International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2025): 5.29
IJABR 2025; 9(8): 159-163
www.biochemjournal.com
Received: 08-05-2025
Accepted: 11-06-2025

Tanisha Kharadi
Research Scholar, Department of Food Science and Nutrition, (CCAS), Maharana Pratap University of Agriculture and Technology (MPUAT), Udaipur, Rajasthan, India

Muskan
Research Scholar, Department of Food Science and Nutrition, (CCAS), Maharana Pratap University of Agriculture and Technology (MPUAT), Udaipur, Rajasthan, India

Dr. Nikita Wadhawan
Associate Professor and Head, Department of Dietetics and Food Technology (DFT), (CDFT), Maharana Pratap University of Agriculture and Technology (MPUAT), Udaipur, Rajasthan, India

Corresponding Author:
Tanisha Kharadi
Research Scholar, Department of Food Science and Nutrition, (CCAS), Maharana Pratap University of Agriculture and Technology (MPUAT), Udaipur, Rajasthan, India

Sensory evaluation of butterfly pea flower (*Clitoria ternatea*) based gummies with varying pectin concentrations

Tanisha Kharadi, Muskan and Nikita Wadhawan

DOI: https://www.doi.org/10.33545/26174693.2025.v9.i8c.5117

Abstract
Butterfly pea (*Clitoria ternatea* L.) is rich in anthocyanins and widely valued for its medicinal, nutritional, and aesthetic properties. This study aimed to develop butterfly pea flower-based gummy formulations using varying pectin concentrations and evaluate their sensory attributes. Dried flower extract was prepared and combined with honey and lemon juice to create three gummy formulations (10 g, 15 g, and 20 g pectin). Sensory evaluation was conducted using a 9-point hedonic scale by 30 semi-trained panellists aged 16-25. Parameters assessed included appearance, color, texture, flavour, taste, and overall acceptability. Results indicated that pectin concentration significantly influenced texture and overall sensory quality, with moderate levels offering optimal acceptability. The study supports the potential of C. ternatea-based gummies as functional, clean-label confections appealing to health-conscious consumers.

Keywords: Butterfly pea, pectin, anthocyanins, gummies, sensory evaluation

1. Introduction

Butterfly pea (*Clitoria ternatea L.*), a member of the Fabaceae family, is a fast-growing perennial plant native to tropical Asia, widely cultivated for ornamental, culinary, and medicinal uses. It thrives in well-drained loamy soils with a fibrous root system and can tolerate moderate climatic conditions, typically between 19°C to 28°C and rainfall levels of 700-1500 mm. The plant is drought-resistant and can survive for up to 7-8 months under limited water conditions (Oguis *et al., 2019*) [18]. *Clitoria ternatea* is known by several vernacular names, including ‘Asian pigeon wing’, ‘blue pea’, ‘butterfly pea’, ‘bluebell vine’ and ‘Chandra kanta’ (Vidana Gamage *et al.*, 2021) [28]. Its edible parts-flowers, leaves, roots, and seeds-are traditionally utilized in food applications, folk medicine, and cultural practices across Asian countries.

The vibrant blue petals of *C. ternatea* are rich in anthocyanins, particularly ternatins, which are polyacylated anthocyanins known for their deep hue and enhanced stability. These bioactive compounds have attracted growing interest for their potent antioxidant and therapeutic potential. Research indicates that the anthocyanins in *C. ternatea* offer superior stability over non-acylated forms, making them ideal for use as natural food colorants (Thuy *et al.*, 2021; Jamil & Pa’ee, 2018) [11, 27]. In countries such as Malaysia, Thailand, and China, C. ternatea flowers are traditionally used to prepare blue rice, herbal tea, and desserts (Caroline *et al.*, 2015) [5].

Phytochemically, *C. ternatea* is a rich source of flavonoids, anthocyanins, alkaloids, tannins, saponins, glycosides, taraxerol, and taraxerone (Neda *et al.*, 2013) [16]. Kazuma *et al.* (2003) [13] reported that the flower contains at least 14 different flavonol glycosides, including kaempferol 3-glucoside, quercetin 3-glucoside, and myricetin 3-glucoside. The aqueous extracts have demonstrated strong free radical scavenging activity compared to methanol-based extracts (Rabeta *et al.*, 2018; Ramaswamy *et al.*, 2011) [20, 22]. Proximate and mineral analysis further revealed the presence of essential minerals such as calcium (3.10 mg/g), magnesium (2.23 mg/g), and potassium (1.25 mg/g), adding to its nutritional value.

