



## Development of Instant Coffee for Value Adding of Coffee Products from Ban Borsiliam, Ngao District, Lampang Province

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### Abstract

This research aimed to develop an instant coffee using the coffee beans from Ban Borsiliam, Ngao District, Lampang Province, as to increase the product's value. Surveys for fundamental data and the demand to develop a coffee product of Ban Borsiliam, Ngao District, Lampang Province were conducted, and it has been found that the locally cultivated coffee was Arabica, which yields approximately 5,000 Kilograms of gross product per annum. The commercial products of the community included parchment coffee beans, honey-process coffee beans, and roasted coffee beans. The study on the condition with spray drying found that the optimal inlet temperature of the spray dryer for developing the instant coffee was at 160°C. The wall material used to encapsulate the coffee extract was 10% maltodextrin. The developed formula of the 3-in-1 instant coffee mix comprises 15.9% instant coffee, 36.3% sugar, 47.6% non-dairy creamer, and 0.2% flavor. The consumer acceptance test showed that the mean liking score toward the 3-in-1 instant coffee was at the moderately like to very like level ( $7.4 \pm 0.8$ ), with 92% of consumers accepting the developed 3-in-1 instant coffee, and 88% of consumers that would purchase the product if available in the market. The results regarding the satisfaction toward the technology transfer of this study found that the participants scored between very satisfied and most satisfied.

### Introduction

Nowadays, coffee has been one of the popular drinks worldwide. Consequently, the coffee market has been growing continuously for at least the past 4-5 years. Thai market value is as high as 39 billion baht in 2016. Especially in Thailand, there is a rise in coffee consumption among the Thai population, making Thailand a fascinating spot for both domestic and foreign investors. Nevertheless, coffee consumption in Thailand

is still less than many countries, when considering coffee consumption per person; therefore, there is an opportunity for the coffee market to be expanded and grow further (Na Nakhon, 2018).

Instant coffee, or soluble coffee, is a form of coffee available to consumers for quickly hot coffee preparation. It is commercially manufactured by either freeze drying or spray drying. Robusta coffee is selected because of its economical appealing and higher extraction yield, Arabica coffee is also used to enhance the flavor

and to provide more aromatic for flavor retention of soluble coffee (Capek et al., 2014).

There are numerous studies regarding spray drying of instant coffee; however, only a small number of literature reviews on these researches are available, with the explanations of principles of spray drying and the effects of spray-drying factors on the properties of coffee powder. Bhumiratana et al. (2011) inspected that the results of aromatic characteristics of the coffee tested by the descriptive panel, indicating that the characteristics were affected by the preparation procedures, levels of roasting, due to the formation of aroma compounds. Besides, the aroma could also be released by grinding, due to the increase of surface area. Ghirisan & Miclaus (2017) reported that higher antioxidant activity is exhibited by spray dried coffee than that by freeze dried coffee, due to the shorter duration of drying. In comparison with freeze drying, spray drying is an efficient method of making soluble coffee, as it produces coffee with better physical properties, i.e. smooth-spherical shape, large amount of smaller particles with 10  $\mu\text{m}$  diameter, higher porosity, less free bulk density, and higher antioxidant activity, as assessed by EPR analysis. Bassoli et al. (1993) studied on aromatic retention of instant coffee powder in the low temperature chamber of the spray dryer, which produced a result equivalent to that using a freeze dryer, which is more costly.

Arabica coffee products from Ban Borsiliam, Ngao district, Lampang province are coffee beans and dried coffee beans, which are to be made into roasted coffee beans. Authors then had the ideology of developing the production process of instant coffee using a spray drying, for it would be further developed in the production of 3-in-1 instant coffee, in order to satisfy certain consumer groups that demand convenience.

Product specifications from preference mapping of commercial instant coffee mix in Thailand (Vittayaporn & Wirunthanakrit, 2016) informed the important sensory characteristics of 3-in-1 instant coffee that had an influence on consumer preference, and hence making it possible to specify the important characteristics of the prototype coffee product that is to be further developed. Moreover, it makes the mentioned product development able to satisfy the consumers' demand better, and also increases the possibility of the product's success. Therefore, this research aims to develop the instant coffee product using coffee beans from Ban Borsiliam, Ngao district, Lampang province under the spray drying condition, including the inlet temperature, the type and

concentration of wall material, and to use the developed instant coffee in production of 3-in-1 instant coffee product, as to widen the varieties for coffee drinkers.

