

# EFFECT OF GELATION ADDITION ON PHYSICO-CHEMICAL CHARACTERISTICS OF BASTARD OLEASTER GUMMY JELLY

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## Abstract:

Gummy jelly, a gelling-based confectionary product, was prepared by the combination of sugar, gelling agent, and other components. The objective of this present studies was to investigate the effect of different levels of gelation on physico-chemical characteristics of fruit gummy jelly product prepared from Bastard oleaster fruits. Bastard oleaster juice was mixed with water, sugar, citric acid, and the varied concentration of gelatin (at 8%, 9%, and 10% by weight of totally ingredients), then formed in molds and placed at 25°C for 2-4 hours until it dried. The physico-chemical characteristics of gummy jelly products were analyzed. It was found that pH value, total soluble solid, total acidity, and springiness of gummy jelly products showed statistically significant increase as the increasing of gelatin addition ( $p \leq 0.05$ ), in the following ranges, 3.51-3.66, 66.4-69.8°Brix, 1.19-1.65% ,8.41-9.19 N, respectively. In contrast, the moisture content decreased from 7.35% to 6.33% with the loss of vitamin C content, 6.88-4.79 mg ascorbic acid/100 g gummy product ( $p \leq 0.05$ ). There were no significant differences in hardness, cohesiveness, gumminess, and chewiness, except of springiness among three gelatin concentrations of gummy jelly samples. The results revealed that gelatin addition was effective in improving the physico-chemical texture characteristics of gummy jelly products.

**Keywords:** Bastard oleaster fruit; Fruit gummy jelly; Physico-chemical characteristic

## Introduction

Bastard oleaster (*Elaeagnus latifolia* L.) is one of an endemic fruit plant cultivated in the upper-north and north-eastern part of Thailand. The fruits are attractive in varied size from small to large with a fresh color, while the mature fruits had dark red, red, orange-red and yellow colors with sourness and sweetness taste (Yingthongchai & Sirikhum, 2008). It is also reported to be a source of vitamins, minerals, essential fatty acids and other phytochemical compounds, especially phenolic acids and flavonoids (Panja *et al.*, 2014; Patel, 2015). Seal (2012) found the high mineral quantities containing in its fruit such as potassium of 13580 mg/kg and calcium of 5860 mg/kg, and sodium of 965 mg/kg. Fruits also exhibited the high content of vitamin A, C, and total phenolic acid at 621.37-626.17 mg/100 g, 2.37-17.26 mg/100 g, and 2.32-3.81 mg/g, (Yingthongchai & Sirikhum, 2008). The bastard oleaster fruits can be consumed in the form of food and drink products, such as jam, leather, salsa, wine, and cookies (Patel, 2015). The shorter shelf life and perishable nature of fruits causes obstacle on its optimum utilization. Hence, the suitable preservation processes can be effective way for maintaining its taste and other nutrients.

Gummy jelly, a gelled confectionary product, is obtained from the mixing process of concentrated sugar solution, gelling agent, and other ingredients such as acids, coloring and flavouring agents. The melted mixture is shaped into the molds of different types, shapes, and sizes. The drying step aims to reduce a moisture content of product and increase its solid content (Delgado & Banon, 2015). Generally, the drying period range from 24 hrs more. This product can be prepared by the traditional processes or using a modern confectionary machine. Gummy jelly products are characterized by a texture in terms of hardness and chewiness incorporated by sugar, gelatin, or starch based gels (Burey *et al.*, 2009; Marfil *et al.*, 2012; Meesang *et al.*, 2003; Delgado & Banon, 2015). The majority of confectionary gel formation contains sucrose, glucose syrup, gelatin, starch, water, including food acids (Burey *et al.*, 2009). According to Meesang *et al.* (2003), it has been reported that the viscosity and texture models of gummy jelly depended on the gelatin content, sucrose/glucose syrup ratio, and citric acid content resulted in the acceptability score. Jiamjariyatam (2018) found that the interaction of gelatin (9, 12, and 15%) and isomaltulose (20, 30, 40, 50, and 100%) concentration affected  $a_w$ , pH value, including sensory texture quality of gummy jelly. Regarding the gummy jelly development, gelatin is a simple component added for its gel formative structure. Gelatin can form junction zones by its helix structure and develop the gelling network. Several publications reported that the amount of gelatin affected the texture characteristics of gummy jelly products. The hardness, cohesiveness, gumminess, and chewiness of gummy jelly products increased with the increasing of gelatin content (Thanomwong, 2008; Tiampakdee, 2006; Meesang *et al.*, 2003).