C. ternatea has a long history of medicinal use in traditional systems like Ayurveda and Siddha. Its various parts have been reported to possess anxiolytic, anti-inflammatory, antidiabetic, hepato-protective, analgesic, and antipyretic properties (Bhatia *et al.*, 2014; Chusak *et al.*, 2018; Mukherjee *et al.*, 2008; Singh *et al.*, 2018) [3, 7, 15, 23]. In particular, its extracts have been studied for improving cognitive functions, attenuating stress-induced amnesia, and enhancing memory in animal models (Taranalli & Cheeramkuzhy, 2000; Rai *et al.*, 2001; Jain *et al.*, 2003) [10, 21, 25]. The pharmacological benefits are largely attributed to its antioxidant mechanisms, including free radical scavenging, inhibition of oxidative enzymes, and metal ion chelation (Karadag *et al.*, 2009; Birben *et al.*, 2012) [4, 12].

In recent years, there has been an increasing demand for clean-label, plant-based functional foods, especially those that offer both health benefits and appealing sensory attributes. Confections such as gummies are widely popular across age groups but are often nutritionally limited. With rising consumer interest in natural ingredients and functional confections, the incorporation of bioactive-rich natural colorants such as *C. ternatea* offers both nutritional and aesthetic advantages (Caroline *et al.*, 2015; Achumi *et al.*, 2018) [1, 6]. As traditional candies lack significant health benefits, especially antioxidant activity, the use of such ingredients in gummy formulations can bridge the gap between indulgence and functionality.

Pectin, a plant-derived polysaccharide, has gained popularity as a gelling agent in functional and vegan confectionery products. Sourced primarily from citrus peels and apple pomace, pectin offers an excellent alternative to gelatin, especially for plant-based applications. It forms a stable gel matrix in the presence of sugar and acid, contributing significantly to the texture, chewiness, and mouthfeel of gummies (Thakur *et al.*, 1997; May, 1990) [14, 26]. Pectin also enhances the bioactive delivery of embedded compounds like anthocyanins, while offering dietary fibre benefits (Sudhakar *et al.*, 2018) [24]. Due to these advantages, pectin-based confections are increasingly being explored as a vehicle for functional ingredients, including natural antioxidants and colorants.

Hence, the present study was undertaken to develop butterfly pea flower-based gummy formulations using different concentrations of pectin and to evaluate their sensory characteristics. The primary objective was to assess the impact of pectin levels on attributes such as appearance, texture, flavour, taste, color, and overall acceptability. Sensory evaluation was carried out to determine consumer preferences and to identify the most acceptable formulation. This investigation aims to support the development of clean-label, plant-based confectionery products with enhanced appeal and potential functional benefits.

2. Materials and Methods

Area of Study

The present study was conducted in the Department of Food and Nutrition, College of Community and Applied Sciences, Udaipur. The objective was to assess the sensory acceptability of various butterfly pea flower gummy formulations using structured questionnaires. A randomized selection of 30 participants was made from undergraduates and postgraduate students of the College of Community and Applied Sciences, Udaipur. Given that butterfly pea flower is especially appealing to younger demographics due to its vivid blue hue, wellness associations, and aesthetic suitability for social media, the study focused on individuals aged 16-25.

Respondents evaluated the gummies using a 9-point hedonic scale ranging from “like extremely” to “dislike extremely” to assess parameters including appearance, colour, flavour, texture, taste, and overall acceptability (Stone & Sidel, 2004) [32].

Preparation of Butterfly Pea Flower Extract

Proper pre-processing of butterfly pea flowers was essential to ensure the optimal recovery of bioactive compounds and color. This phase involved harvesting, cleaning and sorting, followed by sun drying.

