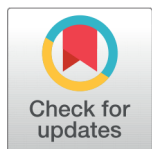


RESEARCH ARTICLE



Butterfly Pea (*Clitoria ternatea*): A natural colorant for soft candy (Gummy Candy)

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Abstract

Background/Objectives: The utilization of natural colorant can improve food appeal. This study determined the potential of *Clitoria ternatea* flower extract as a substitute for synthetic colorants. **Methods:** The researchers prepared gummy candies using 100mL aqueous extracts from various weight samples of *C. ternatea* flowers. Fifty candy eaters with different age brackets were randomly chosen as respondents of this study. The respondents evaluated through the sensorial method the different treatments in terms of taste, texture, color, smell, appearance, and overall palatability using a nine-point scale hedonic scale. The researchers compared the age brackets using the analysis of variance. **Findings:** Results showed that aqueous extract of Treatment 3 (30 grams) has the highest total weighted average mean (TAWM) of 7.78 level of acceptability with a "Like Very Much" description, followed by the TAWM of 6.57 of Treatment 4 (40 grams) with "Moderately Like" description. In comparison, Treatment 1 (10 grams) has the lowest TAWM of 2.97 with a description of "Dislike Moderately." The high level of acceptability implies that *C. ternatea* flower aqueous extract improves the color and appearance of the gummy candies. This study further shows no significant difference in acceptability among the respondents when grouped into age brackets. The researchers conclude that the aqueous flower extract of 30g *C. ternatea* improved the color and appearance of the gummy candies. Furthermore, it could be accepted by the candy consuming public of various ages. **Novelty/Applications (30):** The utilization of *C. ternatea* flower aqueous extract as a colorant improves the acceptability of commercial gummy candies. The use of alternative safe, natural colorants promotes healthy living and sustainable candy production.

Keywords: *Clitoria ternatea*; gummy candies; level of acceptability; sensorial method; hedonic scale

1 Introduction

The use of food colorant in food products is vital in increasing product appeal⁽¹⁾. Food colorants are divided into natural and synthetic food colors. Natural food color is derived from various sources such as seeds, fruits, vegetables, insects, and microorganisms without any chemical treatment⁽²⁾. Synthetic food colorant is water-soluble substances that have been made in a factory and used in foods without any further processing⁽³⁾. Artificial food colors are reliable and economical for restoring the original appearance of the foods compared to the natural colorants, which are expensive and less stable⁽⁴⁾. However, in several cases, food colorants have been misused to conceal lousy quality. Studies linked the consumption of artificial dye to the harmful effect and hyperactivity in children⁽⁵⁾. The synthetic food colorants showed an adverse effect on human health. Consumption of synthetic food color additives could sometimes lead to toxic effects on the liver, kidney, and testes⁽⁶⁾. Synthetic additive usage and synthetic food colors resulted in today's food trend, where everything natural is considered a healthier option. Some alternative to synthetic colors includes anthocyanins, betacyanins, lycopene, turmeric, and chlorophyll⁽¹⁾. One of the most available natural blue sources is the *C. ternatea* flower or Pokindang in the Philippines. The flower contains more than nine types of anthocyanins, which provide the red-purple-blue hues on the extracted pigment.

The food industry traditionally used blue dye aqueous extract from the petal of butterfly pea as a confectionary coloring⁽⁷⁾ and natural colorant for drinks⁽⁷⁾.

C. ternatea originates in Southeast Asia. This perennial plant is erect, with elliptic and obtuse leaves. It grows up 90 to 162 cm as a vine or creeper, doing well in moist, neutral soil⁽⁸⁾. It belongs to the family Fabaceae and has various names. *C. ternatea* is called pokindang in the Philippines. It has various names such as Asian pigeon wings, bluebell vine, blue pea, butterfly pea, Darwin pea, as telang (Malaysia), Kordofan pea (Sudan), and Cunha (Brazil)⁽⁹⁾.

C. ternatea has solitary flowers with vivid, deep-blue, and white coloration. The flowers are 6 to 12 cm long. Furthermore, it contains 6 to 8 brown or black colored seeds per pod, which are slightly pubescent or glabrous^(9,10). The flower of *C. ternatea* appears like a conch-shell that is said to be suitable for the treatment of mental illness⁽¹¹⁾. Butterfly pea flower has high amounts of anthocyanin pigments.

Water-soluble anthocyanins are essential in research. They impart beautiful coloration to food systems and have antioxidant properties and health benefits. These benefits include sight enhancement, antioxidant properties, controlling Type II diabetes, reduction of coronary heart disease, and prevention of cancer⁽¹²⁾.