## Materials and methods

### 1. Materials

Dark-roasted Arabica coffee beans were collected from Ban Borsiliam, Ngao District, Lampang Province in December 2016. Modified starch and 10 DE Maltodextrin were purchased at Nutrition SC, Co., Ltd. (Thailand).

### 2. Survey of basic information and demand in developing coffee products of Ban Borsiliam, Ngao District, Lampang Province

A survey of demand of agriculturalists cultivating coffee at Ban Borsiliam, Ngao District, Lampang Province was collected by using in-depth interview with members of the community to gather basic data, e.g. species of the coffee cultivated, amount of coffee product, type of products being marketed, equipment used for coffee product development in the community, and the agriculturists' demand in developing the quality of the community's product.

### 3. Study of the optimal inlet temperature of spray dryer for developing instant coffee product

#### 3.1 Preparing coffee extract samples

Blend the roasted coffee in a blender, and extract the blended coffee with steam using coffee maker, at the concentration of 6 g blended coffee to 60 mL water (modified from Chu, 2012). The coffee extract was to be used in the following step.

#### 3.2 Production of instant coffee (Modified from Ballesteros et al., 2017)

Mix the coffee extract with wall material, maltodextrin, at 15% of coffee extract's weight using a homogenizer at 12,000 rpm. The resultant solution was dried using a spray dryer, having the compressed air configured at 2 bars, feed at 250 mL per hour, and air flow at 30  $\text{m}^3$  per hour, using inlet temperatures at 150°C, 160°C, 170°C and 180°C, and outlet temperature at 85°C. When the temperature is optimal, the prepared solution of coffee with maltodextrin was fed into the spray dryer using a nozzle with 0.5 mm diameter. The wall material that is suitable for instant coffee production was chosen for, concerning the instant coffee's moisture and the yield of instant coffee.

#### 4. Study of wall material used for encapsulating the coffee extract

Mix the obtained coffee extract with wall materials, including maltodextrin and modified starch, at 15% of the coffee solution's weight, using a homogenizer at 12,000 rpm. Then, the solutions were spray dried with 2 bars of compressed air, 250 mL per hour feed, and air flow of 30 m<sup>3</sup> per hour. The inlet temperature was set to the optimum that was determined in the earlier step, and the outlet temperature was 85°C. After the temperature was well adjusted, the solution of coffee with maltodextrin and the modified starch solution were then fed into the spray dryer using a nozzle with 0.5 mm diameter. The wall material that is suitable for instant coffee production was chosen for, concerning the instant coffee's moisture and the yield of instant coffee produced.

#### 5. Study of wall material for developing instant coffee product

Mix the obtained coffee extract with the wall material encapsulating the flavoring agent at the amount of 10% and 15% of the coffee extract's weight. A homogenizer was used for mixing at 12,000 rpm. Then, the solution was dried using a spray dryer with 2 bars of compressed air, 250 mL per hour feeding rate, 30 m<sup>3</sup> per hour air flow, and the inlet temperature was configured. After the temperature was optimally adjusted, the prepared solution of coffee with maltodextrin was fed into the spray dryer using a nozzle with 0.5 mm diameter. The inlet temperature was set to that determined in step 1, and the outlet temperature was 85°C. The wall material suitable for instant coffee production was chosen for, concerning the instant coffee's moisture and the yield of instant coffee produced. The developed instant coffee was analysed for the important qualities of instant coffee products, as follows:

##### 5.1 Chemical qualities

- 1) Moisture content (AOAC., 2012)
- 2) Total ash (AOAC., 2012)
- 3) Caffeine content (AOAC., 2012)
- 4) Solubility (Ishwarya & Anandharamakrishnan, 2015) when having 2.5 g of coffee sample weighed in a 500 mL beaker, then pour 150 mL of boiling water into the beaker, stir until the coffee does not clump and completely dissolves in water.

##### 5.2 Physical qualities

Color (L, a, b) of the instant coffee, measured using a colorimeter FRU Model WF Series.