1. Harvesting

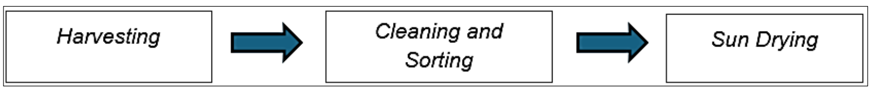
Fresh butterfly pea (*Clitoria ternatea*) flowers were hand-harvested early in the morning to preserve anthocyanin content and minimize mechanical damage. Only mature, intact, and vibrantly coloured blooms were selected, as these contain the highest levels of bioactives (Mukherjee *et al.*, 2008) [15].

2. Cleaning and Sorting

The harvested flowers were rinsed under potable running water to remove dirt, dust, and insects. Wilted or damaged specimens were discarded. Proper cleaning ensured a homogenous, high-quality sample for extract preparation.

3. Sun Drying

Flowers were spread on sanitized trays and dried under natural sunlight for 48 hours, covered with muslin cloth to prevent contamination. Sun drying, though traditional, is effective for moisture removal while preserving phytochemicals (Gulzar *et al.*, 2022) [33]. Once dried, the flowers exhibited reduced size and altered petal shape, aiding in storage and extraction.



Formulation of Butterfly Pea Flower Gummies

The gummy formulation process involved the development of three different samples-T_1, T_2, and T_3 to study the effect of varying pectin concentrations on sensory attributes. The base solution remained constant across all treatments, consisting of 3 g of dried butterfly pea (*Clitoria ternatea*) flowers infused in 300 ml of distilled water. This extract served as the core medium for all formulations (Chusak *et al.*, 2018) [7].

1. Extraction and Filtration

The dried butterfly pea flowers were steeped in pre-heated distilled water maintained at 60-70 °C for 30 minutes to allow effective extraction of anthocyanins and other bioactives. The mixture was then filtered through multi-layered muslin cloth to remove solid residues, yielding a clear, deep blue extract (Nguyen & Nguyen, 2019) [17]. This mild-heat extraction approach is preferred to preserve the integrity of anthocyanins, which are known to degrade at high temperatures (Patel *et al.*, 2021) [19].

2. Sample Preparation and Ingredient Incorporation

Each formulation received the same quantity of extract, sweetener, and acidulant, but varied in pectin concentration as follows:

Table 1: Development of butterfly pea flower based gummies with different pectin concentration

Sample Code	Pectin (g)	Honey (g)	Lemon Juice (ml)	Butterfly Pea Extract (ml)
Sample A	10 g	40 g	30 ml	300 ml
Sample B	15 g	40 g	30 ml	300 ml
Sample C	20 g	40 g	30 ml	300 ml

Pectin was used as the gelling agent at increasing concentrations: 10 g for sample A, 15 g for sample B and 20 g for sample C. Pectin facilitates gel formation by forming a network with water in the presence of acid and sugar, contributing to the characteristic gummy texture (Yuan *et al.*, 2022) [30].

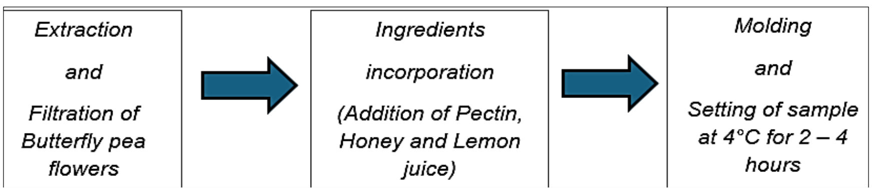
Honey was incorporated as a natural sweetener for its antimicrobial properties and health appeal. It enhances taste while providing functional benefits such as antioxidant activity (Ahmed *et al.*, 2021) [2].

Lemon juice was added as an acidulant to adjust the pH and enhance the color and gelation, as pectin requires a low pH (approximately 3.0-3.5) for effective setting. The pH also influences the pigment behaviour of anthocyanins, turning the extract from blue to purple as acidity increases (Nguyen & Nguyen, 2019) [17].

