Encapsulation of Michelia Champaca L. Extract and Its Application in Instant Tea

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***Abstract*—This research aimed to investigate the encapsulation of Michelia champaca L. (Champaca; MCL) extract and apply in green tea powder to create instant Champaca tea. The MCL encapsulated flavor powder was produced using spray drying. The carries of encapsulation were varied 20% w/v of maltodextrin with 0.5% w/v of trehalose. The experiment was conducted by variation of 5, 10, 15 and 20% MCL extract. The result showed that 10% MCL extract provided the highest encapsulation efficiency (93.39±0.57), the highest overall aroma rating score (6.5±0.5) with high yield recovery (34.52±0.61). The gas chromatograph mass spectrometry showed that there were 15 volatile compounds could be identified from the MCL encapsulated flavor powder. Camphene, limonene, β-elemene, and β-caryophyllene were found in high amount from all powder samples. The principle analysis (PCA) of volatile compound using electronic nose suggested that the MCL encapsulated flavor powder 10% w/v can entrap the extract higher the others. The MCL encapsulated flavor powder with 10% w/v extract was mixed with green tea powder in three variations (0.1, 0.3, and 0.5% w/w) to produce instant Champaca tea. The sensory evaluation showed that the instant Champaca tea with the MCL encapsulated flavor powder at 0.3% w/w provided the highest sensory liking score in the range of 6.0–6.6 with the acceptance at 96.7%. In summary, the MCL extract 10% w/v was the most suitable to produce the MCL encapsulated flavor powder and the suitable amount of the MCL encapsulated flavor powder to produce the instant Champaca tea was 0.3% w/w.**

***Index Terms*—Michelia champaca L., Encapsulation, Spray drying, Gas chromatography, sensory evaluation**

I. Introduction

Champaca (*Michelia Champaca* L.) is a native flowering plant in the south and south-east Asia such as India, Thailand, Myanmar and Malaysia. Champaca is generally extracted for essential oil and used for cosmetics, perfumery, body powders and incenses. Champaca scent is believed to provide relaxation and inspire happiness [1, 2]. Major application for flavor and beverages are generally dry, powdered and encapsulated form. The encapsulation system play a dominant part and is one the most efficient ways to convey flavor into product and can keep most of the specific properties until the product has delivered to consumers [3].

In the last decades, the encapsulation flavors into powder have become very appealing process and the encapsulation of flavor ingredients is one of the most consideration processes in the food industry. The main purpose of microencapsulation is to entrap sensitive ingredients, such as volatile and unstable flavors into carriers increasing their protection, reduce evaporation, boosted easier handling, and control release during storage. Spray-drying emulsions are a particularly economically effective and simple for microencapsulating chemically reactive volatile oils and flavor compounds [4]. Flavor microencapsulation has a purpose on converting liquid flavor extracts into dried powder. It provides protection against degradation and prevents the loss of flavor. In addition, it can be applied for controlling the release of flavors during food processing and storage. Spray drying is used for a preparation of the dried powder in which water is evaporated while flavors are entrapped in carrier material. Hence to the selective diffusion ideal [5], the diffusion coefficient of flavor declines with higher rate than the diffusion coefficient of water during drying.

Spray-drying has seen in mostly preparation of pharmaceutical powders with specific characteristics such as particle size and shape. Established method is initiated by atomizing emulsions or solutions into fine droplets followed by a drying process, resulting in particles in powder form. Although most often considered as a dehydration process, spray-drying can also be used as an encapsulation method when it entraps active materials within a protective matrix which is essentially inactively

Manuscript received June 20, 2016; revised April 5, 2017

doi: 10.18178/ijfe.3.1.48-55

to encapsulated materials. Several dispersed systems such as emulsions or liposomes were successfully spray-dried with carriers using their structure like Maltodextrin and Trehalose [6].