##### 5.3 Sensory qualities

1) A test for intensity of instant coffee by testing the intensities of color, coffee flavor and bitterness, using 9-point category scale (from 1-non intensity to 9-most intensity) (Lawless & Heyman, 1998) with semi-trained panel of 50 people.

2) Preparation of instant coffee - dissolving 2 g of instant coffee in 50 mL of 90°C water (Geel et al., 2005) for a Monadic serving to the panel.

#### 6. Development of 3-in-1 instant coffee prototype from the developed instant coffee

##### 6.1 Development of the prototype

Using the developed instant coffee, mix with sugar (Thai Roong Ruang Sugar Group, Bangkok, Thailand), non-dairy creamer (Nestlé Thai Ltd., Bangkok, Thailand) and flavor at proportions indicated in the product specification in accordance to the preference mapping of commercial instant coffee mix in Thailand (Vittayaporn & Wirunthanakrit, 2016). The prototype coffee sample was prepared by brewing with 100 ml hot boiling water at 90°C and tested for preference using the 9-point hedonic scale (1-dislike extremely to 9-like extremely) for 50 consumers alongside with the just-about-right scale; JAR (1-not enough, 2-just about right; JAR, and 3-too much) was used to evaluate color, coffee aroma, caramel aroma, bitterness, sweetness, and creaminess in order to develop for the product that most satisfies the consumers.

##### 6.2 Acceptance test of consumers

A survey for acceptance of target consumers that consume 3-in-1 instant coffee product at least once per week using a questionnaire, including demographic data, data of consumers' liking scores toward the product using the 9-point hedonic scale, and data of 100 panelists' acceptance using the binomial (yes/no) scale.

##### 6.3 Statistical analysis

Spray drying condition data were subjected to analyses of variance (ANOVA) and T-test. The results of acceptance test comprised the frequency (percentage) and the average liking score of consumers toward the developed 3-in-1 instant coffee. Statistically difference was established at  $p < 0.05$ .

#### Results and discussion

##### 1. Basic information and demand in developing coffee products of Ban Borsilam, Ngao District, Lampang Province

The survey of basic information and demand in developing coffee products of Ban Borsiliam, Ngao District, Lampang Province, aiming to investigate the community's general data, i.e. species of the coffee cultivated, amount of coffee product yield, type of products being marketed and the equipments used for coffee product development in the community, has found that the agricultural area has an altitude above sea level of 1,000 to 1,200 meters, which is suitable for cultivating Arabica coffee, yielding approximately 5,000 kg of coffee beans annually. The community members have assembled to establish a cooperative, in order to request for the provincial budget as to purchase the equipment and machineries necessary for producing roasted coffee beans, which includes a pulp remover, a grinder, and a roaster, yielding 5 kg of roasted coffee beans per session. The community's products include coffee berries (dried unpeeled coffee beans), honey-process coffee beans (un-immersed, peeled coffee beans) and roasted coffee beans with different roasting levels (light-roast, medium-roast and dark-roast) (Fig.1). The roasted coffee beans will be manufactured upon receiving the purchase orders from clients, which are coffee shops in the Northern Thailand, e.g. Chiang Mai, Lampang and Chiang Rai, being sold at 400 baht per kg, in laminated packages. The price of roasted coffee sold by the community is lower than those being commercialized in the market, which are typically 500-600 baht in price. Therefore, the researchers recognized the appropriateness of developing the community's roasted coffee into instant coffee, further as an ingredient of the 3-in-1 instant coffee product.

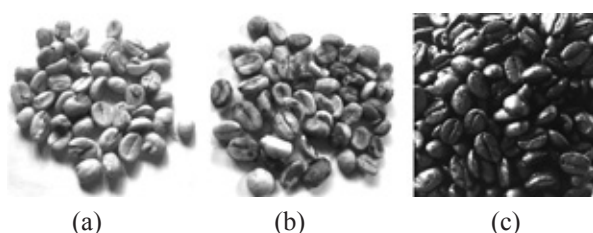


Fig. 1 Coffee bean product of Ban Borsiliam Community (a) coffee berries (b) Honey-process coffee beans and (c) roasted coffee beans

