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Research Article

Comparative study chemical properties of blended oil containing coconut oil and sacha inchi oil or peanut oil by cold extraction

Sirirat Suprit[1], Paphawarin Srichan[1], Sasiporn Sanghirun[1], Jariya Sai-iad[1], Wipawadee Ruangsang[1] , Nantika Thongprasart[1] and Pensri Penprapai[1*]

[1]Faculty of Science and Technology,Rajamangala University of Technology Srivijaya, Nakhon Sri Thammarat, Thailand
*__E-mail__: pensir_srivub@hotmail.com

Abstract

Vegetable oil such as sacha inchi oil and peanut oil contains unsaturated fatty acid. It is susceptible to oxidation. Medium chain saturated fatty acid is often used to protect and inhibit oxidation of vegetable oil. Coconut oil contains high medium chain saturated fatty acid such as lauric acid (C12). The objectives of this work were to (1) produce blended oils containing coconut oil and sacha inchi oil and coconut oil and peanut oil by cold extraction and (2) to study chemical properties of blended oil. The blended oils was produced by incubating the mixture of coconut milk and emulsion of sacha inchi seed or peanut seed at room temperature for 24 hr. The stability of blended oil was evaluated with free fatty acid, peroxide value and rancimat induction time. Induction time, peroxide value and free fatty acid of blended oil were lower than pure sacha inchi oil and peanut oil. The antioxidant activity of blended oil was assayed with DPPH. It was found that blended oil containing coconut oil and sacha inchi oil shows higher antioxidant activity than blended oil containing coconut oil and peanut oil and pure vegetable oil including sacha inchi oil and peanut oil. Fatty acid composition is most important factor affecting to nutritional quality and stability. Blended oils having saturated/unsaturated ratio close to 1 was stable and proper fatty acid composition.

Keywords: blended oil, sacha inchi oil, coconut oil, peanut oil, cold extraction

Introduction

Vegetable oils are used for cooking and frying in food formulations. Pure vegetable oil is no good for functional and nutritional properties and appropriate oxidative stability. To enhance the commercial application of vegetable oils, four different methods such as hydrogenation, interesterification, fractionation and blending was used to improve texture and oxidative stability(Nor Aini & Noor Lida, 2005; Hashempour-Baltork, 2016). For hydrogenation process, some double bonds can be isomerized and converted from cis state to trans state. Trans fats are dangerous to the body. It is difficult to eliminate from the blood vessels but can accumulate in the body and can cause different diseases (Iqbal, 2014). In interesterification process, fatty acids are redistributed in the triacylglycerol structure during this process and no

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saturation or isomerization occurs. However, this process needs special equipment and is more expensive (Dijkstra, 2015). For Fractionation process, some fats or oils are separated into two fractions with different melting and textural properties (Kellens et al., 2007). This process can be used as a pretreatment prior to hydrogenation, interesterification or blending. Blending should not have any adverse effects on health attributes. Blending vegetable oils is one of the simplest methods to create new specific products with desired textural, oxidative and nutritional properties which lead to improved industrial applications (Hashempour-Baltork, 2016). One unmixed vegetable oil has low physical, chemical and nutritional properties and poor oxidative stability. For example, pure sesame oil and soybean oils have low oxidative stability. Coconut oil has high oxidative stability with low amounts of unsaturated fatty acids and high amounts of saturated fatty acids. Therefore, Vegetable oil blending can be a simpleway to take advantage of the different characteristic properties of each oil (Hashempour-Baltork, 2016). There are many reports where blending is used in the edible oil industry. Palm oil was blended with extra virgin olive oilto improve heat-oxidation stability (De Leonardis, 2012). Coconut oil was blended with vegetable oil with high unsaturated fatty acid such as soybean oil and sunflower oil to reduce the cost, meet industry demands and improve stability (Bhatnagar, 2009).

The major composition of VCO are medium-chain triacyl glycerols (60%), especially C12:0 (50%) so called lauric acid. VCO has many advantages such as high oxidative stability, high smoke point and strong oxidation resistance (Marina, 2009). However, VCO is easy to become solid. Sacha inchi oil and peanut oil contains unsaturated portion that is susceptible to oxidation. These problems were improved by blending of two or more oils. Therefore, blended oil between VCO and sacha inchi oil and coconut oil and peanut oil could result in new fat formulations with interesting nutritional and technological properties. The oxidation stability of blended oil depends on fatty acid composition. Oxidation stability of VCO and sacha inchi oil and coconut oil and peanut oil are very different. The stability of sacha inchi oil and peanut oil is lower than VCO. Sacha inchi oil and peanut oil contains unsaturated portion that are susceptible to oxidation. The stability of VCO is due principally to its high saturation level. The objective of this work was to study stability and fatty acid composition of blended oil between coconut oil and sacha inchi oil and coconut oil and peanut oil.