The ingredients were combined in a saucepan and heated gently with continuous stirring to dissolve the pectin and ensure homogenous dispersion. On addition of lemon juice, the extract exhibited a characteristic purple hue due to the pH-sensitive anthocyanins present in *Clitoria ternatea* (Ganesan & Xu, 2017) [9].

3. Molding and Setting

The hot mixture for each treatment was immediately poured into silicone moulds to ensure uniformity in size and shape. The filled moulds were cooled to room temperature and then refrigerated at 4 °C for 2-4 hours to facilitate complete gelation. After setting, the gummies were demoulded and stored in airtight containers for sensory analysis. Refrigeration allows the pectin network to set properly, resulting in a firm yet chewy texture ideal for gummy confections (Wang *et al.*, 2017) [29].



D. Sensory Evaluation of Butterfly Pea Flower (*Clitoria ternatea*) Gummies

Sensory evaluation was conducted to determine the acceptability and quality attributes of the butterfly pea flower gummies over the storage period. Key sensory parameters assessed included appearance, color, texture, flavour, taste, and overall acceptability. This assessment provided valuable information regarding consumer preference and potential shelf-life stability of the formulated product.

1. Panel Selection

A semi-trained panel consisting of 30 individuals was recruited from undergraduate and postgraduate students, as well as faculty members of the Department of Food and Nutrition. Panellists were selected based on their availability, health status-ensuring they were free from conditions such as cold or flu that could impair taste perception-and their willingness to participate throughout the sensory testing period. Prior to the evaluation, panel members were briefed on the sensory testing procedures, hygiene protocols, and the importance of unbiased and consistent evaluation. Orientation and training sessions were conducted to familiarize the panel with the sensory attributes specific to gummy products and to calibrate their responses, thereby minimizing variability and bias.

2. Score Card Development

A structured score card employing a 9-point hedonic scale was designed for this study. The scale ranged from 1 ("Dislike extremely") to 9 ("Like extremely") for each sensory attribute evaluated. Clear instructions and definitions for each parameter were provided on the score cards to ensure uniform understanding among panellists. The score cards also allowed space for brief comments, enabling panellists to provide qualitative feedback alongside quantitative ratings (Peryam & Pilgrim, 1957) [34].

3. Sensory Testing Procedure

On each evaluation day, gummy samples were removed from refrigeration at 4 °C and allowed to equilibrate to room temperature for approximately 10 to 15 minutes prior to presentation. Samples were portioned into coded, odourless disposable cups to maintain sample anonymity and reduce potential bias.

The sensory evaluations were carried out in a controlled sensory testing room, designed to be free from noise, strong odour and visual distractions to maintain focus. Samples were presented in a randomized order across sessions to minimize positional bias. Panellists were instructed to systematically evaluate each coded sample and record their responses on the score card. Completed evaluations were collected confidentially and checked for completeness to ensure data integrity.

3. Result

Sample A received moderate sensory scores, with the highest rating for texture (7.3±0.6), followed by appearance (7.2±0.4) and taste (7.1±0.5). Colour and overall acceptability both scored 7.0±0.5, while flavour was rated the lowest at 6.9±0.4. Compared to Sample B, Sample A was less preferred, particularly in terms of flavour and overall acceptability, indicating that Sample B had a better balance of sensory attributes.

Sample B was well accepted by the panel, with overall acceptability scoring the highest at 8.1±0.5, followed by colour (8.0±0.5) and taste (7.9±0.5). Appearance and texture both received 7.8±0.3 and 7.8±0.5 respectively, while flavour scored slightly lower at 7.5±0.6. The results indicate a favourable sensory profile for Sample B across all attributes.

Sample C was moderately accepted by the panel, with colour receiving the highest score (8.2±0.5), indicating good visual appeal. However, compared to Sample B, other sensory attributes such as flavour (7.0±0.7), taste (7.4±0.6), and overall acceptability (7.5±0.6) were slightly lower. Appearance and texture scored 7.5±0.5 and 7.6±0.6 respectively. Although Sample C showed acceptable sensory quality, it was less preferred overall compared to Sample B, which demonstrated superior ratings across most attributes.

