PRODUCTION OF FLAVORED KLUAY HOM TONG FOR MILK ADDITIVE AGENT

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ABSTRACT Hom Tong Banana (*Musa acuminate* AAA group 'Gros Michel') is a fruit that has a unique flavor. Therefore, bananas are popular to develop as natural flavoring substances for many products such as ice cream infant food and milk. The aim of this research was to produce easy-to-use banana flavoring agent powders, give stable flavors by a spray drying technique from aqueous banana extracts and use for natural flavoring agent in milk application. The influence of inlet air temperature; 120, 140 and 160 ºC and maltodextrin concentration of 20, 30 and 40 (%w/v) on physicochemical properties of the banana flavoring agent powders; color, drying yield, moisture content, water activity solubility and retention of volatile compound were studied in this work. The experimental results showed that inlet air temperature and maltodextrin concentration had synergistic effect on physicochemical properties of banana flavoring agent powder ($p<0.05$). Thirty percent of maltodextrin at 140 ◦C gave the product with good physicochemical properties. Yellowish banana flavoring agent powder gave L*, *b**, Chroma and Hue angle values of 93.02, 6.23, 6.23 and 87.23, respectively. Yield, moisture content, water activity and water solubility of banana flavoring agent powder were 21.54%, 3.89%, 0.26 and 93.61%, respectively. Moreover, volatile compounds of the spray-dried banana flavor from this condition gave the highest retention of major volatile compounds; isoamyl acetate, 2-methylpropyl butyrate, butyl butyrate, isoamyl butyrate and 3-methylbutyl 3-methylbutyrate. Finally, banana flavoring agent powder using maltodextrin concentration of 30 % as carrier agent and inlet air temperature of 140ºC was applied to banana milk at various; 10, 15 and 20 (%w/v). The sensory evaluation results including sweet odor, banana odor, sweet taste, banana taste and overall acceptance showed that the milk with all concentration of banana flavoring agent powder were not significantly difference ($p>0.05$), except milk with 10% of banana flavoring agent powder had the highest of color and appearance.

1. INTRODUCTION

Hom Tong Banana (*Musa acuminate* AAA group 'Gros Michel') is a tropical and subtropical fruit with a pleasant flavor. Accordingly, Hom Tong Banana is widely consumed throughout the world. Hom Tong banana is one of the most important crops of Thailand. It was exported to many countries, especially the European and American markets. However, Hom Thong banana, a climacteric fruit, was easily rotten and spoiled due to the rapid producing ethylene (C_2H_4) after harvesting and their thin skin which was an important problem for exportation and storing. Although there are many techniques for prolong storage life, the delayed ripening of banana was complicated (Brennan et al., 1990). Moreover, the yield greatly exceeded demand in some seasons, declining the price of banana.

Therefore, banana have been used to develop as natural flavoring substances for enhancing banana flavor, which added value of various food products especially dairy products such as milk. Generally, Hom Tong Banana flavoring was extracted by water, which gave originally banana flavor. However, the obtained banana flavor from water extraction gave in paste form and unstable flavor because volatile compounds in banana flavoring had low molecular weight, unstable and easily degraded during food processing and storage. Therefore, drying technique was used to produce a banana flavoring in dry powder form for easy-to-use banana flavoring and enhancing shelf life of flavors.

There are several drying technologies such as spray drying, fluidized bed, freeze drying and drum drying etc. Some of techniques have high operating costs, long operation time and causing the loss of nutrition, flavor and color. One of popular drying technique is spray drying which was a commercial process because of short contact time, good retention of volatiles, good stability of the finished product, and wide choice of carrier agents (Reineccius, 1989). Several studied have been used maltodextrin as a carrier agent in spray drying for various fruit juice powder processing such as watermelon (Quek et al., 2007), guava (Osorio et al., 2010) and durian (Chin et al., 2010) because it exhibited low viscosity at high solids content, good solubility, no off-flavor, and non-toxic. Therefore, maltodextrin was used as carrier agent in this study for enhancing stability of banana flavoring by a spray drying technique and banana flavoring was applied as natural flavoring agent in milk product.