Anthocyanin pigment from *C. ternatea* has anti-viral and anti-inflammatory properties. Besides, this pigment is antioxidant, anti-allergic, and anti-microbial properties. Further, anthocyanin prevents diabetes, protects the cardiovascular system from damage, and many more health benefits⁽¹³⁾. Moreover, research findings suggested that anthocyanin helps in protecting the cell as an anti-aging agent, protects cell damage, and promoting healthy eyes⁽¹⁴⁾.

Experimental results indicate that *C. ternatea* to be rich in antioxidant properties compared to other flowers and medicine elements. In ancient human civilization, *C. ternatea* has been used to treat neurological disorders⁽¹⁵⁾. Besides, *C. ternatea* shows promising effects as having antioxidant, can cure diabetic and hepatoprotective activities⁽¹⁶⁾. The significant phytoconstituents analyzed in *C. ternatea* are flavonoids, phlorotannins, reducing sugars, and carbohydrates. Other published researches reported the medicinal effects of *C. ternatea*, such as antipyretic, analgesic, and anti-inflammatory⁽¹⁷⁾. These properties are good for one's health and well-being because they help to reduce health disorders.

The antioxidant activity of the aqueous extractions of *C. ternatea* flowers showed a much higher scavenging activity than methanol-based extracts⁽¹⁸⁾. When the concentrations of extracts increased, the extracts' percentage to scavenge off free radicals also increased⁽¹⁹⁾.

Researchers conducted studies and found out that *C. ternatea* flowers can be used as natural substances to reduce blood glucose levels. Researchers administered 150 mg/kg of *C. ternatea* flower extract per kg body weight of diabetic rats⁽²⁰⁾. They reported a significant decrease in glucose level after 14 days. Moreover, a rat treated with *C. ternatea* flower extracts showed improvement against the hyperglycemic and hyperlipidaemic. These properties can prevent liver and renal damage.

Butterfly pea flower plays an essential role in nervine medicine by improving the brain system⁽²¹⁾. Further, the whole plant has medical value. The flower juice extract of *C. ternatea* can cure skin diseases and insect stings⁽²²⁾

Proximate and mineral analysis of *C. ternatea* flowers contained calcium (3.10 mg/g), magnesium (2.23 mg/g), and potassium (1.25 mg/g)⁽²³⁾. The major constituents found in *C. ternatea* were flavonoids, anthocyanins, alkaloids, ternatins, saponins, tannins, taraxerol, and taraxerone. Spectroscopy analysis showed that *C. ternatea* had 14 types of flavonol glycosides⁽²⁴⁾. Moreover, *C. ternatea* contains kaempferol 3-glucoside, quercetin 3-glucoside, and myricetin 3-glucoside.

Natural dye from *C. ternatea* could be a coloring agent for making products⁽¹⁴⁾. In countries like China and Malaysia, people used *C. ternatea* flowers for making blue colored tea and blue rice. This edible natural colorant can be used in any food compound, replacing synthetic colorants in color, taste, and cost economy⁽²⁵⁾. Moreover, anti-pollution and biodiversity

policies imposed environmental standards in response to allergic reactions and toxin in the synthetic dye.

Nowadays, natural candies with high antioxidant properties and medicinal properties are not commercially available at low cost. Antioxidant enriched food products are many, but candies with free radical scavenging activity are rarely found⁽²⁵⁾. Candy equally attracts children and adult age people.

Candy has little nutritional value. Historically, when malnutrition was severe at the onset of the 20th century, the high-calorie content of candies was promoted as a virtue among the poor and working-class people. Researchers suggested that candy, especially candy with milk and nuts, was a low-cost alternative to healthy meals⁽²⁶⁾. In this study, the researchers added gelatin to make the candy gummier and more appetizing to consumers of all ages. Gummy candies are made with a gelatin base and are often flavored with fruit juice extracts. Gelatin gives a distinctive chewy texture that ranges from soft to very firm, depending on the gelatin amount used. Gelatin is a thickening agent similar to agar-agar. However, it has made from the collagen found in animal skin and bones.

Food attributes depend on sensory evaluations. One of these attributes is food texture. Texture evaluation is affected by age⁽²⁷⁾. Another visual food attribute is color. Food color is known to affect food evaluation, and it varies according to age⁽²⁸⁾. Generally, the appearance of foods includes color and texture⁽²⁹⁾. Aside from these, taste and overall food palatability depends on the ingredients of the food product.

This study determined the potential of using the Butterfly pea flower extract as a substitute for synthetic colorant to soft candy. This study determined the level of acceptability of the different treatments by the respondents. It further determined if there was a significant difference in the level of acceptability of the treatments of the respondents when grouped according to age profile.