## 2. The optimal inlet temperature of spray dryer for developing instant coffee product

From the study of inlet temperature of the spray dryer for drying the coffee extract with 15% maltodextrin, using inlet temperatures of 150°C, 160°C, 170°C and 180°C, the results of moisture level and the yield of instant coffee are as shown in Table 1. Considering the

moisture level and the yield of instant coffee from spray drying, it was found that spray drying at temperatures of 160°C, 170°C and 180°C produces the instant coffee with less moisture than at 150°C with statistically significant difference ( $p < 0.05$ ), which conformed to the Ministry of Health Notification, (No.197) B.E.2543 (2000) Re: Coffee, that instant coffee products must not have over 5 percent of moisture. As for the yield of instant coffee, it was found that spray drying at temperatures of 160°C, 170°C and 180°C yielded more amount of instant coffee than at 150°C with statistically significant difference ( $p < 0.05$ ). Due to one of the limitations of spray drying that flavoring agents and essential chemical compounds are less affected when spray drying with lower inlet temperatures than higher inlet temperatures (Shishir & Chen, 2017), the inlet temperature of 160°C was chosen, for it is the lowest temperature that yielded a greater amount of instant coffee with less moisture.

Table 1 Moisture content and yield of instant coffee from spray drying at different inlet temperatures

Inlet temperature (degrees Celsius)	Moisture content (percentage)	Instant coffee yield (percentage)
150	3.81±0.03 <sup>a</sup>	31.3±4.4 <sup>b</sup>
160	3.72±0.03 <sup>b</sup>	38.8±4.7 <sup>a</sup>
170	3.63±0.03 <sup>c</sup>	39.9±4.2 <sup>a</sup>
180	3.55±0.04 <sup>d</sup>	41.1±4.3 <sup>a</sup>

Remark: Means in columns followed by different letters represent significant differences ( $p < 0.05$ ).

## 3. Wall material for encapsulating the coffee extract

From the study of wall material used for encapsulating the coffee extract, which involved different types of wall materials-maltodextrin and modified starch, using coffee extract from roasted coffee of Ban Borsiliam community, Ngao District, Lampang Province, at the concentration of 6 g per 60 ml of water (modified from Chu, 2012), mixed with wall materials, including maltodextrin and modified starch at 15% of coffee extract's weight. When tested for solubility of the instant coffee, the maltodextrin-mixed instant coffee had a lower moisture level than instant coffee with modified starch with statistically significant difference ( $p < 0.05$ ), as maltodextrin is less viscous than modified starch, it therefore dispersed more and contacted with more heat in the dryer when used as a wall material in drying. As a result, the instant coffee's moisture level is influenced, which is in accordance to Loksuan (2008). For the yield of instant coffee from spray drying, the instant coffee with maltodextrin as a wall material also yielded more than that with modified



starch, as shown in Table 2. Hence, maltodextrin was selected as the wall material in instant coffee production, due to the higher yield that led to the lowered cost of production than in modified starch' case.

**Table 2** Moisture content, yield and solubility of instant coffee with maltodextrin and modified starch as wall materials

Properties	Types of wall material	
	Maltodextrin	Modified starch
Moisture content (percentage)	3.74±0.03 <sup>b</sup>	4.28±0.04 <sup>a</sup>
Instant coffee yield (percentage)	38.3±4.6 <sup>a</sup>	25.0±4.3 <sup>b</sup>
Solubility (seconds)	108±6 <sup>a</sup>	86±4 <sup>b</sup>

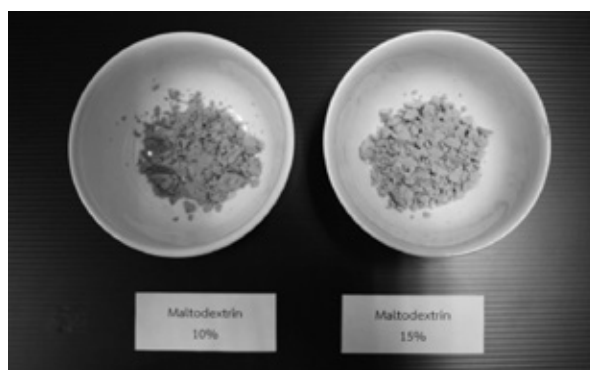
**Remark:** Means in rows followed by different letters represent significant differences ( $p < 0.05$ ).