2. EXPERIMENT

2.1 Sample preparation and spray drying

The 80% mature Hom Thong Banana, which acceleration the ripening with Calcium carbide at 25°C for 5 days, was extracted the flavor with water at 2:1 w/w (banana:water) mix with blender for 1 min. The slurry was then squeezed and filtered through a double layer muslin cloth to acquire about banana extract and stored at -20°C until further processing.

A Buchi mini spray dryer (Model B-290, Buchi Laboratoriums-Technik, Flawil, Switzerland) was employed for the spraying process. Spray drying was carried out at the aspirator rate of 80%, feed flow rate of 10ml/min and inlet air temperatures of 120°C, 140°C and 160°C, respectively. Maltodextrin (20%, 30% and 40% w/v) was added according to the volume of banana extracts.

2.2 Analysis physicochemical properties of the banana flavoring agent powder

Drying yield: Banana flavoring agents drying yield was evaluated by the determination of the product recovery given by the percentage ratio between the total mass of product recovered by the mass of extract feed to the system (dry basis) (Fazaeli et al., 2012).

Color: The color characteristics of the banana flavoring agent powder were analyzed by using Hunter Color Lab (Miniscan EZ color reader) calibrated with black and white tiles. Obtained results were expressed as Hunter color values L*, b*, Chroma (C*) and Hue angles (h°).

Moisture content and water activity: The moisture content was determined based on AOAC method (AOAC, 2000). Triplicate samples of banana flavoring agent powder (1g) were weighed and dried in oven at 105±1 °C. The drying and weighing processes were repeated until a constant weight was obtained. Measurement of water activity was carried out a water activity meter (Novasina AG Switzerland) at 25 °C. Triplicate sample were analyzed and the mean was recorded.

Solubility: Solubility of the banana flavoring agent powder was determined according to the method used by (Gomez NHA, 1984) with some modifications. Each banana flavoring agent powder 1g was dispersed in 10 ml of distilled water at 25 °C in a 50 ml centrifuge tube, stirred intermittently for 30 min, and centrifuged at 6000×g for 30 min. The supernatant was carefully poured off into a Petri dish and oven-dried at 80 °C for 24 h. The solubility (%) of banana flavoring agent powder was calculated as the weight difference.

Volatile compound analysis using *dHS-SPME*: The composition of volatile compounds in the banana flavoring agent powders was analysed on a headspace solid-phase microextraction- gas chromatography-mass spectrometry (HS–SPME-GC–MS) system (789DA MS, Agilent Technologies, Santa Clara, CA).Each sample 3 ml of banana extract and 1.5 g of banana flavoring agent powder mixed with 3 ml of water distilled was placed into a 20 ml vial and heated at 40 °C for 5 min. Volatile compounds were absorbed onto an SPME fiber (50/30 lm DVB/Carboxen™/PDMS StableFlex™; Supelco, Bellefonte,PA) for 10 min. After equilibrium, the SPME fiber was desorbed into the injector port at 240 °C for 20 min, and the injector was operated in splitless mode. Helium was used as the carrier gas at a constant velocity of 1.5 ml/min. Volatile compounds were separated using a DB-Wax capillary column (30 m length × 0.25 mm i.d. × 0.5 µm thickness; J&W Scientific Inc., Folsom, CA). The oven temperature program was as follows: initial temperature of 50 °C and increased to 240 °C at 4 °C /min. Volatile compounds were detected using MSD (scan range of m/z 35–350) at 230 °C. The identification of compounds was based on the comparison of their retention time and mass spectrum with data in the Wiley 275 and NIST libraries at a quality match greater than 85%. A series of n-alkanes (C_6–C_{20}) was analysed by direct injection on the GC–MS to obtain retention index (RI) values. The RI data were compared with previously published literature values.