This objective was to study the effect of gelatin addition in gummy jelly products produced from Bastard oleaster pulp. The physico-chemical criteria qualities of gummy jelly, especially texture profile were investigated among each treatment.

## Materials and Methods

### *Bastard oleaster fruits*

The fresh Bastard oleaster (*Elaeagnus latifolia* L.) fruits was collected during November, 2018 from Nong Khai province, Thailand. It was washed, kept in a vacuum bag, and frozen at  $-18^{\circ}\text{C}$  to  $-20^{\circ}\text{C}$  in a freezer until using. Then, Bastard oleaster fruits were thawed and depulped to achieve the clear juice. The physico-chemical characteristics of Bastard oleaster juice such as pH value, total soluble solid content, total acidity, and total ascorbic acid content were analyzed.

### *The Bastard oleaster fruit gummy jelly preparation*

The preparation of Bastard oleaster fruit gummy jelly was conducted following as: Bastard oleaster juice (50 g) was mixed with water (40 mL), sugar (36 g), glucose syrup (50 mL), and gelatin 250 bloom with the different concentration (at 8%, 9%, and 10% by weight of totally composition) at  $70\text{-}80^{\circ}\text{C}$ . The gelatin solution was prepared by dissolving in warm water at the ratio of gelatin and water of 1:1 (w/w). The mixture was heated until  $65^{\circ}\text{Brix}$  and cooled to  $55\text{-}60^{\circ}\text{C}$ . After that, the mixed syrup was subsequently added glycerin (4 g), citric acid (1.9 g) and apple flavor (0.10 g) then formed in casing molds into a circle shape. The mold was placed at  $25\text{-}30^{\circ}\text{C}$  for 2-4 hours.

### *Physico-chemical analysis*

Sample was blended to measure the water activity using a water activity analyzer (4 TE, Agua lab, UK) and moisture content using an infrared moisture analyzer (IR-35, Denver instrument, USA).

Sample (5 g) was homogenized with distilled water (20 mL) at 5,000 rpm for 30 seconds. The sample solution was filtered through Whatman paper No.4 and taken the clear solution for analysis. The total soluble solid content (TSS) and pH value were determined using a digital hand - held pocket refractometer (PAL-1 and PAL-3, Atago, Japan) and a pH meter (Seven easy, Mettler Toledo, Switzerland), respectively. The content of total titratable acidity (TTA) was analyzed by the titrimetric method No.942.15 (AOAC, 2000) using an auto-titrator (DL53, Mettler-Toledo, Switzerland). The data was computed and reported as the percentage of citric acid content. The content of vitamin C was conducted by the titrimetric method No.967.21 (AOAC, 2020) using an auto-titrator, in which of visual reduction of 2,6 dichloro-phenolindophenol dye was measured and expressed as mg of ascorbic acid (AA) per 100 g sample.

Color value was measured using a Minolta chromameter (CR-400, Konica Minolta Inc., Japan). The chromameter was calibrated by a white color standard ( $Y=86.80$ ,  $x=0.3196$ ,  $y=0.3372$ ) using the Illuminant  $D_{65}$  light source with 2 degree standard observer. The colorimetric data was operated as CIE Lab scale in triplicated measurement and displayed the average data in forms of L value (Lightness, 0-100), a value ((-) green to (+) red), and b value ((-) blue to (+) yellow) value.

