Abstract

Extracts from mango (Mangifera indica Linn.) cultivar Chok-Anan seed kernels have been studied as encapsulated bioactive substances, since they are known as a good source of phenolic antioxidants with metal chelating and tyrosinase inhibitory capacity. This finding showed new interest in thermal stability of non-encapsulation and encapsulation of mango seed kernel (MSK) phenolics. The thermal stability of samples was evaluated under 1, 3, 6 and 48 hour storage at 60°C for phenolic retention and UV-Vis spectrum. In addition, the heating effect of spray dry was also investigated. The encapsulated emulsion sample before spray dry was used to measure UV-Vis spectrum. The phenolic content and absorbance (200-400 nm) spectrum of non-encapsulation and encapsulation MSK exhibited up to 40% loss after 48 hour storage at 60°C. Moreover, the absorbance values of emulsion sample before spray drying showed higher than that of spray dried encapsulation form. These results suggested that heating process affected properties of MSK extract phenolics.

Keywords: thermal stability, phenolics, mango seed kernel, spectrum

Introduction

Mango (Mangifera indica L.) is a tropical fruit in plant family Anacardiaceae and originated in India and Southeast Asia (Karunasawat and Anprung, 2010). It is the most cultivated fruit in Thailand. Processed mango products are among the major goods exported from Thailand. Therefore, several million tons of mango seed wastes are produced annually from factories. There are several varieties of mango grown in Thailand; the better known cultivars are Nam-Dok-Mai, Kaew and Chok-Anan. The Chok-Anan cultivar is popular for processing in factories and is available in all seasons (Maisuthisakul and Gordon, 2009), which is normally discarded when the fruit is processed. Mango seed kernel extract and oil can be used as natural antioxidant and antimicrobial in different kind of foods, due to high content of different phenolic compounds, their fatty acid pattern rich with saturated fatty acids and with mono-unsaturated oleic acid besides tocopherols.
squalene, and different sterol fractions (Abdalla et al., 2007). Extracts contained phenolic components by a high antioxidant and tyrosinase inhibitory properties of extracts of mango seed kernel (Maisuthisakul and Gordon, 2009). However, the potential changes on phenolic compounds of the extract following thermal treatment have not been investigated yet. This finding showed new interest in thermal stability of non-encapsulation and encapsulation of mango seed kernel (MSK) phenolics. The thermal stability of samples was evaluated under 1, 3, 6 and 48 hour storage at 60°C for phenolic retention and UV-Vis spectrum.

**Materials and Methods**

**Materials;** Sun dried seeds from ripened mango (Mangifera indica cultivar Chok-Anan) were donated from a mango processing manufacturer in Thailand from March to June in 2008 as by-products. Moisture content on a dry weight basis according to AOAC (1990) of dried mango seed kernel equaled to 9.81±0.34 %. The dried material was kept in freezer at -20°C no longer than two months.

Maltodextrin (DE = 16-20, 5% moisture, bulk density = 6000 kg m⁻³ was purchased from natural Starch and Chemical (Sydney, Australia). Arabic gum (food grade) was provided by Colloides Naturels International Co. (Rouen, France). Polyglycerol polyricinoleate (PGPR, 4150, HLB ≈ 3) was obtained from Palsgaard (New Jersey, USA). The emulsifier used was Tween 80 (Fisher Scientific, New Jersey, USA). The other chemicals and solvents used in this experiment were analytical grade purchased from Sigma-Aldrich Co., Ltd (Steinheim, Germany).

**Extraction of mango seed kernel;** The freezing kernel (80 g) was blended for 1 min with 95% ethanol and refluxed with 1.2 M hydrochloric acid in ethanol for 3 h. The supernatant, after filtration through cheesecloth and Whatman No 4 filter paper, was evaporated under vacuum. Sample was dried in a freeze dryer and stored in aluminum foil after flushing with nitrogen at -20°C until usage.