Maltodextrin provides important functional benefits and currently uses as an encapsulating agent. It has low bulk density, confrontation to caking, tastelessness, compulsory, oxygen barrier and surface glossiness [7]. Trehalose is a naturally occurring non-reducing disaccharide which consists of two D-glucose molecules with 1,1 linkage by a α-glycosidic bond [6]. Trehalose contributes to the physical stability of spray-dried matrices containing trehalose instead of sucrose. During spray-drying encapsulation of flavours partial usually loss of volatile compounds that could lead to an alteration of the total volatile composition and variation of the ratio of the different compounds in the spray-dried product [8]. Komes *et al.* [9] noted that the addition of trehalose to dehydrated strawberry and apricot purees resulted in the lowest loss of total aroma as well as of individual fruit volatiles when compared with sucrose.

Instant tea, a product dried from tea infusion was first produced in England, from black tea in 1940. Flavored tea that developed from regular instant effected from consumers who liked flavored tea for instance, Earl Grey tea. The aromatization or encapsulation of essential oil brings stronger pleasant odor on the one hand but the addition of many unsaturated terpenic compounds causes lower stability of the product to oxidation processes on the other hand. Flavored-tea product can affect the sensory quality of tea or beverage substantially and improve the undesirable aroma and flavor that happened from regular instant tea. Flower flavor-mixed tea becomes more popular since it not only provides beneficial properties of tea, but also incorporates good aroma of flowers, resulting in a good mood. The flower aroma is mainly originated from petal part of flowers [10] and enhances good emotion and sensation to consumers. Moreover, it has been proved that flowers added to the green tea stimulate blood circulation and help the respiration system [11]. This research aimed to encapsulate Champaca extract and create Champaca encapsulates flavor powder. The instant Champaca tea was prepared from suitable percentage of Champaca encapsulated flavor powder. The results provide information regarding properties of encapsulated flavor powder and its sensory evaluation rating score can be used to apply in others flavored product

II. Materials and Methods

A. Materials

The flower of *Michelia Champaca* L. (MCL) was purchased from Kratonn-Waan garden, San Pee Suear Subdistrict, Mueang District, Chiang Mai, Thailand from June 2009 to December 2009. The blossoms were collected early from 8 am. – 10 am. The dried green tea leaves was obtained from Raming Co., Ltd., Thailand. Methanol (RCL Labscan Limited, Thailand), dichloromethane (RCL Labscan Limited, Thailand), and Maltodextrin (Cp Kelco ApS, Lille Skensved, Denmark) were purchased from Union Science, Co., Ltd. Trehalose was obtained from EAC Chemicals, Bangkok, Thailand.

B. The MCL Extract Preparation

The MCL flower was de-petaled and then washed through fresh water at room temperature (25±2 °C) prior to expose to sun light for 2 hr. The dried MCL petal was ground using hammer mill (C31896, Armfield, Christy & Norris Ltd., England) with 0.5 mm mesh. All dried MAD was collected in vacuum foil packages and kept at -20 °C. The MAD extract was prepared from the dried MAD petals in solvent extraction using 70% v/v ethanol under 30 °C for 12 hr with sample and solvent ratio at 1:10. After time lapse, the solvents was filtered and drained. The evaporated filtrate under reduce pressure at the 40 °C (R-200, Buchii, Switzerland) was weighed and contained in amber vial under storage temperature at 4 °C for further experiment [12, 13].

C. Microencapsulation of MCL Extract Using Spray Drying

He procedure for the emulsion preparation for spray drying was modified from Roser [14] and Flores-Mart ńez *et al.* [15]. The aqueous phase of carrier was prepared by dissolving the maltodextrin 20% w/v and trehalose 0.5% w/v in deionized water at 50 °C while stirring for 30 min until the solution became homogenous. The MCL extract was then added in to the solution with variation of 5, 10, 15, and 20% w/v. The MCL extract was mixed into carrier solution using homogenizer (L4RT, Silverson, MA, USA) at 9000 rpm. The spray dryer (March Cool Industry Co., Ltd., Bangkok, Thailand) was operated using the inlet and outlet temperature at 200 °C and 110 °C, respectively. The blower speed was set at 57.38 rpm with 10% feed pump [16].

1) Physical and encapsulation properties of encapsulated MCL flavor powder

The encapsulated MCL flavor powder from spray drying was analyzed for yield recovery, moisture content, water activity, color value (L^*, a^*, b^*). The moisture content calculated followed the method from AOAC NO. 934.01. The water activity was analyzed using AquaLab LITE (DECAGON Devices Inc., USA). The color value was analyzed using Hunter LAB (Colorquest XE, Hunter Lab, USA). The solubility of the encapsulated MCL flavor powder was examined according to the method described in Fernandes *et al.* [17].