Materials and methods

Materials

Coconut milk was extracted from 10-12 month old coconut which was obtained from local markets in Thongsong, Nakhon Si Thammarat, Thailand.

Preparation of virgin coconut oil

Coconut milk (5 kg of coconut endosperm)was added into a 10-L flask (10 L). This coconut milk was incubated at 30-40 ^{o}C for 24 hr and then the oil layer was separated from cream and water, Virgin coconut oil was kept in brown flask. This oil was analyzed for fatty acid composition. Oxidative stability was determined by using rancimat method.

Preparation blended oil from coconut oil and peanut seed by cold extraction

200 mL of water was added to 0.8 kg of peanut seed. Then this mixture was blended in blender for 10 min. The emulsion from peanut seed was added into a 10-L flask (10 L) containing coconut milk (5 kg of coconut endosperm). This mixture was stored at 30-40 ^{o}C for 24 hr and then the oil layer was separated from cream and water, blended oil was kept in

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brown flask. This blended oil was analyzed for fatty acid composition. Oxidative stability was determined by using rancimat method.

Preparation blended oil from coconut oil and sacha inchi seed by cold extraction

200 mL of water was added to 1 kg of sacha inchi seed. Then this mixture was blended in blender for 10 min. The emulsion from peanut seed was added into a 10-L flask (10 L) containing coconut milk (5 kg of coconut endosperm). This mixture was stored at 30-40 ^{o}C for 24 hr and then the oil layer was separated from cream and water, blended oil was kept in brown flask. This blended oil was analyzed for fatty acid composition. Oxidative stability was determined by using rancimat method.

Extraction of pheholic compounds

The procedure reported by Kapila (2009) was slightly changed : Five grams of oil sample was weighed, dissolved in 25 ml hexane and transferred to a separatory funnel. Twenty–five milliliters of the methanol-water mixture (80:10 v/v) was added. After 2 min of shaking the lower methanol-water layer was removed. The extraction was repeated twice and the methanol-water phase was combined. The methanol-water extract was condensed in rotary evaporatory under vacuum at 40 ^{o}C. The dry residue was then diluted in 1 ml of methanol.

Determination of total phenolic content

The content of total phenolic compounds in oil sample and was determined by Folin-Ciocalteau reagent. The reaction mixture contained 1 ml of methanol-water extract, 1 ml of freshly prepared diluted Folin-Ciocalteau reagent and 8 ml of sodium carbonate solution. The mixture was kept in the dark at ambient conditions for 30 min to complete reaction. The absorbance at 725 nm was measured on UV spectrophotometer (Biochrom S22, England). Gallic acid was used as standard. Results are expressed as mg of gallic acid per kg of oil.

Radical scavenging activity (RSA) toward DPPH radicals

Radical scavenging activity were examined by reduction of DPPH radical in ethyl acetate. 1.0000 gram of oil (exactly weighted) was dissolved in ethyl acetate in 10 ml volumetric flask, then 1 ml of this solution was transferred into the second 10 ml volumetric flask containing DPPH radical solution, which was freshly prepared in ethyl acetate at a concentration of 10^{-4} M. Reaction flask was shaken for 10 s in vortex apparatus (Genie 2, U.S.A) and it was allowed to stand in the dark for 30 minutes. The absorption of this mixing was measured with UV spectrophotometer (Biochrom S22, England). in a 1 cm quartz cell at 30 min against a blank of pure ethyl acetate without DPPH radicals. After that %inhibition was determimed from differences in absorbance of DPPH solution with or without sample (control).

$$\% \text{ Inhibition} = \frac{(A_{cotrol} - A_{sample}) \times 100}{A_{cotrol}}$$

The gap between %inhibitions vs. concentration of sample or standard antioxidant was plotted to obtain linear equation. The concentration of an sample or standard antioxidant at with 50% inhibition of free radical activity was determined.

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ABTS method

The antioxidant activity of sample oils was dertermined by the ABTS radical cation ($ABTS^{\cdot+}$) delocourisation assay. The $ABTS^{\cdot+}$ working solution was prepared from ABTS (7 mM) 8 ml and potassium persulfate (2.45 mM) 12 ml and allowing the mixture to stand in dark at low temperature for 16-18 hr before used. The solution was diluted in ethanol to give an absorbance at 750 nm of 0.800± 0.200 before used. The stock solution of sample oil and standard antioxidant were prepared. In the test reaction, $ABTS^{\cdot+}$ working solution and sample were mixed.The solution for determined antioxidant activity were prepared as follows: 1) sample solution was the mixture between the sample oil and ABTS working solution, 2) blank solution was the mixture between the sample of sample oil and ethanol, 3) positive solution was the mixture between ethanol and ABTS working solution, 4) negative solution was the ethanol. These solution were measured absorbance at 750 nm at 30 minutes. The percentage inhibition was calculation by using the following equation: %Inhibition=[(Abs $control_c$-Abs $sample_e$)/Abs $control_c$]x100, when Abs $control_c$ is Abs positive – Abs negative, and Abs $sample_c$ is Abs sample – Abs bank. The grap between %inhibitions vs. concentration of sample or standard antioxidant was plotted to obtain linear equation. The concentration of the samples or standard antioxidant at with 50% inhibition of free radical activity was determined.

