Effect of ultrasound on the physical and chemical properties of alginate-based marjoram essential oil nano-emulsions.

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Marjoram essential oil (MEO) is a natural preservative rich in compounds with antimicrobial properties, which can be applied in the form of emulsions in active coatings in order to improve foods' shelf life. Emulsion droplet size reduction to the nanoscale (< 200 nm) may improve coating stability, transparency, and antimicrobial activity. This work aimed to evaluate the effect of ultrasound treatment on the physical and chemical properties of alginate-based marjoram essential oil nano-emulsions. A coarse emulsion containing water, sodium alginate (1%), MEO (1%), and Tween 80 (1%) was prepared using an Ultra-Turrax at 10,000 rpm for 3 min; this emulsion was then homogenized with an ultrasonic probe in order to produce the nanoemulsions. Six ultrasound treatments were tested, varying process time (1 to 5 min) and power (150 to 250 W), resulting in six coating forming nanoemulsions (CFN) (1min/150W; 1min/25 W; 3min/150W; 3min/250W; 5min/150W; and 5min/250W). The effect of ultrasound treatment on the oil droplet size, polydispersity index, zeta potential, oil retention, turbidity, viscosity, and visual stability were investigated. CFNs were within nanoscale, except that produced at 5min/250W. Long-term high-energy treatments (5 min/250W) increased oil droplet size and polydispersity index, and reduced zeta potential to critical values (33 mV) to prevent oil droplet agglomeration. Ultrasound treatment did not affect oil retention (CFNs mean oil retention was 72%). Turbidity was associated with oil droplet size, as reduced oil droplet size CFNs showed high optical transparency. In general, CFNs behaved as Newtonian fluid, and long-term high-energy treatments promoted viscosity reduction. Visual stability against phase separation was affected by ultrasound treatment. Long-term high-energy treatments showed visual phase separation, confirming coalescence problems previously described in the droplet size and polydispersity index analysis, due to a possible overprocessing. Processes performed at milder conditions (150 W: 3 and 5 min; 250 W: 1 and 3 min) allowed to produce CFNs within the nanoscale, with high essential oil retention, good optical transparency, and stable against coalescence and gravitational phase separation, being promising for the application as active coating in plant or animal food products.