

## Development and Quality Evaluation of Blue Butterfly Pea Flower (*Clitoria ternatea* L.) Extract Incorporated Jelly

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**Abstract-** Blue butterfly pea (*Clitoria ternatea* L.) flower (BPF) is an underutilized plant known for several health benefits. BPF can be used for increasing consumer demand for healthy foods by replacing artificial flavours and colours. This study was carried out to develop and evaluate commercially potential jelly incorporated with BPF extract. The dried BPF extract was obtained by the aqueous extraction method. Fruit pulp and BPF extract incorporated different jelly formulations were developed. Further, it was evaluated for colour, pH, moisture, titratable acidity, fibre, ash, and energy value. The sensory evaluation for different treatments was carried out using a 9-point hedonic scale test for taste, texture, colour, smell, appearance, and overall acceptability. The results showed significant differences ( $p < 0.05$ ) observed in different treatments for colour, pH, moisture, titratable acidity, fibre, ash, energy value, and sensory attributes. The moisture content of jelly formulated with different formulations was ranged from 13.1% to 20%. When considering ash content, it is considerably higher in the only BPF added jelly. The fibre content of the jelly samples ranged from 0.7% to 2.7% while higher fibre content was observed in banana pulp incorporated jelly. Energy value of jelly samples ranged from 357.03 to 428.66 J/100g and the titratable acidity of the jelly ranged from 0.02% to 1.023%. The sensory analysis exhibits that watermelon and BPF extract incorporated jelly obtained higher ranks. Eventually, the jelly formulations produced with BPF extract received a higher mean score for sensory analysis and had a good proximate figure for nutritional values.

**Keywords:** *Clitoria ternatea* L, composite jelly, fruit pulp, proximate analysis, sensory qualities

### I. INTRODUCTION

*Clitoria ternatea* L. is a well-known herb that belongs to the family Fabaceae. The blue butterfly pea is a legume plant with a long, thin, climbing herbaceous vine with five leaflets, white to purple

flowers, deep roots, and growing wild and in gardens in tropical regions (Morris, 2009). Blue butterfly pea flower (BPF) has solitary flowers with vivid, deep-blue, and white colouration (Loñez and Banwa, 2021). The butterfly pea flower is full of health-promoting antioxidants, flavonoids, and peptides as a natural remedy for various health complaints and it has historically been used as a laxative, purgative, diuretic, inflammation, indigestion, constipation, headache, arthritis, eye ailments, sore throat, and anthelmintic, as well as to relieve gastrointestinal swelling, sore throat, and mucous dysfunction (Gollen *et al.*, 2018). The BPF is commercially valued for natural food colouring, pea tea, dried flowers used for beauty products (Nair and Reghunath, 2008).

The use of food colourant in food products is important in increasing product appeal. Food colourants are broadly categorized into natural and artificial food colours. The synthetic food colourants showed an adverse effect on human health. Some alternative to synthetic dyes includes anthocyanins, lycopene, turmeric, and chlorophyll. One of the leading available natural blue sources is that the *C. ternatea* flower. The food industry traditionally used blue dye aqueous extract from the petal of butterfly pea as a confectionary colouring and natural colourant for drinks (Loñez and Banwa, 2021).

This edible natural colourant can be used in any food compound, replacing synthetic colourants in colour, taste, and cost economy (Loñez and Banwa, 2021). There are many different products formulated from BPF extract in the market nowadays. Natural jelly candies with high antioxidant properties and medicinal properties are not commercially available at low cost. The antioxidant-enriched jelly with free radical scavenging activity is rarely found on the market. Jelly candy equally attracts children and adult age people and has little nutritional value (Loñez and Banwa, 2021). This study aims to develop the

potential commercial jelly enriched with antioxidant potential using natural BPF colour extract by replacing artificial colourants.

## II. METHODOLOGY

### A. Study area

The experiment was conducted at the Food Science and Technology Laboratory, Faculty of Technology, South Eastern University of Sri Lanka.

### B. Procurement of raw materials

Blue-coloured, fully bloomed, disease-free, and undamaged healthy flowers of *Clitoria ternatea* obtained from home gardeners of Hanwella, Awissawella, Sri Lanka. Other ingredients like agar-agar, fruits like banana, watermelon, and orange, sugar, sugar syrup, and salt were purchased locally in Akkaraipattu, Sri Lanka.