Texture quality was evaluated by measuring the texture profile analysis (TPA) test with a Texture Analyzer (TA500, Lloyd instrument, UK). The gummy jelly sample was compressed twice with a compression plate probe and a 5-kg load cell. A probe penetrated to a depth of 50% distance at a test speed of 30.0 mm./min and a trigger point of 0.05 N. Five pieces of sample were tested for each treatment. The Hardness1 and Hardness2 were expressed as maximum force (N) achieve at the first bite and the second bite, respectively. Springiness related to the distance (mm) that a sample recovers during the time that elapses between the end of the first bite and the start of the second bite. Cohesiveness was calculated as ratio of area of second compression cycle to that of area of first compression cycle. Gumminess is defined as the multiplication of product hardness and cohesiveness and Chewiness is defined as the product of hardness x cohesiveness x springiness.

### *Statistical analysis*

Data were analyzed by the analysis of variance procedure (ANOVA) using a completely randomized design (CRD) with the addition of gelatin in fruit gummy jelly preparation. Mean separation was calculated according to the Duncan's New Multiple's Range Test (DMRT) at the 95% confidence level. The T-test differential mean between two samples was analyzed at the 95% confidence level. The results were presented as mean and standard deviation. All statistical analysis was performed with SPSS.

## **Results and Discussion**

The changing of gummy jelly texture can be observed by texture profile analysis (TPA), in which the deformation of different descriptors is under a force, a distance, and the time deformation. Texture characteristics of gummy product made from Bastard oleaster fruits were shown in Table 1. There were no significant differences in hardness, cohesiveness, gumminess, and chewiness ( $p>0.05$ ) except for a statistically significant difference in springiness ( $p\leq 0.05$ ).

The Hardness1, a maximum force (N), was achieved from the first compression force test and the Hardness2 was also obtained from the second bite, respectively. In this study, gummy jelly samples from Bastard oleaster fruit with 8-9% gelatin addition showed 5.96-6.41 N of Hardness1 with the 30-40% reduction of Hardness2 (3.66-4.11 N). This also seems to indicate that Bastard oleaster gummy jelly remained a strong formation after the first bite. The averages of springiness showed an increased springiness from 8.41 mm to 9.19 mm when the gelatin content was added from 8% to 9% ( $p \leq 0.05$ ). The springiness means elasticity or property of resisting deformation. This finding is agreed with the reports of Thanomwong (2008) suggesting that the springiness, hardness and chewiness intensity scores of lemongrass flavour gummy jelly increased with the predictive regression models when the amount of gelatin increased from 7% to 8%. The increase in hardness, springiness, gumminess, and chewiness through the gelation addition can be explained that the simultaneous action of gelling agent as gelatin on gelation system containing sugars, water, and food acids resulting in the chewy gel formation (Burey *et al.*, 2009; Delgado & Banon, 2014). Gelatin provides elasticity through a sol-gel transition with a gelling network junction zones by the weak hydrogen bonds (Zainol *et al.*, 2020) resulting the hardness of gelatin-based gummy confection increased (Marfil *et al.*, 2012; Jiamjariyatam, 2018; Zainol *et al.*, 2020).

**Table 1:** Texture of Bastard Oleaster fruit gummy jelly with the different contents of gelatin

Texture	8% Gelatin	9% Gelatin	10% Gelatin
Hardness1 <sup>ns</sup> (N)	6.16±1.34	5.96±0.90	6.41±0.94
Hardness2 <sup>ns</sup> (N)	3.66±1.08	4.11±0.43	4.11±0.96
Cohesiveness <sup>ns</sup>	0.25±0.11	0.21±0.04	0.18±0.07
Springiness (mm)	8.41±0.45 <sup>a</sup>	9.19±0.06 <sup>b</sup>	9.19±0.18 <sup>b</sup>
Gumminess <sup>ns</sup> (N)	1.20±0.53	1.24±0.11	1.44±0.75
Chewiness <sup>ns</sup> (N.mm)	11.04±4.99	11.38±1.05	12.19±6.71