2) Encapsulation efficiency (%EE)

The quantities of the surface content and the total content of the MAD extract were determined and calculated for %EE. Five grams of sample was washed with 70% v/v ethanol for 5 min. The total content was determined the cleansed solvent from the encapsulated powder with 70% (v/v) ethanol for 15 min. The quantities were reported as the mean and the standard deviation of triplicate measurements [17, 18].

3) Morphology of MCL encapsulated flavor powder

The microstructures of microparticle from spray drying were examined using a scanning electron microscope (SEM, JSM5410-LV, JEOL, Japan). Photographs were taken at an excitation voltage of 10 kV [19].

4) Volatile compound identification of MCL encapsulated flavor powder using gas chromatograph-mass spectrometry (GC-MS)

The volatile compounds identification in MCL encapsulated flavor powder was analyzed using GC-MS. Three grams of sample was prepared in a septum-capped vial. The equilibrium air from headspace of sample was analyzed for volatile compounds using the 85 μm Carboxen™/Polydimethylsiloxane StableFlex™ type fiber (CAR/PDMS, Supelco, USA). The CAR/PDMS was exposed for 30 min in the equilibrium air of the headspace. Subsequently, the fiber was directly injected into the injection port of a gas chromatograph (HP 6890N, Agilent technologies, USA). The GC was operated with the sampling rate at 40 msec, an air flow rate of 400 mL min^{-1}, and with the source temperature at 230 °C. The GC was operated on the HP-5MS column (30 m × 0.25 mm, i.d., 0.25 μm film thickness) (Model 19091S-433, Agilent Technologies, Inc., USA), and helium was used as the carrier gas at a flow rate of 1.0 mL/min. The temperature program was started with an initial temperature of 50 °C, which was then heated up to 200 °C at the rate of 7.5 °C/min and held for 5 min at 200 °C. The MS was operated in the electron impact mode with electron energy of 70 eV and with the scan over range of 20–300 amu, the source temperature being 230 °C. The obtained mass spectra were preliminarily interpreted by comparing with those of the enhanced chemstation version D00.00.38 (Agilent Technologies), the mass spectral search library of the National Institute of Standards and Technology (NIST, Gaithersburg, USA).

5) Volatile profiling of MCL encapsulated flavor powder using electronic nose

Groups of volatile compound found in encapsulated Champak extract were determined using an electronic nose (National Nanotechnology Center, Thailand). Three grams of sample were put into a glass vial connected to sensors shutter. The electronic nose was equipped with seven sensors for detecting humidity and temperature (SHT1x and SHT7x, sensirion, Switzerland), ethanol (af63, GE, USA), hydrogen sulfide sensor (TGS-825, FIGARO USA, INC., USA), organic solvent vapors sensor (TGS-822, FIGARO USA, INC., USA), LP gas sensor (TGS-2610, FIGARO USA, INC., USA), and air contaminant sensor (TGS-2600, FIGARO USA, INC., USA). Data was analyzed based on principle component analysis (PCA) using MathCAD and Enose analyzer (National Nanotechnology Center, Thailand).

D. Application of MCL Encapsulated Flavor in the Instant Green Tea Powder

1) The green tea powder preparation

The green tea powder was prepared using green tea leaves put in the tea bag and soaked into boiled water (98 ±2 °C) for 5 minutes. The ratio of tea leaves and water was 2 g per 100 ml of water. The prepared tea solution was then mixed together with 20% w/v of maltodextrin and homogenized at 5000 rpm for 20 minutes with homogenizer (L4RT, Silverson, MA, USA) before spray drying. The spray dryer (March Cool Industry Co., Ltd., Bangkok, Thailand) was operated using the inlet and outlet temperature at 140 °C and 80 °C, respectively. The blower speed was set at 50 rpm with 10% feed pump [20].