Table 2: Comparison of the mean and SD of all sensory attributes for the different samples

Sample	Sensory Attributes						TAWM	Hedonic rating	Ranking
	Appearance (Mean ±SD)	Color (Mean ±SD)	Flavour (Mean± SD)	Texture (Mean± SD)	Taste (Mean± SD)	Overall Acceptability (Mean± SD)			
Sample A	7.2 ± 0.4	7.0 ± 0.5	6.9 ± 0.4	7.3 ± 0.6	7.1 ± 0.5	7.0 ± 0.5	7.08	LS	3
Sample B	7.8 ± 0.3	8.0 ± 0.5	7.5 ± 0.6	7.8 ± 0.5	7.9 ± 0.5	8.1 ± 0.5	7.85	LVM	1
Sample C	7.5 ± 0.5	8.2 ± 0.5	7.0 ± 0.7	7.6 ± 0.6	7.4 ± 0.6	7.5 ± 0.6	7.53	LM	2

(LS= like slightly, LM= like moderately, LVM= like very much)

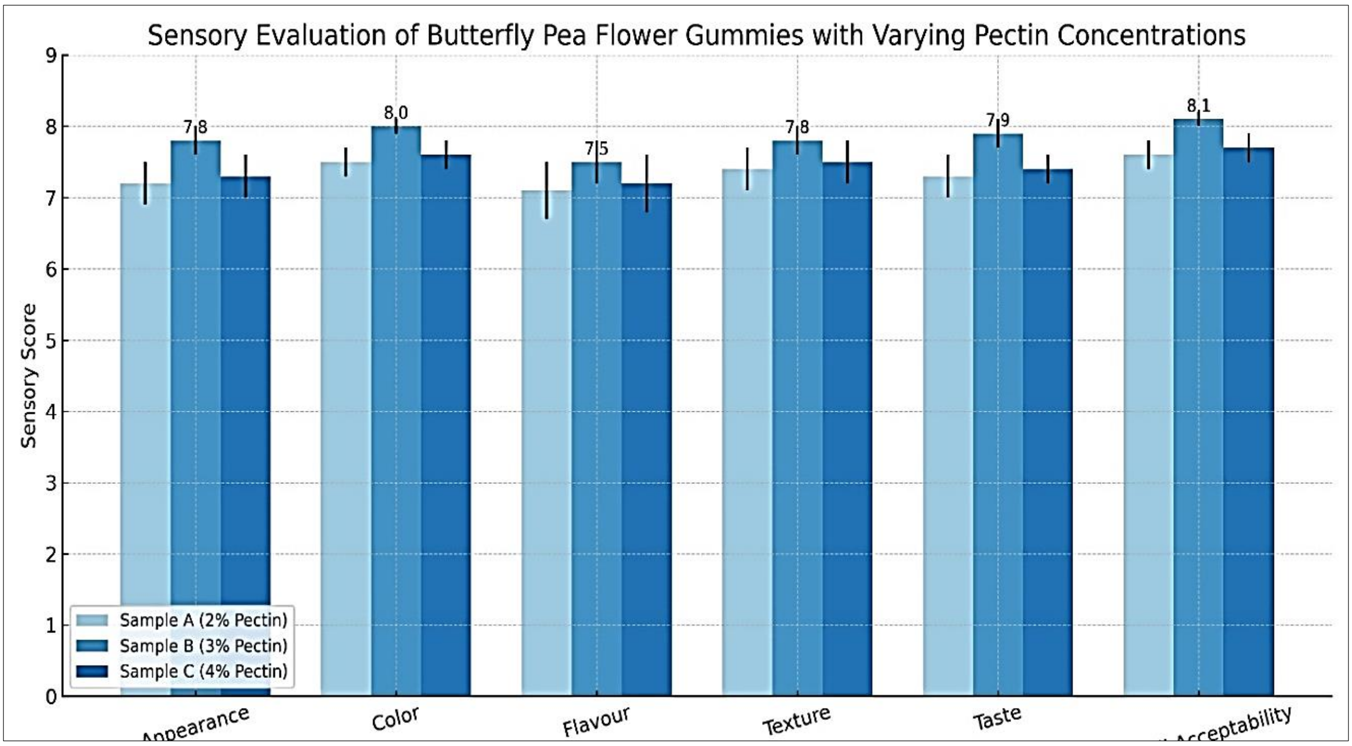


Fig 1: Sensory Evaluation of Butterfly pea flower gummies with varying pectin concentrations