Note: <sup>ns</sup>no significant difference values ( $p > 0.05$ )

<sup>a-c</sup>The superscript lowercase in the same row are significantly different ( $p \leq 0.05$ )

The physico-chemical properties of Bastard oleaster fruit gummy were presented in Table 2. The pH value, total acidity, total soluble solid content, and moisture content of all three gummy samples were in the range of 3.51-3.66, 1.19-1.65%, 66.4-69.8°Brix, 6.33-7.35%, respectively. The results of pH value, total soluble solid (TSS), and total acidity of gummy product showed significant increase because of the increasing of gelatin content ( $p \leq 0.05$ ). In contrast, the moisture content and the content of vitamin C decreased while the amount of gelatin was added. There were no significant differences in water activity within the range of 0.73-0.74. In the gelled gummy systems, water acts as a plasticizer to aid gelation of gelatin formation (Siegwein, 2010). Gummy preparation is a varied combination of water, sugars and gelling agents presenting in various viscosity and gel formation ability. Gelatin has a high affinity for water (the value of bound water 0.44 g/g dry material) in sucrose/starch/gelatin system (Burey *et al.*, 2009). Burey *et al.* (2009) suggested that the higher of solid content in gelatin solution, the gel formation will set faster affecting by gel concentration. Then, the free water move from gummy composition and evaporate during drying stage causing decreases a moisture content and increases a solid content linked to the texture changing from soft to hard shape (Delgado & Banon, 2014). Regarding results in Table 2, it also showed the increasing of TSS with decreasing of moisture content in Bastard oleaster gummy jelly with addition of gelatin powder. The increasing of gelatin content; as a result, pH value of products considerably increased ( $p \leq 0.05$ ). This finding is in agreement with the report of Jiamjariyatam (2018). There is a possibility that gelatin derived from collagen, which is a protein and the subunit of gelatin is

amino acid causing the high pH value. (Jiamjariyatam, 2018). The increasing of total acidity in gummy jelly product was found in the 10% and 9% gelatin addition treatments using a shorter cooking time than 8% gelatin addition. It is possible to observe the different in moisture content of each gummy jelly product. In addition, the content of vitamin C in the 10% gelatin formulation would rather lose after a longer drying period than that of the 8% and 9% gelatin formulas.

**Table 2:** Physico-chemical characteristics of Bastard oleaster fruit gummy jelly with the different contents of gelatin

Physico-chemical characteristics	8% Gelatin	9% Gelatin	10% Gelatin
pH value	3.51±0.01 <sup>a</sup>	3.59±0.01 <sup>b</sup>	3.66±0.01 <sup>c</sup>
Total soluble solid (°Brix)	66.40±0.17 <sup>a</sup>	68.30±0.17 <sup>b</sup>	69.80±0.17 <sup>c</sup>
Total acidity as citric acid (%)	1.19±0.07 <sup>a</sup>	1.49±0.11 <sup>b</sup>	1.65±0.15 <sup>b</sup>
Moisture content (%)	7.35±0.12 <sup>c</sup>	6.62±0.18 <sup>b</sup>	6.33±0.07 <sup>a</sup>
Water activity <sup>ns</sup>	0.73±0.01	0.73±0.01	0.74±0.01
Color: L* value	29.53±0.04 <sup>a</sup>	30.81±0.26 <sup>b</sup>	32.51±0.39 <sup>c</sup>
a* value <sup>ns</sup>	20.91±0.06	20.78±0.28	20.60±0.53
b* value	10.87±0.10 <sup>b</sup>	11.68±0.21 <sup>c</sup>	8.44±0.32 <sup>a</sup>
Vitamin C (mg AA/100 g sample)	6.88±0.63 <sup>b</sup>	6.67±0.36 <sup>b</sup>	4.79±0.36 <sup>a</sup>

Note: <sup>ns</sup>no significant difference values ( $p>0.05$ )

<sup>a-c</sup>The superscript lowercase in the same row are significantly different ( $p\leq 0.05$ )

Moreover, the addition of gelatin in gummy products had affected L\* value and b\* value ( $p\leq 0.05$ ). The results showed that the increasing of gelatin content in gummy resulted the L\* value increased but a\* value decreased. It is possible that gelatin solution has a light yellow causing the color changing in gummy products. In addition, the acidifying or pH regulating agent such as citric acid, which might affect jelly gelation depending on the isoelectric point (pI) of gelatin types used (Burey *et al.*, 2009).