### C. Preparation of dried BPF flower

The BPFs were washed and placed on an aluminium tray and directed to the hot humid tropical sun for drying (31±5 °C, RH: 67±5%). The BPFs were dried until the flower's petals felt like parchment and were no longer soft or wet. Afterwards, dried flowers were grounded and packed in an airtight container and stored under ambient conditions (27 °C) until further use.

### D. Extraction of anthocyanin content

The aqueous extraction method was performed to extract the anthocyanin from dried BPF (Lakshan *et al.*, 2019). The 5 g of dried BPF powder was added to 100ml hot water and mixed for 30 minutes and then the extract was filtered.

### E. Preparation of fruit pulps

The fully ripened healthy, and fresh fruits were washed thoroughly with potable water and the skin was removed. The fruits were ground using a domestic grinder (Model-TL740B, India) and fruit pulp was obtained.

### F. Experimental design

#### Treatments

- T1; BPF extraction 200 ml
- T2; Orange 200 ml
- T3; Banana 200 ml
- T4; Watermelon 200 ml
- T5; BPF and orange pulp; 100 ml: 100 ml
- T6; BPF and watermelon pulp; 100 ml: 100 ml
- T7; BPF and banana pulp; 100 ml: 100 ml

### G. Preparation of jelly

The BPF extract and fruit pulp were mixed with agar-agar powder (2 g), gelatin (10 g), sugar (50 g), sugar syrup (15 g), and salt (0.5 g). The mixture was stirred well before heating. During the heating, BPF extract was added gradually and mixed well, and bring it up to a boiling point. The mixture scooped into jelly molds. The jelly was set aside to cool in the refrigerator (4 °C) for about 2 hours.

### H. Colour measurement

The colour of jelly was measured using a colorimeter (CHN Spec, CS 10, China). The colorimeter was calibrated with a white surface. Measurements were recorded as L (lightness), +a (redness), +b (yellowness) CIE color co-ordinates.

### I. pH measurement

The benchtop pH meter (Starter 3100, OHAUS, USA) was used to measure the pH at 27 °C (AOAC, 2002).

### J. Moisture content

The empty weight of the oven-dried moisture cans was measured. Then, the five grams of sample was transferred into the moisture cans and weighed. The samples were oven-dried at 105 °C for four hours. The moisture cans were transferred into a desiccator and weighed quickly as soon as they cooled. The oven-drying process was repeated until the constant weight was observed (AOAC, 2020).

$$\text{Moisture content \%} = \frac{W_1 - W_2}{W_1} \times 100$$

Where,

W1 = Initial weight

W2 = Oven dried weight

### K. Ash content

The weight of the oven-dried empty crucibles was measured. Then, the five grams of sample was put into the crucibles and weighed. The samples were kept in a muffle furnace at 550 °C for five hours. The crucibles were transferred into a desiccator and weighed quickly as soon as they cooled. Finally, ash content was recorded (AOAC, 2020).

$$\text{Ash (\%)} = \frac{W_1 - W_2}{W_3} \times 100$$

Where,

W1=Weight of crucible with ash (g)

W2 =Weight of crucible (g)

W3 =Weight of sample (g)

#### L. Fibre content measurement

The weight of the oven-dried empty crucibles was measured. Then, the five grams of samples were transferred into the 500 ml beaker. After, 0.125 N 200 ml H<sub>2</sub>SO<sub>4</sub> was added to the beakers and boiled for half an hour, and it was filtered through a muslin cloth. Afterwards, it was washed with distilled water to render it free of acid and checked the filtrate with blue litmus paper. After, the residue was transferred into a 500 ml beaker. Then 0.125 N, 200 ml NaOH was added to the beakers and boiled for half an hour. Then it was filtered through a muslin cloth. Afterwards, it was washed with hot water to render free of base and checked the filtrate with red litmus paper. Finally, the residue was placed in the crucible and oven-dried at 105 °C for two hours, after which the crucibles were placed in the desiccator and weighed after cooling. The samples were kept in a muffle furnace at 450 °C for three hours. The crucibles were transferred into a desiccator and weighed quickly as soon as they cooled. Finally, fibre content was recorded (AOAC, 2020).

