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Effect of Lotus Petal (*Nymphaea Lotus*) and Pollen (*Nelumbo nucifera*) on Chemical and Physical Properties of Gummy Jelly Lotus Flavor

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Abstract-The research was aimed to determine the appropriate amount of lotus petals and lotus pollen on the physical and chemical properties of gummy jelly lotus flavor. The research was found that the appropriate amounts of lotus petal adding into jelly product was 25%. The sensory scores including color, flavor, sweet, texture and overall acceptance were 4.20 3.20 3.60 4.05 and 4.15, respectively. The colors value (L*, a*, and b*) were 26.12 3.72 and 7.62, respectively. The moisture content and water activity equal to 36.87 and 0.93, respectively. The hardness value of gummy jelly was 2.56 kgf. For the part of effects of lotus pollen on the quality of jelly, It was found that the appropriate amount of lotus pollen was 3% of dry ingredients. The amount of lotus pollen did not affect the texture of gummy jelly. The color values (L*, a*, and b*) were 27.44 4.00 and 5.70, respectively. The moisture content and water activity were 55.29 and 0.89, respectively. The total phenolic content in the final product was 59.74 (mg GAE/g). Moreovcer, a sample of gummy jelly was composed of camphor menthol and γ-terpinene flavor which was expressed the good characteristic of jelly product.

Keywords: Lotus, gummy, antioxidant activity, flavor

1. Introduction

Lotus is a useful flower in Thailand, having taken advantage of lotuses in the past. Most of them are used as the components in medicine. The lotus flower has a mild and cool aroma. It has a comfortable sleep effect (Ketsara *et al.*, 2012). It smells like hyacinth, with a little banana aroma, which has the properties to calm the mind. The cool aroma of the lotus flower also helps to nourish the heart, and it can relieve the heat from fever, as the late lotus is known as a cool ingress that helps to quench the thirst and cool off. There are many different colors such as pink, white, red. The flowers have a chemical composition consisting of 1,2,3,4,6-pentagalloylglucose, myricetin-3-O-rhamnoside (myricitrin), myricetin-30-O-(600-p-coumaroyl) glucoside, nympholide A, nympholide B (Kesara *et al.*, 2012). Lotus pollen from the lotus flower were picked at blooming. Separate the pollen and dry them. Dry pollen has a yellow color fine aroma and astringent. Dry pollen composed of flavonoids and alkaloids (Ketsara *et al.*, 2012). Moreover, lotus scent is commonly added to many foods, beverages as well as confectionery products.

Jelly refers to a product made from juice or concentrated juices such as pineapple, roselle, strawberry, lemon, orange, mango are combined with sweeteners and gelling agent such as gelatin, carrageenan, glucomannan, may mix color and flavor. The finished jelly products sold on the market can be divided into 2 types: 1) Dessert jelly is a jelly with a soft texture with a lot of water. Use a spoon or a straw to eat chilled as a dessert as a snack or after a meal. Contains gelling agent such as carrageenan gelatin or konjac sugar citric acid colorant and flavoring agent. The product has a good taste, sweet and sour taste, jelly must be clear and soft textured but not sticky. The samples were found in the market may be the finished jelly powder that consumers mix with hot water in proportion, and gel was made by chilled. 2) Dried jelly, also known as gummy jelly, means confectionery products derived from gelling agents such as gelatin, carrageenan or agar, mixed with sweetener such as sugar glucose syrup and other ingredients (fruit, vegetables, and herbs). Flavoring agent andtogether with organic acid (citric acid) were added consequently, then mix the ingredients until homogeneous. After that the thermal process was applied until the sticky property was observed at the room temperature. Generally, the gummy jelly product is dry, sticky, and it can be mixed with the other ingredients such as sugar or starch (Rattanapnon & Pornchalermpong, 2016).

Nowadays, people's lifestyles are busy resulting in a decrease in self-care, as well as food consumption. Most are focused on the convenience and rapid lifestyle. Not only most modern foods usually consist of a large amount of flour, sugar and sodium, but also the children's food group. Today's children consume sweets that contain large amounts of sugar, resulting in obesity state development and tooth decay effects. When obesity developed, it can lead to increase the risk factors of several diseases for example, type 1 and 2 of diabetes, cardiovascular disease or arteriosclerotic effects on the human body. Intake a healthy diet is a one way to reduce those of diseases. Therefore, this study would like to determine the effect of lotus petals and lotus pollen supplementation into gummy jelly products to increase nutritional value

along with identifying the jelly quality in term of physical and chemical properties, contributing to the functional jelly development for childrentchildren.