2) Sensory evaluation on instant Champaca tea preparation

The overall aroma liking of MCL encapsulated flavor powder from previous experiment was evaluated by untrained consumer (n=50) using 9-point Hedonic scale [21] then selected for preparing instant Champaca tea. The selected MCL encapsulated flavor powder was mixed together with prepared green tea powder in variation of 0.1, 0.3, and 0.5% w/w. The sensory evaluation on the instant Champaca tea was also conducted using 9-point Hedonic scale [21] with flavored tea attributes (appearance, color, clearness, tea aroma, Champaca aroma, overall aroma, tea flavor, Champaca flavor, taste, bitterness, and aftertaste) and its acceptance.

E. Statistical Analysis

All the data were collected in triplicate. Analysis of variance (ANOVA) was performed and using the Duncan's multiple range test (DMRT) for mean separation. The analysis of all data was conducted using SPSS 17.0 (SPSS Inc., IBM Corp., Chicago, IL, USA), with the significant level determined at 95% confidence limit ($p<0.05$).

III. Results and Discussion

A. Physical and Encapsulation Properties of MCL Encapsulated Flavor Powder

The physical and encapsulation properties of MCL encapsulate flavor powder showed significant difference as shown in Table I. The yield recovery of MCL encapsulated flavor powder was in the range of 30.70–34.93%. The lowest MCL extract added at 5% w/v provided the highest yield recovery, followed by 10, 15, and 20%, respectively. The decreasing yield recovery from spray-drying happened to obtain when with the amount of the wall material was decreased and core material was increased in the infeed solution. The increasing of the extract into wall material mixture can also cause by an insufficient amount of the obtainable wall material to create film-forming altogether with the sprayed water droplets, which can caused some of the droplets to stick to the cyclone chamber wall inside the spray dryer before they were sufficiently dry [22].

The increasing MCL extract also affected the moisture content and water activity to be increased, which suggested that the ratio of core material to wall material can affect moisture content and water activity. The result was in the same trend as Singthong *et al.* [23] which suggested that the increasing of *Tiliacora triandra* leaves extract in encapsulation using maltodextrin and gum arabic lead the moisture content and water activity to be increased. The color value (L^*,a^*,b^*) from this experiment was affected from the increasing MCL extract. All of the color value showed that the increasing of MCL extract can cause the color of encapsulated powder to be darker. The increasing of wall material affected the lightness to be increased because of wall material presented a white color whereas the increasing amount of MCL extract can increase color value a* and b* as suggested in Bernstein and Nore ña [24] investigation. In addition, the values a* and b* increased significantly with a higher amount of core material, resulting an accumulation in the red and yellow tonalities. This can be explained by dilution of is also discussed in Quek *et al.* [25] and Samakradhamrongthai *et al.* [26] that the increasing amount of core material can increase values a* and b* of encapsulated powder.

The solubility was affected from the decreasing wall material as the result showed that the decreasing of wall material can decrease the solubility of encapsulated powder. As Mur ía-Pagola *et al.* [27] stated that high concentration of modified starch decreased solubility as the fact the low water content powder lead to high value of water solubility. This is suggested that starch hydrolysis products can generally reduce the oxygen permeability of the matrix in spray-dried powders, generating a high water adsorption and can cause the higher solubility values [28].

TABLE I. HYSICAL AND ENCAPSULATION PROPERTIES OF MCL ENCAPSULATED FLAVORPOWDER

Properties of MCL encapsulated flavor powder	MCL extract (%w/v)			
	5%	10%	15%	20%
Core: Wall Ratio	1:4	1:2	1:1.5	1:1
Yield recovery (%)	34.93 ±0.51ᵃ	34.52 ±0.61ᵃ	32.26 ±0.23ᵇ	30.70 ±0.36ᶜ
Moisture content (%)	0.31 ±0.01ᵇ	0.32 ±0.17ᵇ	0.51 ±0.03ᵃ	0.53 ±0.08ᵃ
water activity	0.21 ±0.01ᶜ	0.25 ±0.01ᵃ	0.25 ±0.01ᵃ	0.24 ±0.01ᵇ
L*	86.25 ±0.17ᵃ	79.42 ±0.83ᵇ	78.12 ±0.87ᵇᶜ	77.83 ±0.89ᶜ
a*	-0.60 ±0.03ᶜ	2.19 ±0.37ᵇ	2.96 ±0.52ᶜ	2.13 ±0.21ᵇ
b*	23.64 ±0.14ᵈ	35.58 ±0.25ᶜ	40.61 ±0.55ᵃ	37.14 ±0.24ᵇ
Solubility (%)	73.86 ±0.06ᵃ	65.63 ±0.15ᵇ	60.10 ±0.17ᵇ	48.90 ±013ᶜ
Surface content (%)	0.50 ±0.01ᵈ	0.61 ±0.01ᶜ	0.62 ±0.01ᵇ	0.93 ±0.01ᵃ
Encapsulation efficiency (%)	90.96 ±0.84ᵇ	93.39 ±0.57ᵃ	46.72 ±0.15ᶜ	41.62 ±0.35ᵇ