#### 4. Wall material concentration for developing instant coffee product

After mixing the coffee extract from the sample preparation procedures with the wall materials - maltodextrin - at concentration levels of 10% and 15% of the coffee solution's weight, and spray drying the resultant solution, it was observed that using maltodextrin at 15% of the coffee solution's weight showed no difference when compared to using maltodextrin at 10%, as shown in Table 3. Then, the instant coffee with 10% and 15% maltodextrin were tested for solubility; the instant coffee with 10% maltodextrin dissolved faster than the one with 15% maltodextrin, for the reason that a droplet of 10% maltodextrin-mixed coffee solution contains more water than in 15% maltodextrin-mixed coffee solution - resulting in a higher moisture level, in accordance to Oberoi & Sogi (2015) which studied the usage of maltodextrin at 3% to 10% and found that the amount of water fed into the dryer has an effect on the final moisture level of the product; using maltodextrin at a higher concentration, as to increase the solid content before feeding, results in less amount of water to be evaporated, and thus, the product with less moisture. Furthermore, the research by Quek et al. (2017) showed that increasing maltodextrin by 3% to 5% resulted in a statistically significant decreasing trend of moisture level in powdered watermelon ( $p < 0.05$ ). The caffeine content in the instant coffee with 10% maltodextrin is higher than in the instant coffee with 15% maltodextrin, as a result from that the surface area of the coffee extract is insufficient for the level of maltodextrin at 15%, which agreed with the research of Sultana et al. (2018) that studied the D-Limonene encapsulation using maltodextrin and indicated that D-Limonene can be stored less when

using an excessively high amount of maltodextrin.

From the measuring of color using a colorimeter, the instant coffee with 10% maltodextrin presented a lower L (brightness) value than the instant coffee with 15% maltodextrin; hence, the instant coffee with 10% maltodextrin is darker. The a (red/green colors) value of the instant coffee with 10% maltodextrin is higher than the instant coffee with 15% maltodextrin - thus, the instant coffee with 10% maltodextrin has a more intense red color. The b (blue/yellow colors) value of the instant coffee with 10% maltodextrin is higher than the instant coffee with 15% maltodextrin; the instant coffee with 10% maltodextrin therefore has a more intense yellow color. To sum up, using maltodextrin at 10% produced the instant coffee with darker brown color than at 15%, which is in accordance to the research of Oberoi & Sogi (2015) that the powdered watermelon with higher amount of maltodextrin had higher L value and lower a and b values, showing the lighter tone of the product. The instant coffee with 10% and 15% of maltodextrin are displayed as in Fig. 2.



**Fig. 2** Instant coffee with 10% and 15% maltodextrin

**Table 3** Chemical and physical qualities of the instant coffee with 10% and 15% maltodextrin as wall materials

Properties	Amount of maltodextrin (percentage)	
	10	15
Moisture (percentage)	4.08±0.04 <sup>b</sup>	3.69±0.03 <sup>a</sup>
Quantity of ash (percentage)	2.38±0.01 <sup>b</sup>	3.36±0.01 <sup>a</sup>
Quantity of caffeine (percentage)	1.00±0.01 <sup>a</sup>	0.77±0.01 <sup>b</sup>
Instant coffee yield (percentage) <sup>ns</sup>	33.25±3.2	38.38±4.3
Solubility (seconds)	95.43±3 <sup>b</sup>	108.22±4 <sup>a</sup>
Color L	63.36±0.38 <sup>b</sup>	65.59±0.05 <sup>a</sup>
a	5.31±0.07 <sup>a</sup>	5.18±0.04 <sup>b</sup>
b	14.37±0.05 <sup>b</sup>	14.61±0.07 <sup>a</sup>

**Remark:** Means in rows followed by different letters represent significant differences ( $p < 0.05$ )

<sup>ns</sup> = Means in row is not significant differences ( $p \geq 0.05$ ).