2. Materials and Methods

Lotus sample from The Lotus Museum, Rajamangala University of Technology Thanyaburi was collected (in the morning), soaked in the water, removed the petals by hand. Then the obtained sample was washed 3 times with water to make sure the completed defect elimination. The dried lotus pollen was purchased from Chinese pharmacies at Rangsit Market, Pathum Thani Province. The chemical reagents were used as food grade and analytical grade for their properties charaterizationscharacterizations.

2.1 The appropriate amount of lotus petals.

The three levels of lotus petals were variations: 15, 25 and 35%, respectively. Prepare the ingredients of gummy jelly production. All of ingredients (200 ml water, 50 g sugar, 0.5 g sucralose, 4 g citric acid, 40 g gelatin) were mixed until gentle. Bring water to the pot. Pour the mixture into the mixture until it dissolves and boiled. Measures the total soluble solid to 70o Brix by hand refractometer then added the lotus petals until itsboiled again, pouring into the mold, refrigerated for 4 hours. All samples were analyzed for chemical, physical and sensory quality as follows: L*a* and b*values were measured using colorimeter (Minolta co., Ltd, Osaka, Japan) water activity using Aqualab water activity meter (model series 3, Decagon Device Inc., Pullman, USA.). Analyze the texture with texture analyzer (TA-XT2 Plus, Stable microsystems Co., Ltd., Surrey, UK) using texture profile analysis (TPA) with cylindrical probe (P/3) sensory test using 5-points hedonic scale were used 50 consumers.

2.2 The appropriate amount of lotus pollen.

The optimal amount of lotus petals selected from the 2.1 was 25 %, adding to the formula when all the ingredients dissolved well. The obtained sample was completely boived and then measured the total soluble solid to reacatat 70^{o} Brthenafddedthat added the lotus pollen at differt 3 level (1, 3 and 5%) with the late lotus petals until its boils. All saplessere analyzed for chemical and physical quality, as well 2.1optimal amount of lotus petals supplementaton., The antioxiants activitysere performed by used DPPH method in accordeing to Dangie(2016) guideline. Alo, Ttotal phenolic compound was determined by followed to method of Dangnoi (2016). In addition, Analysis of flavoring substances was investigated by using the GCdof(Adam, R.P. 2001).

2.3 Statistical Analysis

The experimental data was subjected to analysis of variance and mean comparison by Duncan's multiple range tests, in order to determine any significance of the differences in the data.

3. Results and Discussion

3.1 The Optimal Amount of Lotus Petals.

The effect of the amount of lotus petals on the sensory scores. It was found that the amounts of lotus petal was significant ($p < 0.05$) effect all attributes (color, lotus flavor, sweet, texture and overall acceptability) color acceptance of consumers. Participants rated the maximum 25% and 35 % of the petals in all of attributes. This is because the lotus petals filled in are dark red color. When added into large quantities, the color of the product becomes darker, thus decreasing the color preference scores when the amounts of lotus petals are added. In terms of flavor and sweet, the consumers accepted at 25% and 35% of the amount of lotus petals. On the texture, the consumers like 25% of the petal. This is because the petal contains flavonoids, which are classified as substances in the polyphenols (Darinee, 2016), which affect the hardness of product. Overall acceptability showed that the consumers accepted 25 % of the petals, as shown in (Table 1).

Table 1. Sensory attribute scores of gummies at various lotus petal amount

	Hedonic scores		
Attribute	**Lotus petal 25%**	**Lotus petal 35%**	**Lotus petal 45%**
Color	$4.20^{a} \pm 0.83$	$3.65^{a} \pm 0.81$	$3.15^{b} \pm 1.26$
Lotus flavor	$3.20^{a} \pm 1.00$	$3.15^{a} \pm 0.98$	$2.35^{b} \pm 0.98$
Sweet	$3.60^{a} \pm 1.04$	$3.50^{a} \pm 0.68$	$2.55^{b} \pm 1.23$
Texture	$4.05^{a} \pm 0.88$	$3.35^{b} \pm 0.93$	$2.70^{c} \pm 1.08$
Overall acceptance	$4.15^{a} \pm 0.93$	$3.40^{b} \pm 0.82$	$2.75^{c} \pm 0.96$

The volume of the lotus petals has a statistically significant effect on the chemical, physical quality. The physico-chemical properties of gummy products, varying at different levels of the lotus petals, the brightness (L) of the samples showed the highest score of Color Lotus flavor Sweet Texture and Overall acceptance at 25 and 35 % petals. In terms of redness (a*), it was found that as the lotus petals increased, the redness increased. On the yellowness (b*), it was found that when the lotus petal increased, the yellowness value decreased. The moisture content was significantly increased with higher amounts of lotus petals adding into the jelly product. The water activity (aw) value showed that the amount of lotus petals did not affect the amount of water activity (aw) in the sample, as shown in (Table 2).

