freeze-dried mucilage. The ammonium sulphate 60 kg ha^{-1} mucilage sample displayed similar functionalities as high protein content commercial products, isolated soy protein and albumin. Sodium dodecyl sulphate–polyacrylamide gel electrophoresis of freeze-dried mucilage revealed that nitrogen fertilization affects the concentration of low molecular weight proteins the most. A concentration increase was observed in low molecular weight proteins from high nitrogen fertilizer level samples.