Original Article
Food Science and Technology
ISSN 0101-2061 (Print)
ISSN 1678-457X (Online)
DOI: https://doi.org/10.5327/fst.00120

Chemical and Organoleptic Characteristics of Beef Meatballs Added With Butterfly Pea Flower Powder (*Clitoria ternatea L.*)

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Abstract

Meatballs are one of the favorite foods in the world. Adding butterfly pea flower powder to meatball products can increase their functional value. This study aimed to determine the effect of the concentration of butterfly pea powder on the chemical and organoleptic characteristics of the meatballs. The research methodology included four treatments and three repetitions. The experimental design used was a completely randomized design (CRD) with four treatments, namely, T0 (control), T1 (0.75 g/300 g butterfly pea flower extract), T2 (1.5 g/300 g butterfly pea flower extract), and T3 (2.25 g/300 g of butterfly pea flower extract). This study shows the highest water content in the T3 formulation of 79.63% and the lowest in the T1 formulation of 63.36%. The highest fat content was in the T3 formulation of 17.11% and the lowest was in the T0 formulation of 16.28%. The highest protein content was in the T3 formulation of 15.25%, and the lowest protein content was in the T0 formulation of 14.66%. This study also showed the antioxidant activity with the intensity of the IC50 value in the moderate category in the T1 formulation of 117.29 mg/L. It showed the active category in the T3 formulation of 87.13 mg/L. The formulation of beef meatballs with the addition of butterfly pea flower powder did not significantly affect the value of protein content, fat content, and antioxidant activity contained therein. Differences in the formulation of beef meatballs with the addition of pea powder significantly affected the quality attributes of aroma, texture, taste, and color in the four treatments.

Keywords: beef meatballs; butterfly pea flower; chemical characteristics.

Practical application: This text is relevant for the food industry, especially products with the addition of natural colorings. Apart from providing color to food, especially meatballs, this research also aims to increase the nutritional value of drinks by adding natural coloring substances containing anthocyanins which can function as antioxidants. This research also aims to increase the marketability of butterfly peas as a food ingredient. This research can be applied to the food industry, especially to products that have characteristics that resemble meatballs such as sausages, nuggets, etc.

1 INTRODUCTION

As the name implies, the butterfly pea flower (*Clitoria ternatea* L.) originates from Ternate, Maluku. This plant can grow in tropical areas such as Asia, so its spread has reached South America, Africa, Brazil, the North Pacific, and North America. Butterfly pea flower is well known by its various names such as Butterfly pea (English), telang flower (Java), and Mazerion Hidi from Arabic (Angriani, 2019). Genetically, butterfly pea also has high diversity (Nurhasanah et al., 2023). In addition, the yield potential of each butterfly pea accession is also different (Filio et al., 2023)—the opportunity for developing research on these plants.

Butterfly pea flowers have been widely used as a dye in various local food products in Indonesia and Southeast Asian countries. Several researchers reported that butterfly pea is often used as traditional herbal medicine (Mukherjee et al., 2008), natural dye (Kumar & Prabha, 2018), and animal feed (Abreu et al., 2014). This utilization is still limited to food products that last only a short time. Knowing and identifying it in depth is necessary to utilize the butterfly pea flower extract optimally. Identification of the potential of butterfly pea flowers in food products is known by various pH and temperature treatments on storage time (Handito et al., 2022).

Butterfly pea flowers in Indonesia are widely used as a food coloring agent or as a herbal medicine, which is not consumed widely in society. They are used in the food sectors in various countries. In Malaysia, butterfly pea flower is widely used as a coloring agent. In Kerala (India) and the Philippines,

Received 6 Aug., 2023.
Accepted 19 Sept., 2023.
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people consume butterfly pea flowers as vegetables (Martini et al., 2020).

The main use of the butterfly pea flower is that it acts as a dye due the presence of anthocyanin pigments, which are red to deep purple. Anthocyanins have an aromatic ring structure that has a polar component and a glycosyl residue; therefore, they can produce polar molecules. The opposite nature of anthocyanins causes them to dissolve more easily in water than in non-polar solvents (Enaru et al., 2021). In addition, anthocyanins can also dissolve in some solvents, such as ether, because they have molecules that ionize well in polar solvents (Enaru et al., 2021).