The sensory evaluation for the coffee sample's intensity using the 9-point category scale in color, coffee aroma, coffee flavor and bitterness (1-non intensity to 9-most intensity), for identifying the optimal amount of wall material in the development of instant coffee, led to the results that the panelists rated the intensity scores of color, coffee aroma, coffee flavor and bitterness higher for the coffee sample from instant coffee with 10% maltodextrin as wall material than that with 15% maltodextrin, because the amount of maltodextrin used as a wall material was too excessive for binding with the coffee extract, causing the brewed coffee to have less intense color, aroma, flavor and bitterness (Table 4) which agreed with the research of Oberoi & Sogi (2015) indicating that the amount of pigment, flavor and lycopene were lower in the powdered watermelon with high amount of maltodextrin. Thus, the researchers have chosen the instant coffee with maltodextrin at 10% of the coffee solution's weight, to be developed into a 3-in-1 instant coffee. The brewed coffee, using maltodextrin at 10% and 15%, are shown in Fig. 3.

**Table 4** Mean intensity scores of instant coffee with 10% and 15% maltodextrin as wall materials

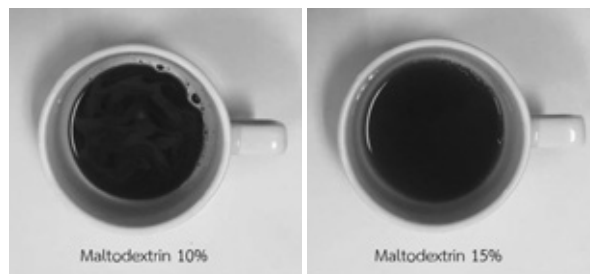
Sensory attributes	Amount of maltodextrin (percentage)	
	10	15
Color	7.5±0.4 <sup>a</sup>	6.4±0.5 <sup>b</sup>
Coffee aroma	6.8±0.6 <sup>a</sup>	5.5±0.5 <sup>b</sup>
Coffee flavor	7.2±0.4 <sup>a</sup>	6.0±0.5 <sup>b</sup>
Bitterness	6.5±0.3 <sup>a</sup>	5.8±0.4 <sup>b</sup>

**Remark:** Means in rows followed by different letters represent significant differences ( $p < 0.05$ ).

## 5. Development of 3-in-1 instant coffee prototype from the developed instant coffee

### 5.1 Results from prototype 3-in-1 instant coffee samples

The results from the sensory evaluation, with the use of liking scores on the 9-point hedonic scale (1-dislike extremely to 9-like extremely) alongside with the just-about-right scale, using the 3-in-1 instant coffee from the prototypic formula in Table 5 to be tested by 50 target consumers – consumers that drinks 3-in-1 instant coffee at least once per week. The tested quality included color, coffee aroma, caramel aroma, bitterness, sweetness, creaminess and overall liking; the average liking score of color, coffee aroma, caramel aroma, bitterness, sweetness and overall liking were in the range 7.0-7.6 - like moderately (Table 6), while the average liking score of creaminess was 6.6±1.1 - like slightly to like moderately.



**Fig. 3** Brewed instant coffee with 10% and 15% maltodextrin

From the results of consumers' just-about-right scale (Table 7), over 70% of the panellists rated "just about right" for the qualities of color, coffee aroma, caramel aroma, bitterness and sweetness; however, less than 70% of the panellists rated "just about right" for the creaminess quality (63.33% rated "just about right"), the rest of the panellists (36.67%) rated "not creamy enough". The researchers therefore are able to comprehend the way of fine-tuning the product - increasing the product's creaminess.

**Table 5** Ingredients of the prototype instant coffee

Ingredient	Weight	
	(gram)	(percentage)
Instant coffee	3.5	15.88
Brown sugar	8.0	36.29
Non-dairy creamer	6.5	29.49
Powdered skimmed milk	4.0	18.14
Flavor	0.04	0.20

**Table 6** Mean liking scores of the prototypic 3-in-1 instant coffee

Sensory attribute	Mean liking score
Color	7.0±0.5
Coffee aroma	7.2±0.8
Caramel aroma	7.4±0.5
Bitterness	7.0±0.6
Sweetness	7.3±0.6
Creaminess	6.6±1.1
Overall liking	7.6±0.8

**Table 7** Frequency of panelists selecting different scales on the JAR (percentage) for the prototypic 3-in-1 instant coffee

