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## Development of banana flavor carrageenan jelly drink fortified with banana peel extracts

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**Abstract** The results from sensory evaluation with acceptance showed that the suitable gelling agent was carrageenan at level of 0.4 percent by weight, but after pasteurized jelly drink at 73°C 15 min, The hedonic score decreased at the term of banana flavor because that is not enough banana flavor. Thereafter, the optimal amount of banana puree and artificial banana flavoring were varied by the amount of banana puree added with artificial banana flavoring (puree: flavor). Five formulations for banana flavor carrageenan jelly drinks (100:0, 50:0.01, 50:0.02, 25:0.01, and 25:0.02) were evaluated in sensory characteristics with 9-point hedonic scale. The results showed that the most suitable formula of product was banana puree 50 percent and adding with artificial banana flavor 0.02 percent. Banana flavor carrageenan jelly drink fortified with banana peel extracts was a hardness value of 0.59 Newton and the color L\* a\* and b\* was 2.86- 31.06 and 22.81 respectively. The appropriate banana peel extracts content for adding in product was 1 percent with no difference from formulas without the extracts. In addition, it was found that banana peel extract gave 2,2-Diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity (7.92 g sample/mol DPPH).

**Keywords:** Jelly drink, Banana peel extract, Banana, Gelling agent

### Introduction

Banana (*Musa acuminata* Colla AAA) or “Kluai Hom Thong” is one of the world’s most important fruit crops that is widely cultivated in tropical countries, especially Thailand. Banana can be easily cultivated. Therefore, many farmers choose cultivated at the same time, it may cause banana market face a price war as a result of an oversupply of banana that will lower prices in both domestic and export markets. Also, bananas have a relatively short shelf life that creates challenges for both producers and consumers.

Bananas are considered to be one of the most important sources of energy and a good source of several vitamins and minerals, especially

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potassium, vitamin B6, and vitamin C also has properties to prevent disease and treat various symptoms such as depression, diarrhea etc.

Several reports indicated that banana possess higher phenolic compounds and antioxidant properties (Sulaiman *et al.*, 2011). Therefore, bananas are considered fruits that should be eaten for health. Free radicals are continuously produced in our body either naturally or on exposure to environmental stress as well as other factors and can be implicated in many diseases like cancer, atherosclerosis, arthritis, Parkinson's disease, Alzheimer's disease, aging and other age related problems (Kumar *et al.*, 2012). Antioxidants are agents, which scavenge the free radicals and prevent the damage caused by them. In spite of these in-built defense mechanisms, it seems more meaningful to utilize extra antioxidants available in diets, especially from fruits, vegetables and whole grains (Silva *et al.*, 2005). Due to their minimal side effects, there are growing interests in using natural products for preventive and therapeutic medicine (Jo *et al.*, 2008). Banana peel, an underutilized source of phenolic compounds is considered as a good source of antioxidants for foods and functional foods against cancer and heart disease. The peel of the fruit contains various antioxidant compounds such as gallic acid and dopamine (Someya *et al.*, 2002).

The objective was to develop banana flavor carrageenan jelly drink fortified with banana peel extracts which the main by-product of the banana processing and to evaluate consumer acceptance, physical properties and antioxidant activity.

## Materials and Methods

Banana (*Musa acuminata* Colla AAA from Talad Thai, Pathumtani Province), Carrageenan GC 300 (supplied by Thai Food Chemical Co., Ltd, Thailand), Milk (CP-Meiji Co., Ltd.), Syrup (Mitr Phol Group), Salt (Thai Refined Salt Company) and 1,1-Diphenyl-2-picrylhydrazyl (DPPH) were used in the experiments.

Plant material preparation: Banana (*Musa acuminata* Colla AAA) at 6<sup>th</sup> stage of ripening level (Soltani *et al.*, 2011) were purchased from local Market Talad Thai Market, Thailand. The banana were peeled, sliced into small pieces, soaked in 2% w/v Citric Acid for 5 minutes and stored at -18 °C.

Banana peel extracts preparation: Banana peel were cut into small pieces, dried by using Tray dryer at 50 °C for 24 hours and crushed to make a coarse powder. The dried powder was extracted with water (Ratio 1:20) at 25 °C for 18 hours. The extracts obtained were evaporated to dryness by rotary evaporator, packed and stored at 4 °C.

Evaluation of the properties of banana jelly drink: This study concentrated specifically on the effect of ingredients had on the final properties of the banana drink. The parameters were evaluated in physical, chemical and sensory properties of the final banana jelly drink. The different formulations were studied on the Hedonic test to ensure that the banana drink met the consumers' expectations as shown in Table 1 and Table 2.