Table 2. Physico-chemical of gummies at various lotus petal amount

Properties	Lotus petal 25%	Lotus petal 35%	Lotus petal 45%
L	$26.12^{a} \pm 0.33$	$25.76^{a} \pm 0.49$	$24.18^{b} \pm 0.18$
a^{*}	$3.72^{b} \pm 0.48$	$4.4^{b} \pm 0.85$	$6.38^{a} \pm 0.24$
b^{*}	$7.62^{a} \pm 0.26$	$7.30^{a} \pm 0.67$	$6.06^{b} \pm 0.15$
Moisture content (%)	$36.87^{b} \pm 0.47$	$37.88^{a} \pm 0.02$	$38.62^{a} \pm 0.03$
$a_w a_w$ns	0.93 ± 0.04	0.97 ± 0.01	0.95 ± 0.01

* ns is mean the all of sample not significant
* a,b and c is mean the sample significant at $p < 0.05$

On the texture quality, it was found that the amount of lotus petals affected hardness of samples. The increase in the amount of lotus petals had resulted in increasing the hardness properties of the gummy jelly sample. Previous studied found that the lotus petals supplement can build-up the cross-link formation of a protein structure to tighter and harder structure (Staroszczyk *et al.*, 2020). On the other side, it was found that the volume of the lotus petals did not affect the cohesiveness, springiness, gumminess, chewiness and adhesiveness, respectively. This is due to the high acidity of gummy. It results in low viscosity and strength of the gel. The effect of reducing the inversion of sugar causes the hydrolysis process of gelatin, which will result in a decrease in gelatin strength (Lichanporn *et al.*, 2015), as shown in (Table 3).

Table 3. Texture properties of gummies at various lotus petal amount

Texture properties	Lotus petal 25%	Lotus petal 35%	Lotus petal 45%
Hardness (kgf)	$2.56^{b} \pm 0.42$	$3.21^{a} \pm 0.14$	$3.47^{a} \pm 0.24$
Cohesiveness^{ns}	0.63 ± 0.07	0.57 ± 0.15	0.62 ± 0.07
Springiness^{ns} (mm)	10.57 ± 0.25	10.86 ± 0.30	10.81 ± 0.16
Gumminess^{ns} (kgf)	1.61 ± 0.36	2.14 ± 0.34	2.15 ± 0.35
Chewiness^{ns} (kgf.mm)	17.08 ± 4.04	23.33 ± 4.30	23.32 ± 4.10
Adhesive Force^{ns} (kgf)	0.01 ± 0.01	0.02 ± 0.02	0.04 ± 0.04

* ns is mean the all of samples were not significant different ($p > 0.05$)

3.2 The Appropriate Amount of Lotus Pollen.

According to the study, the appropriate amount of lotus pollen was varying the amount of lotus pollen are 1, 3 and 5% by weight respectively. It was found that the amount of pollen affects the brightness value redness yellowness and moisture content. The research finding

that when the lotus pollen was added, the solution was reduced in brightness due to the yellow color derived from the lotus pollen (Wongklang,2015). The redness and yellowness increase as the lotus pollen increases. This was due to the effected of color from lotus pollen (Wongklang, 2015). The moisture content decreases as the amount of pollen increases. While the lotus pollen does not affect the free water content (Table 4).