Note:The different letters in the same row mean significant difference ($p \leq 0.05$)

The surface content and encapsulation efficiency had significant difference which happened from the core-to-wall ratio. The increasing of MCL extract was affected the surface content to be increased whereas the encapsulation efficiency was decreased as shown in Table I. These results happened due to the increasing of core-to-wall as suggested in Mohideen *et al.* [29] investigation on encapsulating of blueberry juice using spray drying.

B. Morphology of Encapsulated Mcl Flavor Powder

The external structure of the MCL encapsulated flavor powder was observed using SEM. The images showed skin-forming morphology with a rounded and dented on the external surface as shown in Figure 1. The microstructure of the MCL encapsulated flavor powder was found to similar to Samakradhamrongthai *et al.* [30] study on encapsulation of *Michelia alba* D.C. extract using octenyl succinic anhydride starch. The encapsulating capsules were measured using micron scale from observed images of encapsulating powder under SEM There were differences in amount and size but from average of particle size were slightly different but non-significant difference:5% (2.99 ±2.41 μm), 10% (3.68 ±2.95 μm), 15% (3.47 ±2.65 μm), and 20% (3.37 ±2.01 μm). Those non-significant differences were explained in Cheng *et al.* [31] that the larger of amount of core matter toward 10% show a larger filming surface. The increasing of core material over 10% will take more time to film and form the shape of capsule for encapsulating powder, resulting smaller particle size.

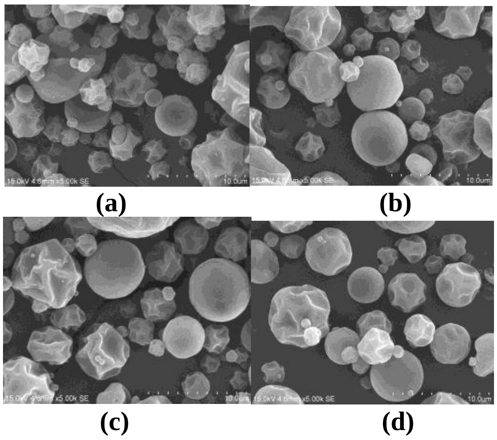

Figure 1. Scanning electron microscope images of MCL encapsulated flavor powder prepared using different concentrations of MCL extract: (a) 5% extract, (b) 10% extract, (c) 15% extract, and (d) 20% extract.

C. Volatile Compound Identification of MCL Encapsulated Flavor Powder Using Gas Chromatograph-Mass Spectrometry (GC-MS)

The volatile compounds in encapsulating powder were determined using GC-MS and peaks were compared with NIST database. The relative content of identified compounds in samples was shown in Table II. There were different amount of compounds released from MCL encapsulated flavour powder. The α-humulene and delta-cadinene were found to be absented in 5% encapsulated extract. Para-cymene was absence in 15% encapsulated extract. The α-cubebene and aromadendrene were not detected in the samples prepared using5%, 10% and 15% of extract. In contrast, α-pinene was not detected in sample prepared using 20% extract. There were volatile compounds that found in extracts which conformed to Rout *et al.* [32] studied concrete, absolute and headspace aroma from Champaca. Rout *et al.* [32] also noted that methyl hexanoate and *β*-elemene can be the key compounds from living Champaca flower but after petal had been extracted and gone through spray drying process the methyl hexanoate could not be detected from GC-MS only *β*–elemene that still be detected. However, there were different compound found in encapsulating powder was 3-carene which gave out citrus and orange peel aroma similar to methyl hexanoate which sometimes gave out citrus aroma. The similarity came from trained panel matching odor for encapsulating power. All key compounds could have been encapsulated but there were still some volatile that could not be encapsulated and coated on surface of encapsulating powder which including limonene, 3-carene, and *β*–elemene. The results showed that encapsulating powder can preserve most of the volatile only some of those were left on the surface of encapsulating powder.