Study on the optimal level of carrageenan in jelly drink: After the evaluation properties of banana drink and find out the best formulation that consumer like the most. All ingredients )Banana, Milk, Sugar, gelling agent and Salt( were blended by blender until the mixture was homogeneous. Each ingredient was weighted for the specific formulation. With 100 g of banana puree, it was then added with 0.2%, 0.4%. 0.6% and 0.8% of carrageenan. Banana jelly drink were pasteurized at 73 °C for 15 second and stored in sterile containers at 4 °C. The banana jelly drink obtained under the optimum conditions was submitted to the following physico-chemical analyse and acceptance tests.

**Table 1.** Basic formulation of banana jelly drink

Ingredients	% by weight
Banana	51.15
Milk	17.90
Syrup	30.69
Salt	0.26
Total	100.00

The improvement of banana flavor in jelly drink: All ingredients of )banana, milk, syrup, gelling agent and salt ( were blended until homogenized. Each ingredient was weighted for the specific formulation. With 100 g of fruit puree, it was then added with banana puree and banana flavor depending on the formulation as shown in Table 2. Banana jelly drink were pasteurized at 73 °C for 15 second and stored in sterile containers at 4 °C. The banana jelly drink obtained under the optimum conditions was submitted to the following physico-chemical analyse and acceptance tests.

**Table 2.** Five formulations for banana flavor carrageenan jelly drinks

Formulations	Banana puree	Banana flavor
1	100%	0.00%
2	50%	0.01%
3	50%	0.02%
4	25%	0.01%
5	25%	0.02%

***Texture profile analysis (TPA) of banana jelly drink***

Textural analysis: Texture properties of samples were determined by the compression method with spherical stainless probe (P0.25S) by using TA-XT2i texture analyzer. All measurements were carried out at 25 °C and performed in three replicates.

***Color measurement of banana jelly drink***

Lightness (L\*), redness (a\*) value and yellowness (b\*) value of the banana jelly drink were measured using colorimeter (Hunter Lab model Colorflex45/0, USA).

***Sensory evaluation of banana jelly drink***

Sensory evaluation: Products characteristics in term of appearance, color, banana flavor, taste, texture and overall liking were evaluated by 50 untrained panelists with 9-point hedonic scale (1 =dislike extremely, 5 = neither dislike nor like, and 9 = like extremely). The optimum intensity of banana flavor was evaluated by using 5-point category scale with Just about right test (1 =Too little, 3 = Just about right, and 5 = Too much).

***Determination of antioxidant capacity of banana peel extract***

The antioxidant capacity of extracts was analyzed by using the stable DPPH method (Blois, 1958). The extracts sample solution in 50% ethanol (v/v) was mixed with 4 ml of 0.2 mM DPPH in ethanol. The mixture was incubated for 30 min in the dark at room temperature before absorbance detecting by UV–vis Spectrophotometer at 517 nm. The result was reported as EC50 value (g sample/mol DPPH).

## Results

### *The optimal level of carrageenan in jelly drink*

The result from physical properties (hardness and color value) and sensory characteristics of the banana jelly drink with different level of carrageenan are shown in Table 3 and Table 4 respectively. The hardness value of banana jelly drink with different level of carrageenan showed that there are a significantly differences in hardness value when varying the amount of carrageenan ( $p \leq 0.05$ ). The amount of carrageenan increased the hardness value.

The color measurement of banana jelly drink was measured. Lightness ( $L^*$ ), redness ( $a^*$ ) and yellowness ( $b^*$ ) of banana jelly drink were significantly affected by the amount of carrageenan ( $p \leq 0.05$ ). According to Table 3, high values of redness were observed at the low levels of carrageenan. The increased in carrageenan from 0.2% to 0.8% decreased the values of lightness and yellowness.

**Table 3.** Hardness and color values of banana flavor carrageenan jelly drink when varying the amount of carrageenan

Carrageenan (%w/w)	Hardness (N)	$L^*$	$a^*$	$b^*$
0.2	0.19 <sup>d</sup> ± 0.02	54.53 <sup>a</sup> ± 0.02	-0.33 <sup>b</sup> ± 0.01	28.38 <sup>a</sup> ± 0.10
0.4	0.67 <sup>c</sup> ± 0.07	51.54 <sup>b</sup> ± 0.01	0.09 <sup>a</sup> ± 0.02	26.60 <sup>b</sup> ± 0.01
0.6	0.87 <sup>b</sup> ± 0.11	50.38 <sup>c</sup> ± 0.10	-0.52 <sup>c</sup> ± 0.02	26.36 <sup>c</sup> ± 0.05
0.8	1.38 <sup>a</sup> ± 0.09	49.31 <sup>d</sup> ± 0.01	-1.23 <sup>d</sup> ± 0.05	25.99 <sup>d</sup> ± 0.08

<sup>a,b,c,d</sup> Mean values followed by the different letter within a same column are significantly different ( $p \leq 0.05$ ).