According to Vidana-Gamage et al. (2021), butterfly pea flowers have high antioxidant activity due to the presence of flavonoid compounds and the color, namely, anthocyanin in the flower crown, so that they can used as an additive in food manufacturing processes such as antioxidants and natural dyes. Besides purple, the color of the butterfly pea flower is also blue and red, which is caused by the presence of anthocyanin compounds. The content of anthocyanin phytochemical compounds in butterfly pea flowers has good stability, so it can used as a local natural dye in the food industry. Other phytochemicals contained in butterfly pea flowers are flavonoids. The flavonoids in butterfly pea flowers can act as a source of antioxidants. Various food industries can develop the flavonoid content. In addition to increasing the quality attributes of color, it can also affect health (Angriani, 2019).

Meat can be processed into various types of attractive products with different shapes and flavors to extend the shelf life and increase the economic value without reducing the nutritional value of the processed meat. Processed meat that has long been known and is very popular is meatballs. Meatballs are processed meat products where the meat is mashed first, mixed with spices and flour, and then formed into balls, especially small balls, which are then boiled in hot water (Siswara et al., 2022).

Meatballs are gel products derived from meat protein, beef, chicken, fish, or shrimp. Besides animal protein, various meats contain other nutrients, including essential amino acids that the human body needs. Therefore, meatballs must be able to meet the public's demand for protein. Meatballs were made using sago flour and meat. High-quality meatballs usually contain 90% meat and 10% sago flour (Ikhlas et al., 2008). The main component in the filler for making meatballs is starch, which has a non-sweet taste, does not dissolve in cold water, and can form a thick gel (Amrullah, 2017).

This study aimed to determine the effect of the concentration of butterfly pea powder on the chemical characteristics of meatballs and the impact of the concentration of butterfly pea powder on the organoleptic properties of meatballs.

2 METHODOLOGY

2.1 Place and time

This study was done in the Postharvest Laboratory, which is an integrated laboratory of the Faculty of Agriculture, University of Garut, from August to October 2022.

2.2 Tools and materials

The tools used in making meatballs were a cooper, knife, basin, cutting board, pan, plastic gloves, spoon, stove, and analytical scales. The tools used in the analysis process were a Soxhlet flask, a Kjeldahl flask, a spatula, a 50-mL volumetric flask, a 10-mL volumetric flask, and a flask.

Grease, oven, desiccator, filter paper, beaker glass, measuring cup, elementer, pipette, burette, funnel, oven, test tube, and test tube rack were used. The raw materials used in meatball preparation were beef, butterfly pea powder, tapioca flour, garlic, ice cubes, seasonings, pepper, salt, and baking powder. The materials used in chemical analysis were distilled water, DPPH liquid, ether (solvent), HCl, methanol, K_2SO_4, $CuSO_4$, H_3BO_3, NaOH, and H_2SO_4.

2.3 Research methods

The experimental design in this research used a completely randomized design (CRD), and the study was conducted in four formulations. The treatment factors were as follows:

1. T0 (control);
2. T1 (0.75 g butterfly pea flower extract/300 g dough);
3. T2 (1.5 g or 300 g of butterfly pea flower extract);
4. T3 (2.25 g/300 g of butterfly pea extract).

The treatment was repeated three times, so there were 12 experimental units. Based on this design, a research layout can made.

The analysis of the data from the results of the study was carried out based on a linear model of non-factorial CRD, according to Gomez and Gomez.

The data obtained were analyzed using the analysis of variance (ANOVA) technique with a list of analyses. The difference in each treatment was determined using the F test with the following decision-making rules:

F-value ≤ 0.05 = No significant effect;

F-value ≥ 0.05 = Significant effect.

The results of the various analyses were then F-tested to determine the level of difference in each treatment. If the calculated F-test value exceeded the value in the F-table, the Duncan test (DMRT) at the 5% level was used.

3 RESULTS AND DISCUSSION

In this study, one variable was observed, namely, the concentration ratio of the addition of butterfly pea powder to beef meatballs, with four formulations, namely, T0 (control), T1 (0.75 g), T2 (1.5 g), and T3 (2.25 g). The parameters analyzed included the physical and chemical characteristics of the butterfly pea flour meatballs (e.g., moisture content, antioxidant activity, fat content, protein content, and organoleptic properties).

3.1 Analysis of chemical properties

3.1.1 Water Content

The results of the ANOVA showed that the ratio of beef meatballs added with butterfly pea powder had a significant effect (0.05) on water content. The level of significant difference was tested with Duncan's test and is presented in Table 1.

Table 1 shows that the results of the Duncan test for the water content contained in the beef meatballs added to the butterfly pea flower powder were significantly different between formulations. The water content of the meatballs added to the butterfly pea powder in the T2 formulation (63 ± 1.40) was substantially different from formulations T0 (74.53 ± 2.11), T1 (63.36 ± 1.33), and T3 (79.46 ± 1.17). Formulation T0 (74.53 ± 2.11) showed no significant difference from T2 (63 ± 1.40), and T3 (79.46 ± 1.17) showed substantial differences from formulations T0 (74.53 ± 2.11), T1 (63.36 ± 1.33), and T2 (63 ± 1.40). The high or low water content is due to the influence of the water content in the main ingredients for making meatballs, namely, beef and butterfly pea flower.