There were volatile compounds that released from encapsulating powder differently as shown in Figure 2. The higher amount of volatile consisted of camphene, trans-ocimene, β-myrcene, 3-carene, and limonene. Camphene was highest in 15% extract encapsulating powder. trans-ocimene was about the same content in 10% and 20% extract encapsulating powder and only 3-carene was highest content in 20% extract encapsulating powder. Limonene was detected in all encapsulating powder and the content from 5% extract encapsulating powder was the highest, followed by 15%, 10%, and 20%, respectively.

Semyonov *et al.* [33] discussed that there where limit amount of core matter that maltodextrin and trehalose matrices could entrap, the excesses extract could not be encapsulated. Those were either evaporated or attached on wall matter of encapsulating powder. The result were not as expected, the original thought was to entrap all extracts in matrices capsule but as we found out that there were limited of entrapment. In this study the ratio of maltodextrin and trehalose was fixed, the matter in this experiment would be only percentage of extracts that applied. As the result showed that GC-MS could detect volatile compound from encapsulating powder, encapsulating powder that applied 20% extracts showed higher amount of 3-carene and 15% extracts showed higher amount of camphene meanwhile encapsulating powder that applied 5% extracts showed higher amount of limonene than others.

Those volatile compounds affected to consumer liking. The high intensity aroma could reflect to decrease consumer rating score meanwhile medium intensity aroma could reflect to increase consumer rating score, for example, camphene and 3-carene with characteristic odor similar which are wood odor could decrease rating score meanwhile trans-ocimene from 10% and 20% extract encapsulating powder was not as high as camphene or 3-carene but consumer affected to increase rating score because of characteristic odor is flower odor which consumer might rate the score toward flower odor more than wood odor.

TABLE II. VOLATILE COMPOUNDAND RELATIVE CONTENTFROM MCL ENCAPSULATED FLAVOR POWDER USING GC-MS

Compounds	**Peak area (%)**				**Characteristics odor**[a]
	5% extract	**10% extract**	**15% extract**	**20% extract**	
α-pinene	0.43	0.07	0.76	-	turpentine-like
β-thujene	1.83	1.26	2.29	1.42	turpentine
camphene	21.02	26.77	43.32	23.84	camphor
para-cymene	1.34	0.19	-	0.56	solvent, citrus
3-carene	9.04	5.76	8.80	42.64	citrus peel
limonene	45.06	25.39	33.76	3.57	orange
γ-terpinene	6.53	2.59	3.99	2.98	turpentine
α-terpinolene	1.76	1.02	1.71	1.02	sweet, piney
α-cubebene	-	-	-	0.88	herb, waxy
copaene	0.59	0.34	0.67	1.59	wood, spice
β-elemene	0.61	0.61	1.41	1.86	herb, waxy
β-caryophyllene	3.91	0.65	1.53	1.09	terpene-like
α-humulene	-	0.25	0.39	0.40	woody
aromadendrene	-	-	-	0.40	sweet, dry
δ-cadinene	-	0.28	0.92	1.12	herbaceous

Note: - means not detect in sample
[a] www.pherobase.com and www.flavornet.org

D. *Volatile Profiling of MCL Encapsulated Flavor Powder Using Electronic Nose*

The volatile analysis using electronic nose showed that four variation of MCL encapsulated flavor powder showed had similar volatile compounds with steady relative humidity and temperature (Figure 2). The compounds with organic solvent vapors were the highest amount and the compounds with hydrogen sulfide groups and air contaminants were the lowest amount. The distinctively categorized of encapsulating powder were consequence from organic solvent vapors and LP gas. In addition, those compounds were the main factor that effected to overall aroma liking of consumer in each sample.