Table 3: Comparison between the levels of acceptability of different treatments by the respondents

Sensory attribute	Sample A	Sample B	Sample C	F- value	p - value
Appearance	7.2±0.4^{b}	7.8±0.3^{a}	7.5±0.5^{ab}	5.12	0.014
Color	7.0±0.5^{b}	8.0±0.5^{a}	8.2±0.5^{a}	6.48	0.007
Flavour	6.9±0.5^{b}	7.5±0.6^{a}	7.0±0.7^{b}	3.98	0.032
Texture	7.3±0.4	7.8±0.5	7.6±0.6	2.56	0.097
Taste	7.1±0.5^{b}	7.9±0.5^{a}	7.4±0.6^{b}	4.89	0.016
Overall Acceptability	7.0±0.5^{b}	8.1±0.5^{a}	7.5±0.6^{b}	8.23	0.002

(a,b,c = indicates the statistical significant differences at $p<0.05$, $p<0.05$ = significant, $p>0.05$ = not significant)

4. Conclusion

Among the three formulations, Sample B with 3 g pectin, exhibited the highest sensory acceptability, with significantly greater mean scores ($p<0.05$) in appearance, color, flavour, taste, and overall acceptability. Its formulation ensured desirable texture and enhanced anthocyanin stability, aligning well with the preferences of the young adult panel. The pectin concentration contributed not only to desirable mouthfeel and structural cohesiveness but also enhanced the nutritional quality of the product through the addition of soluble dietary fibre.

Furthermore, the matrix facilitated effective retention of anthocyanin stability, indicating compatibility with the sensory preferences of the Gen Z demographic while supporting the functional food potential of the formulation.