From sensory evaluation with 9-point hedonic score (Table 4) revealed that increased in carrageenan level had more hedonic score in term of taste, texture and overall liking attributes. The hedonic score of banana jelly drink from 0.4%, 0.6% and 0.8% carrageenan showed no significant differences in banana flavor, taste, texture, and overall liking ( $p > 0.05$ ). From Figure 1. The result of optimum intensity of banana flavour from 5-point scale (1 = Too little, 3 = Just about right, and 5 = Too much) showed that carrageenan amount increase at had increase in just about right score. The banana jelly drink added with 0.4% Of carrageenan had the highest in percentage of intensity response in

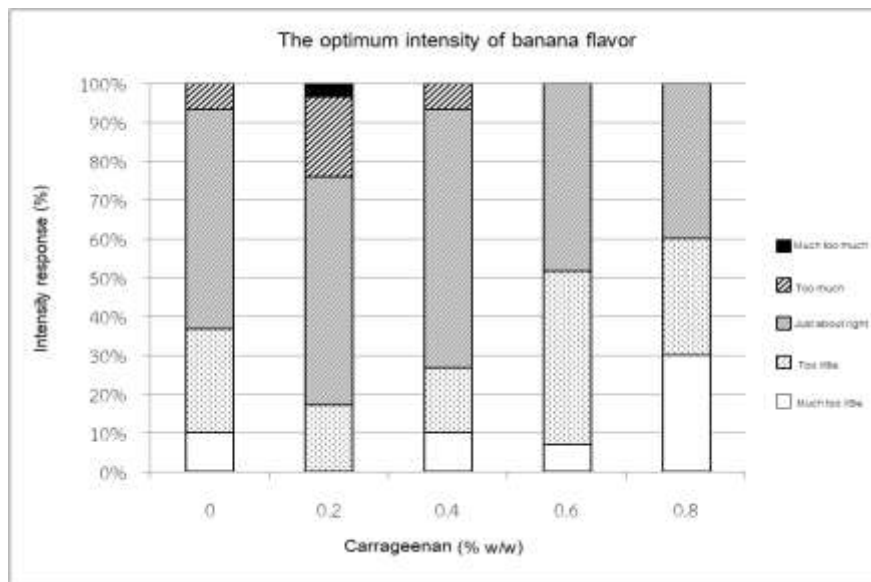
term of just about right score from banana flavour attribute. Therefore, the formulation added 0.4% of carrageenan was chosen for further study.

**Table 4.** Sensory characteristics of banana flavor carrageenan jelly drink when varying the amount of carrageenan

Carrageenan an (%w/w)	Mean $\pm$ standard deviation					
	Appearanc e	Color	Banana Flavor <sup>ns</sup>	Taste	Texture	Overall liking
0	5.9 <sup>a</sup> $\pm$ 2.0	6.4 <sup>a</sup> $\pm$ 1.7	5.8 $\pm$ 1.9	5.5 <sup>bc</sup> $\pm$ 1.9	4.5 <sup>b</sup> $\pm$ 1.9	5.1 <sup>b</sup> $\pm$ 1.8
0.2	3.8 <sup>c</sup> $\pm$ 1.6	4.7 <sup>c</sup> $\pm$ 1.6	6.1 $\pm$ 1.6	5.8 <sup>ab</sup> $\pm$ 1.6	5.2 <sup>b</sup> $\pm$ 1.9	5.2 <sup>b</sup> $\pm$ 1.7
0.4	4.6 <sup>b</sup> $\pm$ 2.1	5.5 <sup>b</sup> $\pm$ 1.8	6.0 $\pm$ 1.9	6.0 <sup>ab</sup> $\pm$ 1.5	6.1 <sup>a</sup> $\pm$ 1.9	5.8 <sup>ab</sup> $\pm$ 1.7
0.6	5.9 <sup>a</sup> $\pm$ 1.4	6.1 <sup>a</sup> $\pm$ 1.2	5.6 $\pm$ 1.9	6.6 <sup>a</sup> $\pm$ 1.6	6.4 <sup>a</sup> $\pm$ 1.7	6.3 <sup>a</sup> $\pm$ 1.6
0.8	5.9 <sup>a</sup> $\pm$ 1.4	6.0 <sup>ab</sup> $\pm$ 1.2	5.3 $\pm$ 2.1	6.2 <sup>ab</sup> $\pm$ 1.5	6.1 <sup>a</sup> $\pm$ 1.8	6.3 <sup>a</sup> $\pm$ 1.6

<sup>a,b,c</sup> Mean values followed by the different letter within a same column are significantly different ( $p \leq 0.05$ ).