The compounds with organic solvent vapors and LP gas were distinctively categorized from encapsulating powder. The PCA of MCL encapsulated flavor powders were distinctively distributed as shown in Figure 3. The PCA from 5% and 15% were distributed similarly as well as 10% and 20%. The MCL encapsulated flavor powder with 20% extract was distributed in widest range but not cover data for the rest. The differences of intensity of MCL encapsulated flavor powder happened from different of volatile released. The PCA can suggest that electronic nose can detect the volatile compound from all sample of MCL encapsulated flavor powder but it showed that the MCL encapsulated flavor powder with 10% extract can entrapped most of organic compounds which mostly are the volatile compounds inside the microcapsule [34].

E. Application of MCL Encapsulated Flavor in Instant Champaca Tea

The instant Champaca tea for sensory evaluation was prepared from the prepared green tea powder mixed with the MCL encapsulated flavor powder with 10% MCL extract in the variation of 0.1, 0.3, and 0.5%w/w.

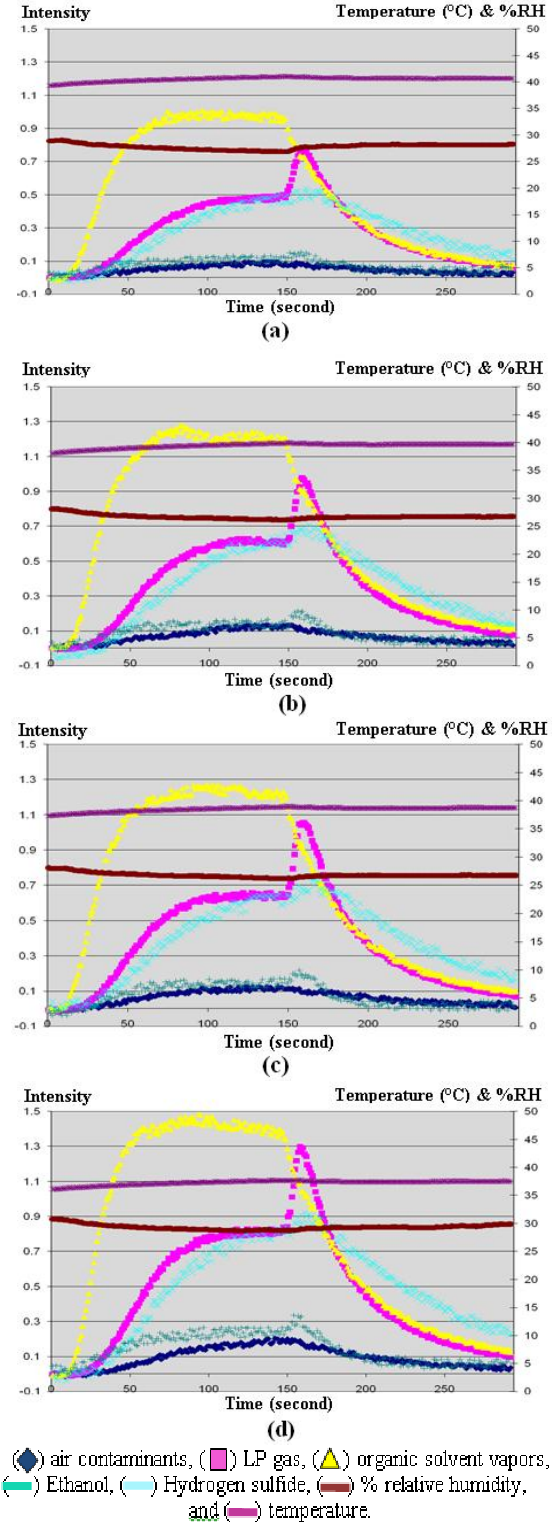

Figure 2. Electronic nose sensor of compounds emitted from MCL encapsulated flavor powder with MCL extract; (a) 5%, (b) 10%, (c) 15%, and (d) 20%.

The results showed that all evaluated attributes were significant difference as shown in Table III. The instant Champaca tea with 0.3% of the MCL encapsulated flavor powder showed the highest rating score in every attributes as suggested in Thompson *et al.* [34] that the intensity affected consumer preferences in sensory evaluation and highest intensity was not always be the most suitable for consumer preferences. The product acceptance also questioned and the 0.3% of the MCL encapsulated flavor powder showed the highest percentage of acceptance (96.7%). The instant Champaca tea with 0.3% of the MCL encapsulated flavor powder was then carried on to the consumer acceptance test.

