ABSTRACT

Mango (Mangifera indica Linn.) is one of the most important tropical fruits in Thailand. From previous report, mango seed kernel extracts contained phenolic components with a high antioxidant activity, which was assessed in homogeneous solution with the 2,2′-azinobis (3-ethylbenzothialozinesulfonic acid) radical cation (ABTS•+) scavenging assays and in an emulsion with the ferric thiocyanate test. The extracts also possessed tyrosinase inhibitory and chelating activities. However, the solubility property of mango seed kernel extract (MSKE) is the main problem for using it as food and cosmetic ingredient. The encapsulated technique can effectively alleviate for crude extract compound deficiency. Hence, the purpose of this study is (1) to investigate the appropriate condition of ratio between oil and water, extract concentration and hydrophobic emulsifier types for water in oil emulsion preparation and (2) to investigate the influence of gelatin, sodium caseinate (Na-Caseinate) and whey protein isolate (WPI), a popular commercial protein, on stability and encapsulated efficiency of W/O/W double emulsion and (3) to investigate the appropriate condition of hydrocolloid types and quantity for water in oil in water emulsion preparation and (4) to characterize of the encapsulated mango seed kernel extract by spray dry including (5) to evaluate the stability of non-encapsulated and encapsulated mango seed kernel extract.

The effects and interactions of emulsion components namely refined soybean oil content (1.87-4.12%, w/w), polyglycerol polyricinoleate (PGPR) content (0.89-1.93%, w/w), mango seed kernel extract (MSKE) content (0.00-0.24%, w/w) on water–oil–water (W/O/W) emulsion characteristics were studied using response surface methodology. The
emulsion properties studied as response variables were droplet size distribution, centrifugation stability, apparent viscosity and encapsulation efficiency. The results indicated that the response surface models were significantly (p<0.05) fitted for stability and viscosity. The effects of PGPR and MSKE were significant (p<0.05) variables affecting all responses. Therefore, the concentration of PGPR and MSKE should be considered as critical variables for the formulation of W/O/W emulsions in term of the emulsion characteristics studied. The overall optimum region resulting in a desirable double emulsion was predicted to be obtained at 2.33% (w/w) refined soybean oil, 1.68% (w/w) PGPR and 0.16% (w/w) MSKE. No significant (p>0.05) difference was found between the experimental and predicted values, thus ensuring the adequacy of the response surface models employed for describing the changes in physicochemical properties as a function of the main emulsion components.

Water-in-oil-in-water (W/O/W) emulsions containing mango seed kernel extract (Mangifera indica cultivar Chok-Anan) and protein (gelatin, sodium caseinate (Na-Caseinate) and whey protein isolate (WPI)) in the inner phase were prepared. The effect of polysaccharides (Arabic gum and maltodextrin) and its combination in the outer aqueous phase on the separation of the aqueous phase due to mainly creaming up during storage were investigated for their potential to improve the stability of emulsion. The double emulsions were prepared using a two-step emulsification process. The emulsions in the absence of protein and polysaccharide were attributed to extensive droplet aggregation during storage. In the presence of protein and polysaccharides, the emulsion containing 1% gelatin had better encapsulation efficiency and stability than that containing Na-Caseinate and WPI at all concentrations. Specifically, considerably less gelatin concentration was required to form stable emulsion when the combination of 10% Arabic gum and 20% maltodextrin were present. Addition of protein and polysaccharide to emulsions can be used to enhance emulsions stability.

Response Surface Methodology (RSM) was used to investigate the effect of polysaccharide combination from gum arabic, maltodextrin and alginate on droplet size distribution, encapsulation efficiency (EE), stability and viscosity of W/O/W emulsions. In addition, the effect of processing storage time after emulsion preparation before spray drying was studied in encapsulated powder. The results showed that there were the interactions between polysaccharides which affected droplet size distribution, stability, viscosity and encapsulated efficiency of multiple emulsions. The RSM showed a good fit

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to the proposed model with $R^2 > 0.83$, 0.79 and 0.69 for viscosity, stability and EE, respectively, showed significant correlations ($p < 0.05$). The optimum mixture of multiple emulsions is 5.95% gum arabic, 23.90% maltodextrin and 0.11% alginate. The formulation which showed an appropriate coating material and gave a good stability in multiple emulsion system was also presented a suitable coating mixture for encapsulated mango seed kernel extract powder. Moreover, if the polysaccharide combinations are not appropriate for coating, the storage time after emulsion preparation will have a greater effect on stability of encapsulated powder. Hence, the polysaccharide coating combination is greater affected properties and stability of multiple emulsions including encapsulated powder than processing storage time.

The encapsulation of Mango (*Mangifera indica* Linn.) cultivar Chok-Anan seed kernel was investigated comparing to methyl gallate as bioactive substances. Mango seed kernel (MSK) lyophilized extracts were encapsulated using water-in-oil-in-water (W$_1$/O/W$_2$) emulsion system before spray drying. After formulation of each type of complex, droplet sizing, solubility, the bioactive compounds microencapsulated yield (BMY) and scanning electron microscopy (SEM) were determined. Overall, the average sizes in term of d32 values of W/O/W emulsions were $2.20 \pm 0.10 \mu m$. The encapsulated samples showed higher soluble in oil than water comparing to MSK extract and methyl gallate. The MSK extract and methyl gallate encapsulation yields reached value above 98% and 92%, respectively. The SEM micrographs of encapsulated MSK extract appeared rather rounded than the others. The results imply that encapsulation is promising technique for MSK extract to develop the solubility in oil.

The effect of light on the oxidative stability of phenolic compound from mango (*Mangifera indica* cultivar Chok-Anan) seed kernel extract and its encapsulated product was determined by absorptivity in the Ultraviolet (UV) spectrum and by total phenolic content induced with white fluorescent lamp (28 watt) intensity over a 1, 3, 6, 24 and 48 h period. Maximum UV absorptive at 276 nm of mango seed extract highly increased during light exposure more than the others. While, encapsulation of the extract showed the shoulder at 252 and 321 nm, the strongest UV absorption change was obtained at 276 nm from 0.625 to 1.054 after 48 hours of photo induction. Total phenolic content of samples showed a significant difference in the initial stage of photoinduced (1—6 hours), but after this time, the total phenolic content slowly decreased. However, the phenolic content of extract was more highly decreased than that of encapsulated product. The correlation of

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maximum UV absorption change values and total phenolics decreasing was highly related (r = 0.71). These results showed that UV absorption is a simply tool for photo-oxidation monitoring in quality control of mango seed kernel extract and its encapsulation.

The changes in antioxidant activity using DPPH and thiocyanate methods and total phenolic content using Folin-Ciocalteu’s phenol reagent of mango (Mangifera indica Linn. cultivar Chok-Anan) seed kernel extract during storage at freezing (-20°C), refrigerated (7 °C) and room (28-32°C) temperatures were monitored for 182 days. The extracts were packed in Al. foil and PE bag during storage. Water activity of extract samples was also evaluated during storage. The antioxidant properties (AP) and total phenolic content (TPC) of mango seed kernel (MSK) extract were decreased during storage. The higher temperature during storage, the higher loss of AP and TPC were obtained. The water activity of extract packing in PE bag was higher than that packing in Al. foil. At the end of 182-day storage, AP of extract in Al. foil stored at -20°C was not different from initial value. The results indicated that storage temperature and type of packaging affected to phenolic antioxidant properties of mango seed kernel extract.

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