2 Materials and Methods

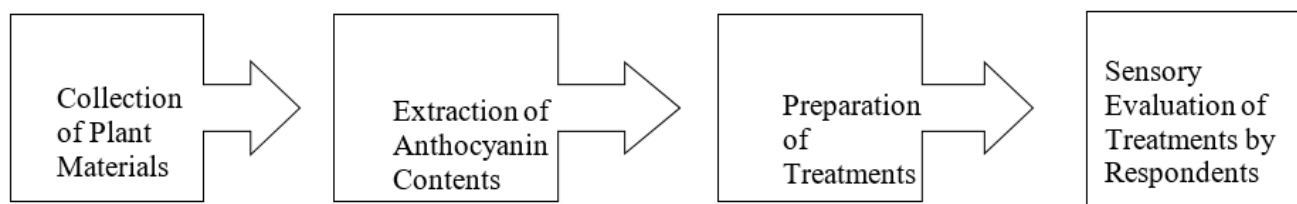
The researchers conducted the study in selected areas of Tabuk City, Kalinga, Philippines, and used the descriptive method in this study. They determined the level of acceptability of the treatments through sensorial evaluation with questionnaires.

The researchers selected the respondents randomly from the general public who ate candies. Then the researchers grouped the respondents based on their age brackets with ten years range. The lowest age bracket of candy eaters who can respond to the survey was 6-15 years old, followed by 16-25 years old, 26-35 years old, 36-45 years old, and 46 years old and above. The researchers chose the first ten interested candy eaters as respondents in the five age brackets. A total of 50 respondents participated in this study.

The respondents evaluated the different treatments using the 9-point hedonic scale with a range of descriptions of “like extremely” to “dislike extremely,” adopted from the work of Peryam⁽³⁰⁾.

2.1 Preparation and sensorial evaluation of gummy candy samples

The preparation of gummy candy samples followed the following flow-chart.



2.1.1 Collection of plant materials

The researchers collected fresh Butterfly Pea Flowers (*C. ternatea*) from home gardens. The individual flower, without defects and diseases, was selected and de-stemmed. The researchers stored samples at 4°C using a standard refrigerator before the experiment, which was not more than three days after the harvest. The aqueous extraction of *C. ternatea* flowers was carried according to the procedure of Kuntapas Kungsuwan⁽³¹⁾.

2.1.2 Extraction of anthocyanin contents

The researchers performed the aqueous extraction method in this study. This extraction method minimizes contamination from the chemical and harmful substances. Different amounts of *C. ternatea* flowers mixed with 1000mL distilled water were used as treatments. These treatments were as follows; Treatment 1 (T1) = 10g *C. ternatea* flowers, T2=20g *C. ternatea*, T3=30g *C. ternatea*, and T4= 40g *C. ternatea*. The researchers separately extracted the natural dyes from the different treatments. The process started with submerging the different treatments in 1000mL of water for 30 minutes. Then, the researchers mixed the *C. ternatea* flowers and distilled water using a commercial blender for 30 seconds. Moreover, the resulting mixture was filtered through 2 layers of cheesecloths to get the crude extracts of the treatments.

2.1.3 Preparation of gummy candy

The resultant crude extracts of the different treatments were separately mixed with 6tbsp Ferna Gelatin, 6tbsp raw honey, and 6tbsp lemon juice to prepare gummy candy. In a small saucepan, combine lemon juice and honey over medium-low heat using a whisk to stir the mixture. The researchers added gelatin into the mixture with constant stirring. Avoid dumping the gelatin at once because it could cause big globs formation that affects the product.

The crude extract of the treatment was added to the mixture, and heating was continued over medium-low heat until all ingredients were mixed thoroughly. The gelatin was completely melted. Well-melted gelatin would change from a grainy, jelly-like consistency to a glassier, smooth consistency.

The mixture was poured into a gummy candy molder and placed in the freezer for about 2 hours to firm up. The gummy candies were removed from the freezer and popped from the molders, and stored in airtight containers. Then we kept in refrigerators for up to 2 weeks. The researcher used the same procedure in preparing different treatments. The gummy candies prepared from the different treatments served experimental gummy candies. Meanwhile, the researchers used a commercial candy as a control treatment.

2.1.4 Sensory evaluation

Sensory evaluation offered the opportunity to obtain a complete analysis of the various properties of food as perceived by the human sense. The evaluation was an important and best method for evaluating new products developed, which provide a quality measure and production control. The respondents sensory evaluated the treatments using a hedonic (9 point) scorecard.

Every respondent evaluated a set of sampling products of gummy candies for taste-testing and rating scales. The taste parameters evaluated included the taste, texture, color, smell, appearance, and overall palatability of the products. We arranged the treatments in a completely randomized design (CRD).