$$\text{Crude fibre (\%)} = \frac{W1-W2}{W3} \times 100$$

Where,

W1=Weight of crucible with oven dried sample (g)

W2=Weight of crucible with ash (g)

W3 =Weight of sample (g)

#### M. Energy value

In a crucible, 1 g of dried sample was obtained, and cotton thread was attached to the fuse wire that was in contact with the dried sample. The sample-loaded crucible was placed inside the bomb, along with 5 ml of distilled water. The bomb was then placed inside the bomb calorimeter (IKA C6000, India). Following that, a bomb calorimeter was started the operation by selecting appropriate set orders (Aggarwal *et al.*, 2016). The results were obtained from the calorimeter as J/100g values.

#### N. Sensory evaluation

Sensory analysis was done using 20 untrained panelists by scoring different attributes based on a 9-point hedonic scale. The jellies were rated for their sensory attributes like taste, texture, colour, smell, appearance, and overall acceptability.

#### O. Statistical analysis

The data were analyzed using SPSS statistical package (SPSS 20.0, IBM, New York, NY, USA). The Analysis of Variance (ANOVA) was used to find the significant differences, and means were compared using Tukey's post hoc test at 5% significant level.

### III. RESULTS AND DISCUSSION

#### A. Moisture content

Moisture content is crucial in determining the jelly quality, particularly in determining the texture (Dewi *et al.*, 2018). The moisture content of jelly developed with different formulations was ranged from 13.1% to 20%. There was a significant difference ( $p < 0.05$ ) observed between the treatments for moisture content. The lower moisture content was recorded for orange pulp incorporated jelly. But the higher moisture content was marked for BPF extract and watermelon incorporated jelly (Table 01). Delgado and Bañón, (2015) also reported that the average moisture content of gummy jelly produced was around 21%. The jelly is an intermediate moisture food that is hygroscopic and hard to dry (Delgado and Bañón, 2015).

#### B. Ash content

The ash content of the food reduces with the increment of the moisture content (Delgado and Bañón, 2015). The percentage of ash content of the jelly samples ranged from 0.67% to 2.29% with a significant difference ( $p < 0.05$ ) between the treatments. Ezzudin and Rabeta, (2018) reported the ash content of *Clitria ternitia* L. flower has 0.45%. But BPF added jelly (T1) resulted in 1.53% of ash content. Compare the BPF extract added jelly (T1) with both BPF and fruit pulp added jelly, ash content is considerably higher in the BPF added jelly (Table 01).

#### C. Fibre content

The fibre content of the jelly samples ranged from 0.34% to 3% with a significant difference ( $p < 0.05$ ) between the treatments (Table 01). There was no fibre content available in BPF extract, orange, BPF + watermelon, and BPF + orange added jellies, while the highest fibre content was observed for only banana pulp added jelly. Ezzudin and Rabeta (2018) reported the fibre content of *Clitria ternitia* L. flower has 2.1%, but the BPF extract incorporated jelly had not been observed for fibre content.

D. Energy value

Energy content of jelly samples ranged from 357.03 to 428.66 J/100g with significant differences ( $p < 0.05$ ) between the treatments. BPF extract + banana pulp incorporated jelly had the lowest content of energy ( $357.03 \pm 13.76$  J/100g), while the high energy content ( $428.66 \pm 1.07$  J/100g) was observed for BPF extract + banana pulp incorporated jelly (Table 01). Zitha *et al.* (2020) reported that total energy value of jelly developed from mangaba (*Hancornia speciosa* Gomes) had around 277 Kcal/100g.

Lakshan *et al.* (2019), the titratable acidity of beverage developed with BPF extract was around 0.13%.

F. pH

The lowest pH value among the treatments was recorded for orange pulp incorporated jelly and BPF extract incorporated jelly recorded as a higher pH level. There was a significant difference ( $p < 0.05$ ) observed between the pH of jellies formulated using different extract and fruit pulps (Figure 02).