2.3 Application and sensory evaluation of the banana flavoring agent powder in milk

The banana flavoring agent powder using maltodextrin concentration of 30 % as carrier agent and inlet air temperature of 140ºC was applied to banana milk at various; 10, 15 and 20 (%w/v).The sensory evaluation by a panel of 15 semi-trained panelists for various quality attributes including color, appearance, sweet odor, banana odor, sweet taste, banana taste and overall acceptability on 9 point hedonic scale.

2.4 Statistical analysis

All the tests were performed in triplicate. Analysis of variance (ANOVA) and Duncan's multiple range test (DMRT) were performed using the SAS Program Version 9.0.

3. ANALYSIS

3.1 Physicochemical properties of the banana flavoring agent powders

3.1.1 Color values

The results of the color measurement for banana flavoring agent powders as shown in Table 1.It was found that when percentage of the maltodextrin and inlet air temperature increased, the +b* and Chroma values decrease for fourty percent of maltodextrin at 160 ◦C. This contributed to the changes in hue angle and chroma (Table 1). Overall, the lightness and the chroma of the banana flavoring agent powders increased. This implied that the color of the powders has become darker at higher inlet temperature. One of the explanation for this phenomenon was banana contains sugars which could contribute to browning of the powders at higher inlet temperature. Moreover, changes of hue angle and chroma might be due to the destruction of β-carotene at higher temperature (Quek et al., 2007).

Table 1 Color of the banana flavoring agent powders containing various percentage of maltodextrin 14 DE, in different inlet air temperature.

%MD	Tem (°C)	*L**	*b**	Chroma	Hue
20	120	80.82 ± 0.00^{h}	11.53 ± 0.01^{a}	11.58 ± 0.01^{a}	84.66 ± 0.01^{f}
	140	85.15 ± 0.01^{e}	10.51 ± 0.01^{b}	10.60 ± 0.01^{b}	82.21 ± 0.04^{g}
	160	82.57 ± 0.02^{g}	9.21 ± 0.01^{c}	9.22 ± 0.01^{c}	87.30 ± 0.01^{e}
30	120	85.99 ± 0.02^{d}	6.10 ± 0.01^{h}	6.36 ± 0.03^{f}	73.48 ± 0.08^{h}
	140	93.02 ± 0.01^{a}	6.23 ± 0.01^{g}	6.23 ± 0.01^{g}	87.23 ± 0.06^{e}
	160	84.51 ± 0.16^{f}	6.70 ± 0.01^{f}	6.70 ± 0.01^{e}	88.07 ± 0.02^{d}
40	120	86.05 ± 0.01^{d}	8.43 ± 0.01^{d}	8.43 ± 0.02^{d}	94.25 ± 0.02^{a}
	140	92.62 ± 0.01^{b}	6.94 ± 0.00^{e}	6.77 ± 0.15^{e}	93.97 ± 0.01^{b}
	160	90.50 ± 0.01^{c}	6.09 ± 0.01^{h}	6.09 ± 0.01^{h}	91.11 ± 0.04^{c}

Values are means ±SD of triplicate determination.
^{a,b,c,} …means within a column with different superscripts are significant difference (p≤0.05).

3.1.2 Drying yield

Drying yield is one of the main indices of spray-dryer performance. Fig.1 shows that % drying yield of the banana flavoring agent powders ranges from 15.68 to 25.18%. It was observed that % drying yield increased with increases percentage of maltodextrin and inlet air temperature. This increase in % drying yield is due to the reduction in stickiness and deposition of powder particles on the walls of drying chamber. Another possible reason may be the increase in the resultant glass transition temperature of the feed mixture of the carrier agent and banana extract, with the increase percentage of the carrier agent (Bhusari et al., 2014).

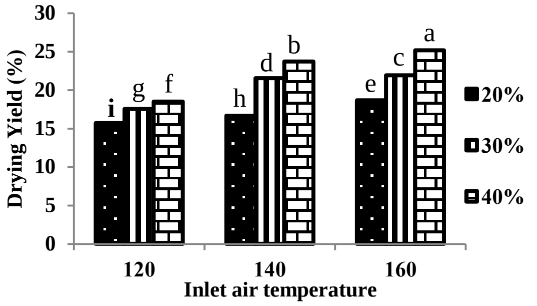

Fig. 1 - Drying yield of the banana flavoring agent powders containing various percentage of maltodextrin at different inlet air temperature.