References

1. Achumi AH, Syukri D, Kusuma IW. Extraction and stability of anthocyanin pigment from butterfly pea flower (*Clitoria ternatea* L.). Int J Appl Chem. 2018;14(3):273-282.
2. Ahmed S, Sulaiman SA, Baig AA, Ibrahim M, Liaqat S, Fatima S, *et al.* Honey as a potential natural antioxidant medicine: An insight into its molecular mechanisms of action. Oxid Med Cell Longev. 2018;2018:8367846.
3. Bhatia H, Kumar Y, Singh B. Pharmacological and phytochemical profile of *Clitoria ternatea* L.: A review. J Pharmacogn Phytochem. 2014;3(3):1-6.
4. Birben E, Sahiner UM, Sackesen C, Erzurum S, Kalayci O. Oxidative stress and antioxidant defense. World Allergy Organ J. 2012;5(1):9-19.
5. Caroline L, Kam SK, Yong SK. Traditional uses and pharmacological properties of butterfly pea (*Clitoria ternatea* L.) flower in Southeast Asia. Asian J Med Plants. 2015;7(6):457-466.
6. Caroline L, Kam SK, Yong SK. Traditional uses and pharmacological properties of butterfly pea (*Clitoria ternatea* L.) flower in Southeast Asia. Asian J Med Plants. 2015;7(6):457-466.
7. Chusak C, Krittasilp K, Ingkaninan K. Anti-inflammatory activity of *Clitoria ternatea* flower extract. J Med Plants Res. 2018;12(4):67-75.
8. Chusak C, Thilavech T, Henry CJ, Adisakwattana S. The effect of anthocyanin-rich extracts from purple rice and butterfly pea on postprandial glycemia and antioxidant capacity in healthy subjects. J Funct Foods. 2018;40:204-210.
9. Ganesan K, Xu B. Polyphenol-rich dry common beans (Phaseolus vulgaris L.) and their health benefits. Int J Mol Sci. 2017;18(11):2331.
10. Jain NK, Singh B, Singh R. Cognitive enhancing activity of *Clitoria ternatea* in rats. Phytother Res. 2003;17(7):718-720.
11. Jamil F, Pa'ee FH. Stability of anthocyanins from *Clitoria ternatea* flower under different pH and temperature conditions. Int Food Res J. 2018;25(2):789-796.
12. Karadag A, Ozcelik B, Saner S. Review of methods to determine antioxidant capacities. Food Anal Methods. 2009;2(1):41-60.
13. Kazuma K, Taira T, Watanabe K. Flavonol glycosides from *Clitoria ternatea*. Phytochemistry. 2003;64(2):597-601.
14. May CD. Industrial pectins: Sources, production and applications. Carbohydr Polym. 1990;12(1):79-99.
15. Mukherjee PK, Kumar V, Mal M, Houghton PJ. Acetylcholinesterase inhibitors from plants. Phytomedicine. 2008;15(4):283-293.
16. Neda M, Kumar KV, Selvaraj C. Phytochemical constituents and pharmacological activities of *Clitoria ternatea*: A review. Int J Pharm Sci Res. 2013;4(8):3001-3006.
17. Nguyen TTH, Nguyen VB. Effect of pH on color stability and antioxidant activity of anthocyanin from butterfly pea flower (*Clitoria ternatea* L.). Viet J Chem. 2019;57(5):602-608.
18. Oguis S, Herawati E, Rahman A. Growth and drought tolerance of *Clitoria ternatea* under varying water regimes. Trop Plant Res. 2019;6(3):589-596.
19. Patel H, Kumar R, Saini A. Influence of processing techniques on stability and bioavailability of anthocyanins: A critical review. J Food Sci Technol. 2021;58(3):873-884.
20. Rabeta MA, Yusof YA, Ismail M. Antioxidant potential of aqueous and methanolic extracts of *Clitoria ternatea* flowers. Int Food Res J. 2018;25(1):209-215.
21. Rai D, Ghosh A, Sen T. Antidepressant and anxiolytic activity of *Clitoria ternatea* in rats. J Ethnopharmacol. 2001;77(1):65-68.
22. Ramaswamy S, Balakrishnan S, Ramaswamy S. Comparative antioxidant activity of methanolic and aqueous extracts of *Clitoria ternatea* flower. Pharmacogn Res. 2011;3(1):15-19.
23. Singh B, Singh K, Kaur J. Traditional and pharmacological applications of *Clitoria ternatea*. J Herb Med. 2018;15:13-21.
24. Sudhakar P, Neelima K, Kumar PA. Role of pectin as a functional ingredient in food and pharmaceutical products. J Food Sci Technol. 2018;55(6):1963-1975.
25. Taranalli AD, Cheeramkuzhy M. Effect of *Clitoria ternatea* extract on learning and memory in rats. Indian J Pharmacol. 2000;32(1):43-47.
26. Thakur BR, Singh RK, Handa AK, Rao MA. Chemistry and uses of pectin—a review. Crit Rev Food Sci Nutr. 1997;37(1):47-73.
27. Thuy BT, Pham HD, Nguyen TT. Stability of ternatins in butterfly pea flower extracts and their application as natural food colorants. J Food Sci Technol. 2021;58(6):2223-2231.
28. Vidana Gamage S, Shanmugam R, Lim H. Butterfly pea (*Clitoria ternatea*): Ethnobotanical uses and phytochemical properties. Medicines. 2021;8(3):61.
29. Wang H, Qian H, Yao W. Melting and gelling behavior of low-methoxyl pectin as influenced by calcium concentration. Food Hydrocoll. 2017;62:282-289.
30. Yuan Y, Gao Y, Zhao J, Mao L. Gelation behavior and properties of low-methoxyl pectin in acidic conditions. Food Hydrocoll. 2022;123:107171.
31. Withey J. Sensory evaluation methods and their applications. London: Food Science Publishers; 2016.
32. Stone H, Sidel JL. Sensory Evaluation Practices. 3rd ed. San Diego: Elsevier Academic Press; 2004.
33. Gulzar T, Iqbal S, Ahmad S, Shahid M. Assessment of sensory acceptability of functional food products enriched with herbal extracts. *J Food Sci Technol*. 2022;59(5):1234–1242.
34. Peryam DR, Pilgrim FJ. Hedonic scale method of measuring food preferences. *Food Technol*. 1957;11(9):9–14.