Table 1: Proximate values of different formulation of jelly

Treatments	Moisture (%)	Ash (%)	Fibre (%)	Energy (J/100g)
T1	$19.5 \pm 1.14^b$	$1.53 \pm 0.04^c$	0.00 <sup>a</sup>	$407.10 \pm 1.72^b$
T2	$13.1 \pm 0.82^a$	$0.95 \pm 0.02^{ab}$	0.00 <sup>a</sup>	$406.38 \pm 1.86^b$
T3	$19.53 \pm 1.24^b$	$2.29 \pm 0.19^d$	$3.00 \pm 0.06^d$	$420.60 \pm 4.16^b$
T4	$16.63 \pm 0.41^{ab}$	$2.18 \pm 0.03^d$	$0.34 \pm 0.01^b$	$415.55 \pm 1.64^b$
T5	$19.37 \pm 1.13^b$	$1.19 \pm 0.01^{bc}$	0.00 <sup>a</sup>	$413.12 \pm 1.16^b$
T6	$20.00 \pm 1.66^b$	$0.67 \pm 0.06^a$	0.00 <sup>a</sup>	$428.66 \pm 1.07^b$
T7	$18.23 \pm 0.95^{ab}$	$1.23 \pm 0.04^{bc}$	$2.70 \pm 0.12^c$	$357.03 \pm 13.76^a$

Different letters superscripted in the mean values within the column indicate the significant difference at 0.05.

T1; BPF extraction 200ml, T2; Orange 200ml, T3; Banana 200ml, T4; Watermelon 200ml, T5; BPF and orange pulp; 100 ml: 100ml, T6; BPF and watermelon pulp; 100 ml: 100ml, T7; BPF and banana pulp; 100ml: 100ml

E. Titratable acidity

The titratable acidity of the jelly ranged from 0.02% to 1.02% with a significant difference ( $p < 0.05$ ) between the treatments. The lowest titratable acidity (0.02%) was seen in jelly with BPF extract alone, while the higher titratable acidity (1.02%) was observed for orange pulp incorporated jelly (Figure 01). According to

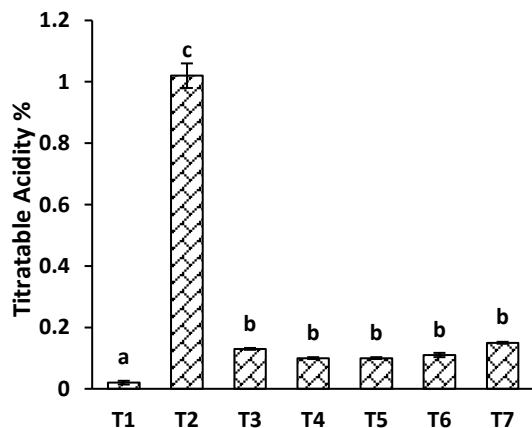


Figure 01: Titratable acidity of different jelly formulations

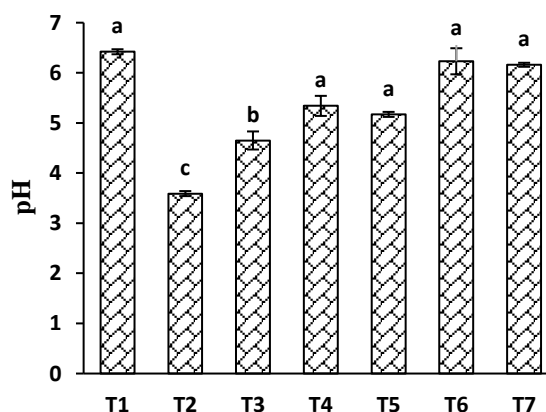


Figure 02: pH values of different jelly formulations

G. Colour

The L\* value reflects the sample's lightness, with 100 denoting white and zero denoting black. When the a\* value is positive, it indicates redness; when it is negative, it indicates greenness. When the b\* value is



positive, it means yellowness, and when it is negative, it means blueness. (Pathare *et al.*, 2013). When comparing the color of only BPF extract added jelly with BPF and fruit pulp mixture added jellies, L\* value of T5, T6 and T8 are reducing while mixing fruit pulps with BPF extract, which explains that darkness increases with the mixing of fruit pulps. Likewise, redness reduces with the mixing of fruit pulps compare to T1. However, the blueness of the jelly increases with the mixing of fruit pulps with BPF extract (Table 02).

another when both products may be unacceptable (Kilcast and Angus, 2007; Risvik *et al.*, 1994).