The water content is in line with that reported by Riansyah et al. (2013), where fresh butterfly pea flowers have a very high water content of 91.74% with a slight reduction after withering for 8 h to 87.79%, and beef has an average water content of 77.65% (Prasetyo et al., 2013). With the water content present in the T2 formulation, the water content of butterfly pea meatballs is 79.63%. Moisture content is a factor that determines the shelf life of the product. The higher the water content in a food product, the more vulnerable it will be and the shorter its shelf life of 91.74%, with a slight reduction after withering for 8 h to 87.79%.

3.1.2 Fat

The results of the analysis of the fat content value of beef meatballs added to the butterfly pea powder from each treatment are presented in Table 2.

Table 1. Value of water content of beef meatballs added with the butterfly pea flower powder.

No.	Formulation	Moisture Content (%db)
1	T0	74.53 ± 2.11b
2	T1	63.36 ± 1.33a
3	T2	79.63 ± 1.40b
4	T3	79.46 ± 1.17c

According to Duncan's test, the numbers in the column followed by different letters show a significant difference at the level of $\alpha < 0.05$.

Table 2. Value of fat content of beef meatballs added with the butterfly pea flower powder.

No.	Formulation	Fat Content (%db)
1	T0	16.28 ± 0.17a
2	T1	16.48 ± 0.20a
3	T2	16.60 ± 0.14a
4	T3	17.11 ± 0.22b

According to Duncan's test, the numbers in the column followed by different letters show a significant difference at the level of $\alpha < 0.05$.

The results of the ANOVA and Duncan's follow-up test found that the ratio of beef meatballs added to the butterfly pea powder had a significant effect ($\alpha < 0.05$) on fat content. In Table 2, the fat content values for beef meatballs added with butterfly pea powder were significantly different between formulations. T0 formulation (16.28 ± 0.17) showed no significant difference with T1 (16.48 ± 0.20) and T2 (16.60 ± 0.14), while the T3 formulation (17.11 ± 0.22) led to a significant difference from the other three formulations. There was no significant difference in value in terms of the numbers produced in the four formulations. The fat contents were due to the addition of butterfly pea flower powder to beef meatballs, which is not added too much when making beef meatballs. According to Neda et al. (2013), the fat content in the butterfly pea flower is 2.5 g per 100 g of the material. This shows that the high-fat content in beef meatballs added with butterfly pea powder is mainly produced from beef, which has a fat content of 14 g per 100 g of the material. The use of meat itself in each formulation is equal to 150 g of beef, and the benefit of other additional ingredients as a whole in each formulation is as much as 300 g before adding the butterfly pea powder.

3.1.3 Antioxidants

Antioxidants are substances or compounds that mainly prevent free radicals, especially in body cells. One example of a free radical that body cells can produce under oxidative stress is lipid peroxide. Lipid peroxide is a by-product of the oxidation of free fatty acids and has radical properties against cells or other cell components. Exploration of natural antioxidant sources is essential because synthetic antioxidants have been reported to trigger tumor growth in experimental animals (Enaru et al., 2021). The levels of antioxidants contained in beef meatballs added with butterfly pea powder were tested using the 1,1-diphenyl-2-picryhydrazil (dpph) method. The results of the ANOVA followed by the Duncan's test on beef meatballs added with butterfly pea powder showed a significant difference in the antioxidants produced (Table 3).

Table 3 shows significant differences in the results of testing the antioxidants contained in beef meatballs that were added with the butterfly pea flower powder. T1 has a value of 117.29 mg/L; T2 has a value of 104.47 mg/L; and T3 has a value of 87.13 mg/L. The results of the antioxidant test showed that the IC50 content found in the meatballs was added with the butterfly pea flower powder. The antioxidants produced in each formulation have different intensities. The IC50 value intensity category (g/mL) is divided into four groups, namely, the Very Active category < 50, Active 50–100, Moderate 100–250, Weak 250–500, and Inactive > 500 (Fatmawaty et al., 2019). The research results show that the

Table 3. Value of antioxidant levels of beef meatballs added with the butterfly pea powder.

No.	Treatment	IC50 (mg/L)
1	T1	117.29 c
2	T2	104.47b
3	T3	87.13 a

According to Duncan's test, the numbers in the column followed by different letters show a significant difference at the level of $\alpha < 0.05$.