Determination of fatty acid composition

Fatty acid methyl esters (FAME) were obtained by methylation with 0.5 M methanolic potassium hydroxide. Fatty acids were determined by gas chromatography by an Agilent 7890 series (Agilent technology, USA) with flame ionization detection (GC-FID). The gas chromatography was equipped with an injector system and an autosampler. Fatty acids separation was carried out on a column (30m x 0.25 mm ID. x film thickness 0.25 µm). Helium was used as the carrier gas. Oven temperature was set at 210 ^{o}C for the initial temperature and held 12 minutes, and ramped to 250 ^{o}C at 20 ^{o}C/min then held for 8 minutes. Temperature of the injector and the detector were 290 ^{o}C and 300 ^{o}C, respectively. The identification of the chromatographic peaks was performed by comparing the retention time of the sample with a certified FAME mix. For quantification of total fatty acid content in the oil, an internal standard was used.

Determination of oxidative stability

An automate Metrohm Rancimat model 893 (Switzerland) was utilized to determine the oxidative stability of the oil sample. Oxidative stability test were carried out using 5.0 g of sample oil at an air – flow rate of 20 L/h at 120 ^{0}C. The conductivity cells were filled with deionized water up to the volume of 50 ml. The induction time of the sample oil was automatically recorded.

Determinations of peroxide value, % free fatty acid

Peroxide value, % free fatty acid were analyzed according to standard method(Firestone, 1997). Free fatty acid and peroxide value were expressed as percentage FFA as lauric acid and meq O_2/kg, respectively.

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Results and discussion

Oxidative stability and chemical properties

Oxidative stability blended oil and chemical properties such as free fatty acid and peroxide value, SIO, PO and VCO was studied (Table 2). Induction time of VCO is the highest. The result clearly showed that VCO has greater oxidative stability than SIO and PO because VCO contains high saturated fatty acid especially medium chain fatty acid (C8:0-C14:0). In contrast, SIO and PO contain high unsaturated fatty acid that is susceptible to oxidation. Induction time of blended oil was lower than VCO. This result indicated blended oils shows greater oxidation stability toward oxidation than SIO, PO. VCO contained high saturated fatty acid (81.68%) has highest oxidative stability. It could improve the quality and oxidation stability of SIO or PO in blended oil during storage or heating. Moreover, blended oil had lower peroxide value, free fatty acid than the SIO or PO**.** This result indicated that blended oil has higher oxidation stability than SIO or PO. Moreover, blended oil had lower peroxide value, induction time and fatty acid than the SIO or PO**.** This result indicated that blended oil has higher stability than SIO and PO. Oxidative stability is related to other components such as antioxidant and fatty acid composition. For example, blending cold pressed black cumin oil with sunflower oil did not change the main fatty acid composition, but oxidative stability blended oil was improved because the level of antioxidant such as thymoquinone and tocopherols in the blended oils (Kiralan et al., 2016) was high.

Table 1. Induction time, free fatty acid (% as lauric acid) and peroxide value (meq O_2 kg) of oil sample

Oil sample	Induction time (hr)	Peroxide value	Free fatty acid (%)
VCO	41.81 ± 2.36^{c}	$.5147\pm.035^{a}$	$.17\pm.02^{a}$
SIO	$1.01\pm.2545^{a}$	$3.0244\pm.36^{b}$	$9.05\pm.246^{d}$
PNO	$2.59\pm.590^{a}$	6.38 ± 1.07^{c}	$1.63\pm.06^{c}$
VCO+PNO	$11.70\pm.141^{b}$	$1.21\pm.15^{ab}$	$.57\pm.082^{b}$
VCO+SIO	$10.26\pm.21^{b}$	$1.09\pm.29^{ab}$	$.27\pm.00^{ab}$