In between testing samples, they were given apple slices as one of the great and most available palate cleansers. The apple helped distinguish flavors between the products when testing and will not affect the results.

2.1.5 Statistical analysis

The data were analyzed and interpreted using weighted means and ranking. The Analysis of Variance (ANOVA) was used to find significant differences in the acceptability of the treatments as to age brackets. SPSS version 16 was used to analyze the data.

3 Results and Discussion

3.1 Level of acceptability of the different treatments based on different sensorial parameters

Table 1 shows that T3 ranks 1st among the treatments with an average weighted mean of 7.78, followed by T4 with 6.57. Treatment 1 ranks 5th with the lowest weighted mean of 2.97. The result shows that the incorporating 30g of *C. ternatea* petals in gummy candy could improve the taste, texture, color, smell, appearance, and overall palatability of the experimental treatment. The high total weighted mean indicates improvement.

Treatment 1 (T1) has a level of acceptability total average weighted mean of 2.97 with a description of “Dislike Moderately.” The result shows that the respondents moderately dislike T1. The minimum amount of 10g of *C. ternatea* petals could have affected the taste, texture, color, smell, appearance, and overall palatability of gummy candies. The color has a mean of 2.33 with a “Dislike Very Much” description. This result shows that the gummy candies’ color with 10g *C. ternatea* petals is not attractive to the respondents.

Treatment 2 (T2) shows a total weighted average mean of 5.90 with a “Like Slightly” description. It indicates that as the amount of *C. ternatea* petals increased from 10g to 20g, there is an increase in the weighted average mean from 2.97 to 5.90.

The respondents’ sensory evaluation weighted mean increased to 7.78 with the “Like Very Much” description in T3. The increase implies that 30g *C. ternatea* flower petals improved the acceptability of experimental gummy candies. The color

acceptance of the gummy candy increases to a weighted mean of 8.22 with a “Like Extremely” description.

Increasing the amount of *C. ternatea* flower petals to 40g seems to lessen the gummy candies’ acceptability to the respondents. The respondents’ taste, texture, and smell on T4 are “Like Slightly.” Meanwhile, the appearance and overall palatability of T4 have a “Like Moderately” description. Further, T4 shows the highest weighted mean of 8.06 in terms of color with a “Like Very Much” description. The result shows that a higher amount of pigment extract increases the gummy candies’ attractiveness but decreases the acceptability of the tastes, texture, and smell of gummy candies.

The researchers used a commercial candy (Gummy Series) as a control treatment (T5) in this study. Table 1 shows that T5 has the lowest weighted mean of 2.30 for texture and the highest weighted mean of 3.90 for an appearance with “Dislike Very Much” and “Dislike Slightly” descriptions. Meanwhile, T5 has a total average weighted mean of 3.07 with a “Dislike Moderately” description.

Table 1. Comparison of the weighted means of the parameters of different treatments

Treatments	Parameters					TAWM	Description	Rank
	Taste	Texture	Color	Smell	Appearance			
T1	3.48	3.40	2.33	2.88	2.90	2.80	DM	5
T2	6.00	5.94	5.59	6.08	5.56	6.20	LS	3
T3	7.70	7.62	8.22	7.66	7.70	7.82	LVM	1
T4	6.02	6.16	8.06	6.20	6.42	6.40	LM	2
T5	2.86	2.30	3.06	3.18	3.90	3.12	DM	4

Legends: TAWM-totalaverage weighted mean, DM-dislike moderately, LS-like slightly, LVM-like very much, LM-like moderately

3.2 Mean difference of the level of acceptability of the treatments by the respondents when grouped to age-brackets

The researchers compared the level of acceptability among the different age brackets of the respondents (Table 2).

Table 2. Mean difference in the acceptability of the gummy candy by respondents when grouped according to age brackets.

Age bracket (years)	Total Average Weighted Mean	F-computed	F-crit	Probability
06-15	5.3148	.011 ^{ns}	2.866081	0.999753
16-25	5.3600			
26-35	5.1067			
36-45	5.3200			
46 above	5.2171			

ns= no significant difference

Table 2 shows a computed F-value of 0.011, which is lower than the critical value of 2.866 with a probability of 0.999. This finding indicates no significant difference in the level of acceptance of the respondents when grouped into age brackets. This result shows that the level of acceptability of the treatments by respondents six years and above does not differ significantly. This finding means the gummy candy product with *C. ternatea* colorant is acceptable to children and adults.

4 Conclusion

The aqueous flower extract of 30g *C. ternatea* improved the color and appearance of the gummy candies, thus resulting in a higher level of acceptability. This study shows that the gummy candies with *C. ternatea* flower colorant are acceptable to consumers aging six years and above.

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