Sensory attribute	Average value		
	Not enough (percentage)	Just-about-right (percentage)	Too much (percentage)
Color	10.00	<b>83.33</b>	6.67
Coffee aroma	20.00	<b>80.00</b>	0
Caramel aroma	10.00	<b>76.67</b>	13.33
Bitterness	26.67	<b>73.33</b>	0
Sweetness	10.00	<b>80.00</b>	10.00
Creaminess	36.67	63.33	0

**Remark:** The bolded letters implies the just-about-right scale being selected by over 70% of the panelists.

## 5.2 Results from adjusted 3-in-1 instant coffee samples

The researchers considered adjusting the ingredients of the 3-in-1 instant coffee from the prototype referring to the results on the just-about-right scale, indicating that the creaminess quality was not high enough to meet satisfaction, by increasing the proportion of non-dairy creamer to replace powdered skimmed milk, as non-dairy creamer provides creaminess more than powdered skimmed milk, as in Table 8.

After taking the adjusted 3-in-1 instant coffee to the test with 50 target consumers, using liking scores on the 9-point hedonic scale (1-dislike extremely to 9-like extremely) together with the just-about-right scale, the average liking score in every characteristics - color, coffee aroma, bitterness, sweetness and creaminess - and the overall liking score were in the range 7.0-7.3 (moderately like), specifically the liking score in caramel aroma and overall liking score were in the range 7.5-7.7 (moderately like to like very much), as in Table 10.

The results of consumers' just-about-right scale (Table 9) indicated that the color, coffee aroma, caramel aroma, bitterness, sweetness and creaminess of the adjusted 3-in-1 instant coffee were rated "just-about-right" in every characteristic by over 70% of the panelists. Therefore, the adjusted formula is optimal for further testing on consumers' acceptance; the developed 3-in-1 instant coffee is shown in Fig. 4.

**Table 8** Ingredients of the adjusted 3-in-1 instant coffee

Ingredient	Weight	
	(gram)	(percentage)
Instant coffee	3.5	15.9
sugar	8.0	36.3
Non-dairy creamer	10.50	47.6
Flavor	0.04	0.2

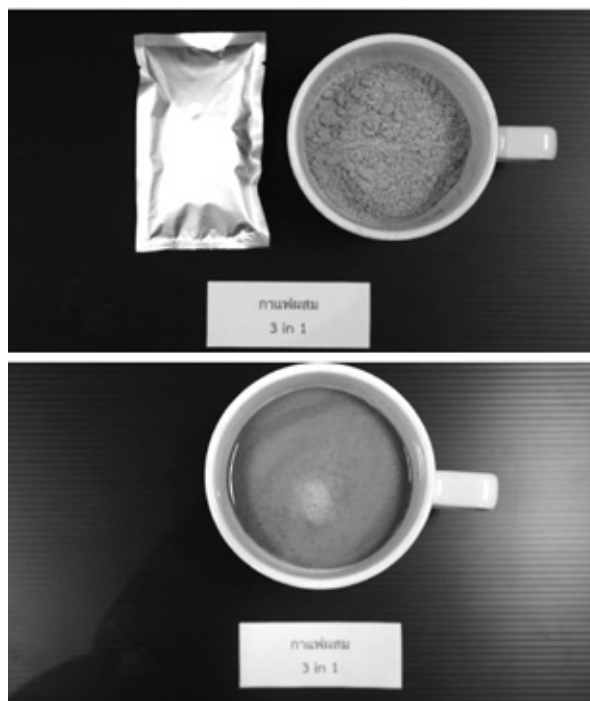
**Table 9** Mean liking scores of the adjusted 3-in-1 instant coffee

Sensory attribute	Mean liking score
Color	7.0±0.6
Coffee aroma	7.1±0.8
Caramel aroma	7.5±0.5
Bitterness	7.0±0.6
Sweetness	7.3±0.8
Creaminess	7.0±0.8
Overall liking	7.7±0.5

**Table 10** Frequency of panelists selecting different scales on the JAR (percentage) for the adjusted 3-in-1 instant coffee

Sensory attribute	Average value		
	Not enough (percentage)	Just-about-right (percentage)	Too much (percentage)
Color	10.00	<b>80.00</b>	10.00
Coffee aroma	10.00	<b>83.33</b>	6.67
Caramel aroma	10.00	<b>76.67</b>	13.33
Bitterness	26.67	<b>73.33</b>	0
Sweetness	10.00	<b>80.00</b>	10.00
Creaminess	26.67	<b>73.33</b>	0

**Remark:** The bolded letters implies the just-about-right scale being selected by over 70% of the panelists.



**Fig. 4** The developed 3-in-1 instant coffee product

## 6. Acceptability test

The study of consumers' acceptance on the developed 3-in-1 instant coffee, which covers the demographic data and the consumers' liking and acceptability test, using 100 panelists in the Bangkok Metropolitan area, has the results as shown in Tables 11.