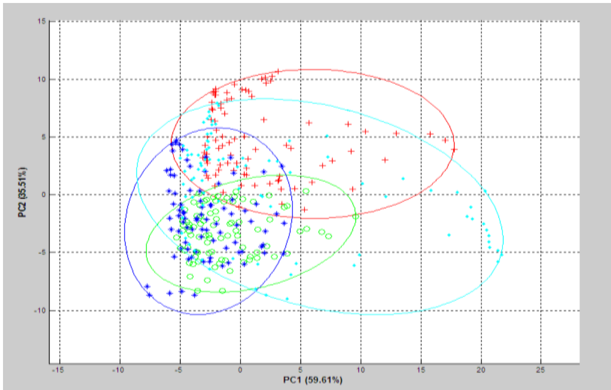

Figure 3. The principle component analysis of encapsulated powder with variation of MCL extract at 5% (+), 10% (○), 15% ( ) and 20% ( ).

TABLE III. SENSORY EVALUATION OF INSTANT CHAMPACA TEA WITH VARIATION OF MCL ENCAPSULATED FLAVOR POWDER

Attributes	encapsulating powder (%w/v)		
	0.1%	0.3%	0.5%
Appearance	5.5±0.5[b]	6.6±0.8[a]	5.1±1.0[c]
Color	5.6±0.5[b]	6.4±0.8[a]	5.0±1.0[c]
Clearness	5.6±0.8[b]	6.2±1.0[a]	4.4±0.5[c]
Tea aroma	5.6±1.2[b]	6.2±1.0[a]	5.4±0.8[c]
Flower aroma	5.2±0.5[b]	6.5±0.8[a]	5.2±0.8[b]
Overall aroma	5.3±0.6[b]	6.5±0.8[a]	5.4±0.8[b]
Tea flavor	6.1±0.5[b]	6.4±0.8[a]	5.2±0.7[b]
Flower flavor	6.0±0.6[b]	6.4±0.8[a]	5.4±0.8[c]
Overall flavor	6.0±0.5[b]	6.6±0.8[a]	5.4±0.8[c]
Taste	6.0±0.6[a]	6.2±0.4[a]	5.2±0.7[b]
Bitterness	5.8±0.7[a]	6.0±0.0[a]	5.4±0.8[b]
Aftertaste	6.0±0.6[b]	6.6±0.8[a]	5.4±0.5[c]
Overall liking	5.7±0.6[b]	6.2±1.0[a]	5.6±0.5[b]
Acceptance	91.7%	96.7%	40.0%

Note: The different letters in the same row mean significantly different ($p \leq 0.05$)
[ns] means non-significant difference

IV. CONCLUSION

The findings from this research suggested that the MCL encapsulated flavor powder can be produced using spray drying technique with maltodextrin 20% w/v and trehalose 0.5% w/v as carriers. The MCL encapsulated flavor powder with 10% of MCL extract showed the highest in encapsulation efficiency (93.39%±0.57) and overall aroma liking (6.5±0.5). The sensory evaluation of instant Champaca tea showed sensory rating score in the range of 6.2–6.5. Moreover, the instant Champaca tea with 0.3% of the MCL encapsulated flavor powder showed the most preferable of sensory rating score. The consumer acceptance of the instant Champaca tea showed high percentage of product acceptance (96.7%). The production of the MCL encapsulated flavor powder and instant Champaca tea from this research can be used as a prototype for another kind of instant flavored beverage. The encapsulated flavor powder can also applied to many kind of another product line both for food and beverages or nonfood products.

ACKNOWLEDGMENT

This research was financially supported by The Cooperation on Science and Technology Researcher Development Project (Co-STRD), under National Science and Technology Development Agent (NSTDA) and the research grants from Chiang Mai University.

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R. Samakradhamrongthai, P. Thakeow, P. Kopermsub, and N. Utama-Ang, "Encapsulation of Michelia alba D.C. extract using spray drying and freeze drying and application on Thai dessert from rice flour," Int. J. Food, Eng., vol. 1, no. 2, pp. 77-85, Dec. 2015, "doi10.18178/ijfe.1.2.77-85"