3.1.2 Moisture content

The results showed the moisture content of the banana flavoring agent powders decreased with the increase in inlet air temperature (Fig. 2). This is because at higher inlet temperature, the rate of heat transfer to the particle is greater, providing greater driving force for moisture evaporation. Consequently, powders with reduced moisture content are formed. Moreover, moisture content of banana flavoring agent powders decreased when the carrier agent concentration increased from 20% to 30 or 40% (Fig. 2). These findings could be explained by the fact that additional concentrations of carrier agent resulted in an increase in feed solids and a reduction in total moisture for evaporation (Fazaeli et al., 2012).

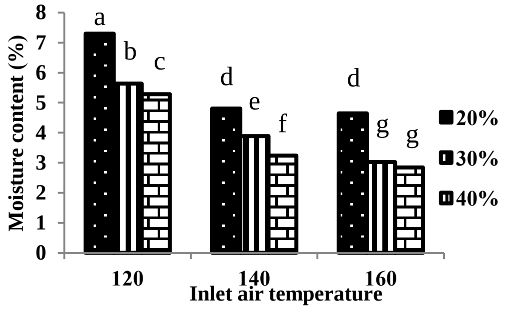

Fig. 2 – Moisture content of the banana flavoring agent powders containing various percentage of maltodextrin at different inlet air temperature.

3.1.3 Water activity (a_w)

Water activity measures the availability of free water in a food system that is responsible for biochemical reactions and is an important index to determine microbial stability of food. From the results (Fig.3), the water activities of the banana flavoring agent powders were in the range of 0.17-0.44. Generally, food with aw < 0.6 is considered as microbiologically stable and if there is any spoilage occur, it is induced by chemical reactions rather than by micro-organism (Quek et al., 2007).

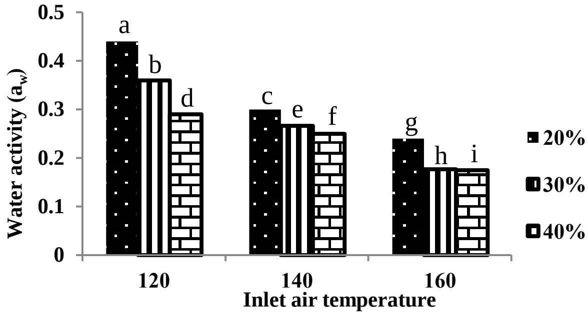

Fig. 3 - Water activity (a_w) of the banana flavoring agent powders containing various percentage of maltodextrin at different inlet air temperature.

3.1.4 Solubility

Solubility of the banana flavoring agent powder was ranged from 90.85% to 95.66%. Increasing the inlet air caused an increase the solubility of spray-dried banana flavoring agent powders (Fig. 4). Increasing the drying air temperature generally produces an increase particle size of powders. Large particles may sink, whereas small ones are dustier and generally float on water, making for uneven wetting and reconstitution (Walton, 2000). Moreover, increasing the carrier agent concentration causes an increase the powder solubility (Fig. 4). This may be attributed to the fact that maltodextrin has superior water solubility and is mainly used in process of spray drying due to its physical properties, such as high solubility in water. (Fazaeli et al., 2012).

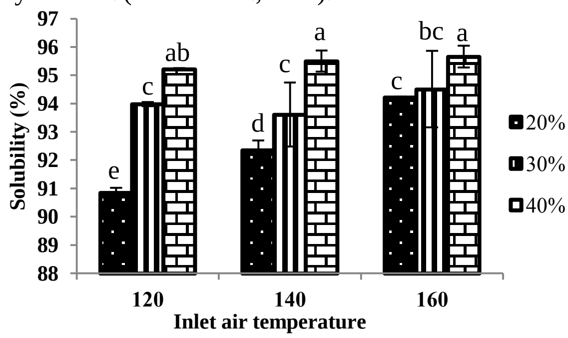

Fig. 4 - Solubility of the banana flavoring agent powders containing various percentage of maltodextrin at different inlet air temperature.