#### IV. CONCLUSION

The *Clitoria ternatea* L. is an under-utilized plant with several health benefits. The BPF extract can be used as an alternative for synthetic colourants mostly in confectioneries food items. The jelly formulations produced with BPF extract obtained a higher mean score for sensory analysis and had a good proximate figure for nutritional values. Therefore, BPF extract can be used as an

Table 2: L\*, a\* and b\* Color coordinates of jelly formulation

Treatments	Classic colour ranges of L*a*b* value		
	L*	a*	b*
T1	38.86±2.37	16.45±3.10	-25.30±0.90
T2	66.50±3.70	27.31±1.10	80.40±4.50
T3	57.34±2.20	12.52±1.65	33.35±2.80
T4	44.44±1.30	52.8±4.14	43.77±1.98
T5	38.86±1.65	16.45±2.60	-25.3±1.65
T6	34.55±1.93	11.86±0.89	-27.91±2.10
T7	32.91±2.20	5.82±0.62	-31.87±3.21

Mean ± SEM values of different color coordinates

#### H. Sensory properties of the jelly

The mean scores for consumer preference in terms of taste, texture, colour, smell, appearance, and overall acceptability are presented in Table 03 showed a significant difference ( $p < 0.05$ ) among the jelly samples. The mean ranks for the colour range between 5.9 and 7.75. The lowest colour preference was given to the T2 while the highest colour preference was given to T1. Among the treatments, the flavour of T4 was predominantly preferred by the panelists while the panelists less preferred T7.

When considering the texture of the treatment, T4 was mostly preferred and T7 obtained a lower rank for the texture. The T4 obtained a higher score for the taste and a lower score for the T2. Among the treatments, the odour was mostly preferred for T4. The overall acceptability showed that T4 was mostly preferred in terms of all sensory parameters while T7 obtained the lowest score out of all treatments. Generally, overall acceptability may slightly differ from preference because a given product for instance could still be preferred over

alternative for blue synthetic colours for jelly confectioneries with market potential.

Table 3: Mean scores for sensory evaluation of different jelly formulations

Treatments	Color	Flavor	Texture	Taste	Smell	Overall acceptability
T1	7.75±0.28 <sup>b</sup>	6.35±0.31 <sup>ab</sup>	6.60±0.31 <sup>ab</sup>	5.65±0.43 <sup>ab</sup>	5.80±0.35 <sup>bc</sup>	6.45±0.36 <sup>b</sup>
T2	5.90±0.51 <sup>a</sup>	4.85±0.44 <sup>a</sup>	5.95±0.40 <sup>a</sup>	4.45±0.39 <sup>a</sup>	3.85±0.41 <sup>a</sup>	4.45±0.46 <sup>a</sup>
T3	6.95±0.35 <sup>ab</sup>	6.26±0.49 <sup>ab</sup>	6.37±0.37 <sup>ab</sup>	5.947±0.47 <sup>abc</sup>	5.26±0.47 <sup>abc</sup>	6.11±0.46 <sup>a</sup>
T4	7.57±0.21 <sup>b</sup>	7.24±0.25 <sup>b</sup>	7.52±0.16 <sup>b</sup>	7.48±0.18 <sup>c</sup>	6.48±0.36 <sup>c</sup>	7.29±0.24 <sup>b</sup>
T5	7.20±0.37 <sup>ab</sup>	6.10±0.37 <sup>ab</sup>	6.70±0.32 <sup>ab</sup>	6.70±0.33 <sup>bc</sup>	5.45±0.42 <sup>abc</sup>	6.55±0.39 <sup>b</sup>
T6	6.80±0.43 <sup>ab</sup>	6.15±0.50 <sup>ab</sup>	7.05±0.52 <sup>ab</sup>	6.05±0.56 <sup>abc</sup>	5.20±0.57 <sup>abc</sup>	6.30±0.52 <sup>b</sup>
T7	6.15±0.46 <sup>ab</sup>	4.80±0.46 <sup>a</sup>	5.85±0.39 <sup>a</sup>	4.50±0.50 <sup>a</sup>	3.90±0.53 <sup>ab</sup>	4.40±0.47 <sup>a</sup>

Different letters superscripted in the mean values within the column indicate the significant difference,

\*= significant at 0.05

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