Table 3 showed the physico-chemical qualities of Bastard oleaster juice, Bastard oleaster fruit gummy jelly, and the commercial gummy jelly products. The developed fruit gummy jelly product with 9% gelatin addition which was selected using sensory evaluation results (it was not shown in this report) had the characteristics following Thai Community Product Standard (TCPS) of dried jelly (TCPS.520/2003). The results of citric acid and vitamin C contents showed that Bastard oleaster gummy jelly product had the significant lower than raw material ( $p\leq 0.05$ ). It is possible that it could be lost by the heating and air sensitivity during the cooking and air drying processes. The developed fruit gummy jelly had a higher water activity than that of the commercial gummy jelly products ( $p\leq 0.05$ ). Wills (1990) reported that jelly confectionary products contained a high moisture (18-22%) showed the water activity in a range of 0.65-0.75. Barbosa-Cánovas *et al.* (2020) reported that the commercial gummies and jellies varied in water content of 11-22% and water activity also widely ranged between 0.51 and 0.79.

Additionally, the solid content and total acidity in the commercial gummy jelly products showed higher than of the Bastard oleaster gummy jelly ( $p\leq 0.05$ ). It might be from the different composition of each product. The commercial gummy jelly product may be contain a higher sugar compositions such as sucrose and glucose syrup and content of acid addition such as ascorbic acid, citric acid and sugar.

**Table 3:** Physico-chemical characteristics of Bastard oleaster juice, Bastard oleaster fruit gummy jelly, and the commercial gummy jelly product.

Physico-chemical characteristics	Bastard oleaster juice	Bastard oleaster fruit gummy jelly	Commercial Gummy jelly
pH value	2.97±0.01 <sup>B</sup>	3.59±0.01 <sup>a,A</sup>	2.92±0.01 <sup>b</sup>
Total acidity as citric acid (%)	3.62±0.03 <sup>A</sup>	1.49±0.11 <sup>b,B</sup>	2.05±0.08 <sup>a</sup>
Total soluble solid (°Brix)	7.73±0.06 <sup>B</sup>	68.30±0.17 <sup>b,A</sup>	74.50±0.06 <sup>a</sup>
Vitamin C (mg AA/100 g sample)	13.25±0.05 <sup>A</sup>	6.67±0.36 <sup>B</sup>	-
Water activity	-	0.73±0.01 <sup>a</sup>	0.67±0.01 <sup>b</sup>

Note: - = no analysis

<sup>a-b</sup>The superscript lowercases in the same row are significantly different between Bastard oleaster fruit gummy jelly and the commercial gummy jelly product ( $p \leq 0.05$ )

<sup>A-B</sup>The superscript uppercases in the same row are significantly different between Bastard oleaster juice and Bastard oleaster fruit gummy jelly product ( $p \leq 0.05$ )

## Conclusion

The investigation of development on gummy jelly product from Bastard oleaster fruit based on gelatin addition has been presented. The increased gelatin levels were significantly affected reducing the moisture content, vitamin C, and a\* value but increasing the total acidity, solid content, and L\* value including springiness. This findings can be concluded that the addition of gelatin in the range of 8-10% in Bastard oleaster gummy jelly product resulted in soft and elastic gummy gel. Its texture is softer than that of the commercial gummy jelly products. It is potential to apply Bastard oleaster fruits in food and drink products. For further experiments, functionality studies of products should be more conducted such as sensory evaluation, biochemical active components with their biological activities.