3.1.5 Volatile compounds of banana flavoring agent powder

Three esters (isoamyl acetate, isoamyl butyrate and isoamyl isovalerat) that have been reported to be responsible for the key banana odour (Cosio et al., 1996) were monitored in this work. Volatiles compounds of banana flavoring agent powders as shown in Table 2 were quantified by comparing the initial amount of specific volatile in the final dried products. It was found that volatile compounds of the banana flavoring agent powders using thirty percent of maltodextrin as carrier agent and inlet air temperature of 140ºC gave the highest retention of major volatile compounds; isoamyl acetate, 2-methylpropyl butyrate, butyl butyrate, isoamyl butyrate and 3-methylbutyl 3-methylbutyrate. The volatile compounds profiles of banana flavoring agent powders using 30% of maltodextrin at 140ºC were similar to that of banana extract.

Table 2 Peak areas of five major volatile compounds in banana extract and banana flavoring agent powder (BFAP) using 30% of maltodextrin concentration as carrier agent and air inlet temperature of 140ºC.

Volatile compounds	RI[a]	Peak area (×10^7)		Odour description[b]
		Banana extract	BFAP	
Isoamyl acetate	774	9.86	0.40	Ripe banana
2-Methylpropyl butyrate	973	8.55	1.76	Fruity
Butyl butyrate	998	6.28	2.29	Fruity, banana
Isoamyl butyrate	1037	41.86	13.36	Fruity, banana-like
Isoamyl isovalerate	1144	9.39	2.31	Fruity, banana peel

[a] RI (retention index) calculated with a DB-Wax stationary phase using a series of alkanes between C_6 and C_{20} as reference standards.

[b] Odour descriptions were cited from www.flavornet.org and recent reports.

3.2 sensory evaluation of the banana flavoring agent powder in milk

The banana flavoring agent powder using maltodextrin concentration of 30 % as carrier agent and inlet air temperature of 140ºC was applied to banana milk at various; 10, 15 and 20 (%w/v). The sensory evaluation results including sweet odor, banana odor, sweet taste, banana taste and overall acceptance showed that the milk with all concentration of banana flavoring agent powder were not significantly difference (p>0.05) (Fig. 5), except milk with 10% of banana flavoring agent powder had the highest of color and appearance.

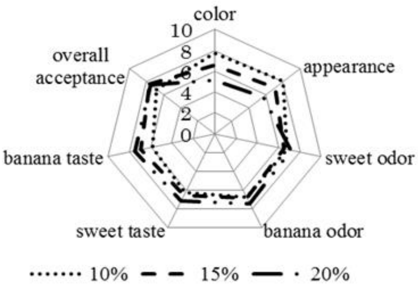

Fig. 5 - Sensory evaluation of banana milks added with banana flavoring agent powder using maltodextrin concentration of 30 % as carrier agent and air inlet temperature of 140ºC at various; 10, 15 and 20 (%w/v).

CONCLUSION

Thirty percent of maltodextrin at 140 ◦C gave the product with good physicochemical properties. Volatile compounds of the spray-dried banana flavor from this condition gave the highest retention of major volatile compounds; isoamyl acetate, 2-methylpropyl butyrate, butyl butyrate, isoamyl butyrate and 3-methylbutyl 3-methylbutyrate. Finally, banana flavoring agent powder using maltodextrin concentration of 30 % as carrier agent and inlet air temperature of 140ºC was applied to banana milk at various; 10, 15 and 20 (%w/v). The sensory evaluation results including sweet odor, banana odor, sweet taste, banana taste and overall acceptance showed that the milk with all concentration of banana flavoring agent powder were not significantly difference (p>0.05), except milk with 10% of banana flavoring agent powder had the highest of color and appearance.

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