<sup>ns</sup> Not significantly different ( $p > 0.05$ ).



**Figure 1.** The optimum intensity of banana flavor was evaluated with -5point category scale

***The improvement of color and banana flavour in jelly drink***

As a result from Table 5, the untrained panelists liked formula with banana flavor significantly different than control (100% banana puree with 0% banana flavor) ( $p \leq 0.05$ ). From sensory evaluation, the formulation with 50% banana puree and 0.02% artificial flavor was no significantly different in hedonic score when compared with the formulation with 25% banana puree and 0.01% artificial flavor ( $p > 0.05$ ).

**Table 5.** Sensory characteristics of banana flavor carrageenan jelly drink when adjusting the amount of banana puree and artificial banana flavor

Formulations (puree: flavor)	Mean $\pm$ standard deviation				
	Color	Banana Flavor <sup>ns</sup>	Taste <sup>ns</sup>	Texture	Overall liking
1 (100:0)	4.7 <sup>c</sup> $\pm$ 1.4	6.2 $\pm$ 1.5	6.0 $\pm$ 1.4	6.3 <sup>b</sup> $\pm$ 1.3	5.9 <sup>b</sup> $\pm$ 1.3
2 (50:0.01)	6.6 <sup>b</sup> $\pm$ 1.1	6.2 $\pm$ 1.2	6.1 $\pm$ 1.1	6.6 <sup>ab</sup> $\pm$ 1.0	6.2 <sup>ab</sup> $\pm$ 1.0
3 (50:0.02)	6.8 <sup>ab</sup> $\pm$ 1.0	6.3 $\pm$ 1.5	6.3 $\pm$ 1.4	6.9 <sup>a</sup> $\pm$ 0.9	6.6 <sup>a</sup> $\pm$ 1.2
4 (25:0.01)	7.3 <sup>a</sup> $\pm$ 1.3	6.5 $\pm$ 1.3	6.4 $\pm$ 1.3	6.9 <sup>a</sup> $\pm$ 1.2	6.7 <sup>a</sup> $\pm$ 1.2
5 (25:0.02)	7.2 <sup>a</sup> $\pm$ 1.0	6.4 $\pm$ 1.2	5.9 $\pm$ 1.2	6.7 <sup>ab</sup> $\pm$ 1.3	6.5 <sup>ab</sup> $\pm$ 1.2

<sup>a,b,c</sup> Mean values followed by the different letter within a same column are significantly different ( $p \leq 0.05$ ).

<sup>ns</sup> Not significantly different ( $p > 0.05$ ).

***Antioxidant activity of banana peel extracts and extracts application***

EC<sub>50</sub> of banana peel extracts was 7.92g sample /mol DPPH. Banana jelly drink with extracts was different from sample without extracts in term of color, flavor and taste. Adding 1% extracts in product was the optimal level. Banana flavor carrageenan jelly drink fortified with banana peel extracts had hardness about 0.59Newton and color L \* a \* b \* was 2.86- 31.06and 22.81 respectively. The color of final product (banana jelly drink) was shown in Figure 2.



**Figure 2.** The final product of jelly drink

## Discussion

Carrageenan used as the gelling agent or texture enhancers in various food such as frozen desserts, chocolate, cottage chesse, whipped cream, instant breakfasts, yoghurt, jellies, pet foods, relishes, sauces and syrups (Černíková *et al.*, 2010). The amount of carrageenan resulted to increase the hardness value as similar result of Totosaus *et al.* (2005) who reported about the competition between sucrose and gums for the available water and the reduction of water molecules accessing to molecular chains of the gums might be the reason for this case that increasing the hardness value of gel. It is observed that the increased in carrageenan from 0.2% to 0.8% that decreased the values of lightness and yellowness. The thermally processed food may occur the non enzymatic browning reaction which called maillard reaction that resulted loss of color and aromatic compounds (Ratnasari *et al.*, 2018). The banana flavor attributes was influenced by most frequency distribution that presented at 3 scores. The banana jelly drink with 0.4% carrageenan was clearly rated for the most frequency of score 3, indicating an optimum in banana flavor.

Many research on banana (*Musa acuminata*) peel extract found that banana peel is potential source of bioactive compounds like flavonoids and polyphenols with wide range of medicinal properties in particular the high free radical scavenging activity (González-Montelongo *et al.*, 2010; Singh and Prakash, 2015; Aboul-Enein *et al.*, 2016) as similar result with banana flavor carrageenan jelly drink fortified with banana peel extracts found that banana peel extract gave 2,2-Diphenyl-1-1 picrylhydrazyl (DPPH) radical scavenging activity (7.92 g sample/mol DPPH).



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