**Preparation of W₁/O/W₂ multiple emulsions;** The inner aqueous phase (W₁) was prepared by hydrating gelatin (1% w/w, Bloom 100), NaCl (0.8% w/w) and mango seed kernel (1% w/w) in distilled water at 40 °C for 2 min using moderate magnetic stirring. The oil phase was prepared by dispersing 8 wt % PGPR into soy bean oil (80.0%, w/w) and heating to 50 °C for 2 min under agitation with a magnetic stirrer and then blended together using a hand homogenizer at 12,000 rpm for 2 min (IKA-Ultra-Turrax T25, Germany). The coarse emulsions were passed through high-pressure homogenizer (Armfield model FT9, UK) three times at 3000 psi. The outer aqueous phase (W₂) was prepared by hydrating Tween 80 (0.5% w/w), gum arabic (10% w/w) and Maltodextrin (15% w/w) in distilled water under moderate magnetic stirring conditions. After adding the water-in-oil (W₁/O, 10 vol%) to the outer phase (W₂, 90vol%), the emulsion was homogenised for 2 min using a hand homogenizer at 12,000 rpm to produce the final double emulsion. The emulsions were analyzed for characterization and used for thermal stability study.

**Preparation of spray dried encapsulated powders;** The dispersions were spray dried using Nitro Minor Dryer (Gea Nitro A/S, Denmark) pilot scale spray dryer. The dispersion was fed by a peristaltic pump at a fixed rate of 30-35 ml/min. Drying was carried out in the concurrent mode. Inlet and outlet air temperatures were 180 °C and 90 °C, respectively. The microcapsule powder was collected at the dryer’s cyclone. The microcapsules were analyzed for characterization and used for thermal stability study.

**Thermal stability of mango seed kernel extract and its encapsulated powders;** The thermal stability of samples was evaluated under 1, 3, 6 and 48 hour storage at 60°C. UV spectrum at 200-400 nm and total phenolics was determined. The total phenolic content of extracts was determined using the Folin-Ciocalteu’s phenol reagent (modified from Maisuthisakul et al., 2008). The concentration of total phenolic compounds in all samples was expressed as mg of methyl gallate equivalent per g dry weight of MSK using a linear equation. All determinations were performed in triplicate.

**Statistical analysis;** The results were analysed ANOVA for significance (p<0.05) using data analysis tool.
Results and Discussions

The changes in the phenolic composition of mango seed kernel extract (MSKE), due to degradation of antioxidant compounds, after thermal treatment (60 °C) during different time intervals (1, 3, 6, 24 and 48 hours) were investigated.

The spectrum of each MSKE and microcapsules were similar. It is found that the spectra of MSKE and its emulsion and encapsulation showed maxima peak at 276 nm and shoulder at 252 and 321 nm (Figure 1). The spectrum of MSKE increased in the spectral interval of 243 to 285 nm, especially at 276 nm (Figure 1a). Typically, different phenolic compound showed different UV spectral characteristics. It was also shown in the present work that effect of heat leads to results in terms of enhanced degradation, particularly at UV maxima wavelength. While at this stage, the observed limiting values cannot be convincingly explained, it may possibly be due to a degradation of large molecules of phenolic compound such as flavonoids to be many molecules of smaller phenolics. Therefore, it was shown that a higher value of absorbance occurred when the samples were heated. This was consistent to phenolic degradation data (Figure 2). The decrease of phenolic content was a little bit sharpened when the thermal treatment took more than 6 h. MSKE and its emulsion were stable during the first hour of heating (approximately), then the decrease was faster, and finally, after 48 h ~60% of the initial phenolic quantity remained in the MSKE. Phenolic in encapsulated MSKE showed to be very resistant to thermal treatment in the studies even though the initial value was decrease due to heating from spray drying. The results obtained in the research seem to be in agreement with the published by Brenes et al. (2002).

It is important to note that the phenolic compounds in MSKE decreased when it performed in emulsion or spray dried form. However, the stability of encapsulated form was better than extract and emulsion forms (Figure 1 and 2). Moreover, minor changes (<10%) were observed following storage at 60 °C, indicating excellent storage stability of encapsulated MSKE even under adverse handling conditions.

Summary

Heat from spray drying affected to phenolic compounds in MSKE. Hence, the phenolic content of MSKE emulsion was higher than that of spray dried encapsulation. However, encapsulated form of MSKE was more tolerance to heat at 60°C than that of extract and emulsion form.

Acknowledgements

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Literature cited

Figure 1 UV spectrum of (a) treated mango seed kernel extract and (b) its emulsion and (c) encapsulation forms.

Figure 2 Kinetic phenolics degradation curve of mango seed kernel extract (MSKE) and emulsion including encapsulated sample.