Table 4. Physico-chemical properties of gummies at varies lotus pollen amount

Quality	Lotus pollen 1%	Lotus pollen 3%	Lotus pollen 5%
L	$29.74^{a} \pm 0.30$	$27.44^{b} \pm 0.39$	$26.66^{c} \pm 0.30$
a^{*}	$3.26^{b} \pm 0.55$	$4.00^{a} \pm 0.16$	$4.20^{a} \pm 0.24$
b^{*}	$5.708.66^{a} \pm 0.22$	$5.70^{c} \pm 0.54$	$8.667.80^{b8} \pm 0.47$
Moisture content (%)	$56.23^{a} \pm 0.15$	$55.29^{b} \pm 0.09$	$53.37^{c} \pm 0.28$
$a_w a_w$ns	0.89 ± 0.00	0.89 ± 0.01	0.89 ± 0.01

* ns is mean the all of samples were not significant different ($p > 0.05$)

In terms of texture, it was found that the amount of lotus pollen did not affect the texture of gummy, because the factor affecting the strength of the gel was the temperature. At the high temperature gelatin melted and harder when it cools down. The gel properties of gelatin depend on concentration (Edwards, 2000). The hardness values of the jelly product ranged from 2.17-2.29 kgf, followed with cohesiveness ranged from 0.52-0.54, springiness ranged from 10.04-10.78 mm, gumminess (1.13-1.23 kgf), chewiness (11.51-13.25 kgf.mm) and adhesive force ranged from 0.00-0.03 kgf (Table 5)

Table 5. Texture properties of gummies at various lotus pollen amount

Texture properties	Lotus pollen 1%	Lotus pollen 3%	Lotus pollen 5%
Hardness^{ns} (kgf)	2.29 ± 0.53	2.17 ± 0.30	2.17 ± 0.13
Cohesiveness^{ns}	0.54 ± 0.04	0.53 ± 0.05	0.52 ± 0.03
Springiness^{ns} (mm)	10.74 ± 0.30	10.04 ± 0.82	10.78 ± 0.15
Gumminess^{ns} (kgf)	1.23 ± 0.28	1.14 ± 0.13	1.13 ± 0.07
Chewiness^{ns} (kgf.mm)	13.25 ± 3.11	11.51 ± 2.26	12.10 ± 0.62
Adhesive Force^{ns} (kgf)	0.03 ± 0.02	0.00 ± 0.00	0.00 ± 0.00

* ns is mean the all of samples were not significant different ($p > 0.05$)

Analysis of antioxidant properties has shown that increasing the amount of lotus pollen it increases the effectiveness of antioxidants activity. This is because in lotus pollen had phenolic compounds. These results are consistence with theory. The antioxidants activity were found to be in the range of 11.09-15.24 mg/g, which

contradicted the research of Buachoon (2019) reported that the antioxidant activity of lotus pollen extract was 22.98 mg/ml. Phenolic content is in the range of 57.43-62.41 mg GAE/g, close to the previous research of Buachoon (2019) which was reported the phenolic compounds in lotus pollen as 89.34 mg GAE/g. (Table 6).

Table 6. Antioxidant activity and total phenolic content of gummies at varies lotus pollen amount

Quality	Lotus pollen 1%	Lotus pollen 3%	Lotus pollen 5%
Antioxidant activity (mg/g)	$15.24^{a} \pm 0.13$	$13.25^{b} \pm 0.36$	$11.09^{c} \pm 0.46$
Totaltotal phenolic content (mg GAE/g)	$57.43^{c} \pm 0.58$	$59.74^{b} \pm 0.32$	$62.41^{a} \pm 0.92$

The component of the aroma compound in the product was conducted by GC-MS. It was found that in lotus pollen composed of δ-1,8-iridadiene, camphor, 1,4-dimethoxy benzene, menthol, γ-terpinene and isoterpinene. When analysis of sample found that only three aroma compounds in the sample were observed (including camphor, menthol and γ-terpinene). This was affected from heat treatment in process thus resulting in a decrease in the amount of aroma in the sample. (Rattanapanon, 2015) (Table 7)

Table 7. Aroma compound composition of gummies at varies lotus pollen amount

Aroma compound	Peak area (%)			
	Lotus pollen extracts	Gummies with Lotus pollen 1%	Gummies with Lotus pollen 3%	Gummies with Lotus pollen 5%
δ-1,8-iridadiene	3.86	-	-	-
camhor	0.74	0.64	1.14	-
1,4-dimethoxy benzene	1.11	-	-	-
menthol	2.93	1.41	2.67	0.49
γ-terpinene	9.76	4.36	1.41	52.78
isoterpinene	10.62	-	-	-

4. Conclusion

The optimal formular of gummy was 25% of petal and 3% lotus pollen with an antioxidant activity and a total phenolic content of 13.25 mg/g and 59.74 mg GAE/g, respectively.

5. Acknowledgement

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