The results from testing of consumers' liking on the 9-point hedonic scale of the developed 3-in-1 instant coffee, in its color, coffee aroma, caramel aroma, bitterness, sweetness, creaminess and overall liking, showed that the consumers had their likings score in every characteristics in the "moderately like" level (7.0-7.4), as shown in Table 12.

**Table 11** Demographic data

Demographic attributes	Frequency (percentage)
1. Gender	
- Male	50
- Female	50
2. Age	
- Less than 20 years old	14
- 20 – 31 years old	34
- 31 - 40 years old	32
- More than 40 years old	20
3. Education level	
- Bachelor's degree	70
- Higher than bachelor's degree	30
4. Occupation	
- Student	15
- Government official	45
- State enterprise	2
- Private sector	18
- Personal business	20
5. Average monthly income	
- Less than 5,000 THB	5
- 5,001 – 10,000 THB	25
- 10,001 – 20,000 THB	36
- 20,001 – 30,000 THB	24
- More than 30,000 THB	10

**Table 12** Mean liking scores of the developed 3-in-1 instant coffee

Sensory attributes	Mean liking scores
Color	7.0 ± 0.9
Coffee aroma	7.2 ± 0.8
Caramel aroma	7.3 ± 0.8
Bitterness	7.1 ± 1.1
Sweetness	7.1 ± 1.0
Creaminess	7.0 ± 0.9
Overall liking	7.4 ± 0.8

The study of consumers' acceptance and purchasing decisions on the developed 3-in-1 instant coffee has the results shown in Table 13.

The results from the survey of consumers' acceptance and decisions on purchasing the developed 3-in-1 instant coffee indicated that 92% of the consumers accepted the product, and 88% of the consumers decided to purchase the developed 3-in-1 instant coffee.

**Table 13** Consumers' acceptance on the developed 3-in-1 instant coffee

Data	Frequency (percentage)
Consumers' acceptance on the developed 3-in-1 instant coffee	
- Accept	92
- Decline	8
Decisions on purchasing the developed 3-in-1 instant coffee	
- Purchase	88
- Not purchase	12

## Conclusion

The roasted coffee beans from Ban Borsiliam community were dark-roasted, with controlled moisture level of not more than 12%. During the production of coffee by spray drying, it has been found that the inlet temperature in the range 160°C-180°C produces the coffee with higher yielding value and lower moisture, as more water from the coffee extract could evaporate. However, the researchers selected for the inlet temperature of 160°C, as it is the lowest temperature to produce low moisture and high yielding of coffee, while also maintaining more of the flavoring agents and essential chemical compositions in the coffee powder. Wall material used in encapsulating the coffee extract, maltodextrin was found to be the most suitable wall material for the production of instant coffee; since it is less viscous than modified starch, maltodextrin disperses better and contacts hot air in the dryer more, and also yields more product than modified starch. Regarding the optimal amount of maltodextrin as a wall material, 10% maltodextrin produces a faster-dissolving instant coffee than 15% maltodextrin. It is due to the less amount of wall material surrounding the coffee, causing the color, aroma, flavor and bitterness to be more intense. With the suitable conditions mentioned, the obtained instant coffee would be used as one of the major ingredients of the 3-in-1 instant coffee. The developed formula of 3-in-1 instant coffee consists of 16% instant coffee, 35.8% sugar, 48% non-dairy creamer and 0.20% flavor. Having the average consumers' liking scores in the "moderately like" range (7.4±0.8), 92% of the consumers accepting the product, and 88% of the consumers deciding to purchase the product if available in the market - the developed 3-in-1 coffee could be commercialized as a new product of the community, and potentially increase the revenue of the community's members.

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