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## References

- AOAC, Association of Analytical Communities. (2000). *Official Methods of Analysis* (17<sup>th</sup> ed.). Gaithersberg, MD, USA.
- Barbosa-Cánovas, G.V., Fontana Jr., A.T., Schmidt, S.J., & Labuza, T.P. (2020). Water activity in foods: Fundamental and applications. Technology & Engineering, Wiley Publisher, 640 p.
- Burey, P., Bhandari, B.R., Rutgers, R.P.G., Halley, P.J., & Torley, P.J. (2009). Confectionery gels: a review on formulation, rheological and structural aspects. *International Journal of Food Properties*, 12, 176–210.
- Delgado, P. & Bañón, S. (2015). Determining the minimum drying time of gummy confections based on their mechanical properties. *CyTA – Journal of Food*, 13(3), 329-335.
- Jiamjariyatam, R. (2018). Influence of gelatin and isomaltulose on gummy jelly properties. *International Food Research Journal*, 25(2), 776-783.
- Marfil, P. H. M., Anhê, A. C. B. M., & Telis, V. R. N. (2012). Texture and microstructure of gelatin/corn starch-based gummy confections. *Food Biophysics*, 7, 236–243. <http://doi.org/10.1007/s11483-012-9262-3>

- Meesang, S., Wuttijumnong, P., Pongsawatmanit, R., & Chenputhi, S. (2003). Effect of gelatin sucrose/glucose syrup ratio and citric acid on physical properties and sensory quality of gummy jelly product. Kasetsart University, Bangkok, 20-27. (in Thai)
- Panja, S., Chaudhuri, D., Ghatge, N.B., & Minh, H.L. (2014). In vitro assessment of phytochemicals, antioxidant and DNA protective potential of wild edible fruit of *Elaeagnus latifolia* Linn. *Fruits*, 69(4), 303-314.
- Patel, S. (2015). Plant genus *Elaeagnus*: underutilized lycopene and linoleic acid reserve with permaculture potential. *Fruits*, 70(4), 191-199.
- Seal, T. (2012). Evaluation of nutritional potential of wild edible plants traditionally used by the Tribal people of Meghalaya state in India. *American Journal of Plant Nutrition and Fertilization Technology*, 2(1), 19-26.
- Siegwein, A.M. (2010). The effect of soy protein isolate addition on the physico-chemical properties of gummi confections. M.Sc. dissertation in Food Science and Nutrition, The Ohio State University, United State.
- Thanomwong, C. (2008). Effect of gelatin and citric acid on sensory qualities of lemongrass flavored gummy jelly. Available online [http://www.conference.phuket.psu.ac.th/proceedings/psu\\_open\\_week\\_2008/data/sci/1\\_31.pdf](http://www.conference.phuket.psu.ac.th/proceedings/psu_open_week_2008/data/sci/1_31.pdf) (in Thai)
- Tiampakdee, A. (2006). Effect of pH, gelatin, pectin, sugars, and fruits juices on texture of gummy jelly. M.Sc. dissertation in Food Science and Technology, Chiang Mai University, Thailand.
- TISI, Thai Industrial Standards Institute. (2003). *Thai Community Product Standard of dried jelly: TCPS.520/2003*. Bangkok, Thailand.
- Wills, D. (1998). Water activity and its importance in making candy. *The Manufacturing Confectioner*, 71-74.
- Yingthongchai, P., & Sirikhum, P. (2008). Genetic diversity of *Elaeagnus litolia* Linn.: morphological and physico-chemical characters of fruits. *Agricultural Science Journal*, 39(3(Suppl.)), 118-121.
- Zainol, M.K., Che-Esa, N.S., Azlin-Hasim, S., Zamri, A.I., Mohd Zin, Z., & Abdul Majid, H.A. (2020). The ramification of Arabic gum and gelatine incorporation on the physicochemical properties of Belimbing Buluh (*Averhoa belimbi*) fruits pastilles. *Food Research*, 4(2), 532-538.