Fatty acid composition

Fatty acid compositions of peanut oil (PO), sacha inchi oil (SIO), VCO and blended oil containing coconut oil and sacha inchi oil or peanut oil were determined (Table 1). Oleic acid (C18:1) (36.09%) in PO are more significant differences than VCO (6.25%) and SIO (9.01%). Linoleic acid (C18:2) in both of of PO(34.29%)and SIO(34.61%) are more significant differences than VCO. Linolenic acid (C18:3) (26.91%) was found especially in SIO. Luric acid and Myristic acid in VCO was 42.23% and 19.00% respectively, while it was about 0% in the SIO. These fatty acid was found a little bit in PO. In SIO and PO, the saturated fatty acid (SFA) content was clearly lower than the unsaturated fatty acids (UFA) content and the SFA/UFA ratio in SIO and PO was calculated to be 0.10 and 0.38, respectively. Moreover, SIO has not fatty acid with less than 16 carbon atoms such as luric acid and myristic acid. The two oil blends; SIO:VCO and PO:VCO, had reduced contents of lauric acid and myristic acid and an increased content of unsaturated fatty acid. The ratio SFA/UFA in blended oil was calculated to be 4.14-5.07. It was lower than VCO. Blending of vegetable oils can change and improve

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the overall fatty acid composition, and can improve the stability of oils (Aladedunye & Przybylski, 2013).
For example, extra virgin olive oil is more sensitive than palm oil to heat treatment, so if olive oil is more than 20% of a mixture, it can have a negative effect on the stability of the blended oil (De Leonardis & Macciola, 2012).

Table 2.Fatty acid composition of oil sample

Fatty acid composition	%w/w				
	VCO	SIO	PO	VCO+PO	VCO+SIO
Caprylic acid (C8:0)	3.42	0.00	0.05	2.76	0.13
Capric acid (C10:0)	4.35	0.00	0.28	3.29	2.22
Lauric acid (C12:0)	42.23	0.00	4.14	33.27	37.69
Myristic acid (C14:0)	19.00	0.00	2.18	16.33	17.61
Palmitic acid (C16:0)	9.17	4.16	11.58	10.39	9.52
Palmitoleic acid (C16:1)	0.00	0.00	0.00	0.00	0.00
Steric acid (C18:0)	3.38	3.09	3.89	3.54	3.22
Oleic acid (C18:1)	6.26	9.01	36.09	10.50	6.98
Linoleic acid (C18:2)	2.24	34.61	34.29	6.57	4.52
Linolenic acid (C18:3)	0.00	29.61	0.00	0.00	2.41
Arachidic acid (C20:0)	0.10	0.00	1.50	0.30	0.00
Gondoic acid (C20:1)	0.00	0.00	0.74	0.00	0.00
Benhenic acid (C22:0)	0.00	0.00	2.70	0.37	0.00
Erueic acid (C22:1)	0.00	0.00	0.00	0.00	0.00
Lignoceric acid (C24:0)	0.03	0.13	1.07	0.18	0.08
Nervonic acid (C24:1)	0.00	0.00	0.14	0.00	0.00
Saturated fatty acid	81.68	7.38	27.39	70.43	70.47
Monounsaturated fatty acid	6.26	9.01	36.97	10.5	6.98
Polyunsaturated fatty acid	2.24	64.22	34.29	6.57	6.93
Unsaturated fatty acid	8.5	73.23	71.26	17.07	13.91
Medium chain fatty acid (C8:0-C14:0)	69	0	6.65	55.65	57.65
Saturated/Unsaturated (SFA/UFA)	9.60	0.10	0.38	4.12	5.07

Antioxidant activity

The %inhibition of resulting oil sample was assayed with DPPH (2,2-diphenyl-1-prohydrozyl) was shown in table 3. The results showed that the SIO had the highest antioxidant activity (97.54%) whereas the lowest were noticed for VCO (6.55%). However, both of blended oil includinf VCO + PNO and VCO + SIO were more %inhibition than VCO but %inhibition of blended oil was lower than SIO and PNO. Antioxidant activity in vegetable oil is related to the level of natural antioxidant. The level of natural antioxidant has beneficial effects on the health and stability of oils and antioxidant activity. Natural antioxidant in vegetable oil

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including tocopherols, beta-carotene, oryzanol and lignans, whose amounts are various in different oils, have beneficial effects on the health and stability of oils.

Table 3. Antioxidant activity of oil sample

Oil sample	%Inhibition
VCO	6.55±.89[a]
SIO	97.54±1.24[e]
PNO	57.65±2.63[d]
VCO+PNO	16.58±1.69[b]
VCO+SIO	32.75±1.35[c]

Conclusion

VCO has high saturated fatty acid shows highest oxidative stability. It could improve the quality and oxidation stability of SIO and PNO in blended oils. The ratio SFA/UFA in blended oil VCO+ SIO and VCO + PNO was calculated to be 4.14-5.07. It was lower than VCO but higher than PNO and SIO. These blended oil show high antioxidant activity and stability to hydrolysis and oxidation reaction.

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