Properties of oil-in-water emulsions and ice creams made from coconut milk

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Abstract

Coconut milk (CM) containing coconut oil extracted from the endosperm (meat) of coconut fruit is not stable and undergoes a rapid separation into a creaming layer at the top and a serum phase at the bottom. In this study, coconut milk was separated into coconut cream (CC) and coconut skim milk (CSM). The ability of proteins in CM, CC and CSM to form and stabilise oil-in-water (O/W) emulsions containing coconut oil was investigated. The unstable nature of coconut oil droplets in CM was found to be due to types of proteins adsorbed on the surface of oil droplets, which were predominantly 11S globulins, known to be hydrophobic and salt soluble proteins. The oil droplets stabilised by 11S globulins in CM and CC were larger in size and highly flocculated, probably due to hydrophobic interaction, thus resulting in rapid creaming and phase separation, compared to those stabilised by proteins (e.g. water-soluble albumins) in CSM. Smaller droplet size with less droplet flocculation and slower phase separation was obtained when emulsions were prepared with a predominance of proteins present in CSM. The CSM-based emulsions were relatively more stable but they were only able to provide short-term stability against phase separation. The results suggest that the ability of proteins (both globulins and albumins) in CM to stabilise the emulsion oil droplets was not high because these proteins did not seem to posses the ability to provide steric and electrostatic stabilisation to the emulsion droplets stabilised by them. An addition of small molecule surfactants, particularly a water-soluble surfactant of Tween 80, induced the formation of smaller droplets in the CM- and CSM-based emulsions, thereby improving their emulsion stability to a certain extent. However, the addition of oil-soluble small molecule surfactants (e.g. mono- and diglycerides and/or partially unsaturated mono- and diglycerides) in the absence of Tween 80 caused a significant increase in droplet size of emulsions prepared from CSM. In contrast, this phenomenon was not observed in emulsions made from CM. The formation and properties of coconut milk ice creams differing in the concentration of CSM proteins, as well as ratios of solid fat-to-liquid oil (blends of coconut oil and sunflower oil) were also investigated. The differences in those variables were found to have a significant influence on the properties and stability (particle size, flow properties, droplet flocculation) of ice cream mixes as well as the characteristics of ice creams, such as overrun, melt resistance and shape retention. Several instrumental analyses, including size measurement, flow behaviour and small-deformation oscillatory tests, showed the presence of an agglomerated structural network in ice creams based on CSM containing oil blends as well as in ice creams based on dairy milk. From the findings, the agglomerated fat structural network in the CSM-based ice creams containing the suitable solid fat content at 68% could change ice creams with a slow melting rate and the more ability to retain their shape during melting compared with those of the dairy milk-based ice cream and ice creams made directly from CM. Overall the results suggest that coconut milk proteins do not possess the properties of proteins suitable for making very small droplets as well as stable emulsions against phase separation, particularly 11S globulins that are one of the major constituent proteins in coconut milk. However, albumins, which are the predominant proteins in coconut skim milk, may be suitable for use as the surface-active proteins for making smaller emulsion droplets in coconut oil-in-water emulsions, but their concentration needs to be increased for use probably by membrane filtration or freeze drying after removal of some carbohydrates from coconut skim milk.

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