IC50 value contained in the T1 formulation, with a total value of 117.29 mg/L, is in the moderate category, which is the same as the T2 formulation, which weighs 104.47. Meanwhile, T3, with an IC50 value of 87.13, is classified as an active category because boiling the meatballs reduces the antioxidant levels. The process of boiling beef meatballs, added with the butterfly pea flower powder, is done by molding them first by hand and then boiling them until they have a chewy texture. This process can cause a reduction in the antioxidant content of the meatballs added with the butterfly pea flower powder. The process is due to the loss of antioxidant compounds in the meatballs during the boiling process. High temperatures and prolonged boiling times caused the loss of antioxidants in meatballs. Apart from that, another factor was the increasing number of compounds that have antioxidant effects carried in the water fraction, causing the measured antioxidant activity to be low.

3.1.4 Protein

Protein is a fundamental food substance because it functions as a fuel in the body. Protein is a source of amino acids containing C, H, O, and N, which are not supplied by fat or carbohydrates (Wahdania et al., 2021). The protein content of the beef meatballs added to the butterfly pea powder is presented in Table 4.

Table 4 shows that the meatball formulation added to the butterfly pea powder was similar to the four formulations tested. From the analysis of protein content, the T0 formulation (14.66 ± 0.17) was not significantly different from formulations T1 (15.00 ± 0.20), T2 (15.07 ± 0.54), and T3 (15.25 ± 0.18). T3 has a relatively high protein value among the other three formulations, and the lowest protein value is in the T0 formulation (14.66 ± 0.17). The value is due to the influence of adding butterfly pea powder. The butterfly pea flower contains a reasonably high protein content, varying from 15 to 25% (Odeyinka et al., 2004). Apart from butterfly pea flower powder, protein content sources are also obtained by using main ingredients such as beef and tapioca flour. The protein content of beef varies between 16% and 22% (Bohrer, 2017), and the protein content of tapioca flour is 32% per 100 g of the materal. Therefore, beef meatballs can be categorized as food that has a relatively good nutritional content and high protein content. After the addition of butterfly pea powder, the meatballs contain many nutrients, such as antioxidants, antibacterial, anti-inflammatory, analgesic, antiparasitic, antidiabetic, anticancer, antihistamine, immunomodulatory activities, which play a potential role in the central nervous system.

3.2 Organoleptic properties

Conducting a test to determine a reasonable and acceptable formulation for the panelists to know the best formulation of beef meatballs added with the butterfly pea flower powder is necessary. Observations of the organoleptic properties included color, taste, texture, and aroma.

3.2.1 Aroma

Table 5 shows the aroma parameter values for beef meatballs added with the butterfly pea flower powder. Adding butterfly pea flower powder significantly affected the meatball's aroma parameters in the T0 formulation (3.84 ± 0.03). Meanwhile, the other three formulations showed no significant differences. The highest aroma parameter value is in the T0 formulation (3.84 ± 0.03). Meatballs with different meat storages produced an aroma value of 4.7 with a meat storage time of 8 days, while 1 day of meat storage produced a value of 5.3 (Firahmi et al., 2015). The meatball's aroma is influenced by the main ingredients and the addition of spices and seasonings. According to Firahmi et al. (2015), spices are ingredients that are deliberately added to improve consistency, nutritional value, taste, control acidity and alkalinity, and stabilize the shape and appearance of the product. The results showed that the addition of the butterfly pea flower powder to the meatballs did not have a significant effect on the aroma. In other studies, butterfly pea flowers added to yogurt as a colorant did not affect the aroma (Dewi et al., 2019). Melati and Rahmadani (2020) reported that the butterfly pea flower extract does not produce a scent when added to food. Adding 0.75 g of butterfly peas to cendol drinks does not provide a significant aroma (Fizriani et al., 2021). The sensory quality of meatballs has a dominant aroma of fresh boiled meat and does not smell rancid, sour, stale, or rotten (Cahyono & Suryani, 2013). It explains that the amount of meat and other ingredients strongly influences the meatball's aroma.

3.2.2 Taste

The parameter value of beef meatballs's taste added by the butterfly pea flower powder is shown in Table 6. The addition of the butterfly pea extract significantly affected the taste parameters of the meatballs added to the butterfly pea powder. Formulation T0 (4.04 ± 0.01) was significantly different from formulations T1 (3.36 ± 0.02), T2 (3.52 ± 0.01), and T3 (3.24 ± 0.01). For the T1 formulation (3.36 ± 0.02), it was significantly different from formulations T0 (4.04 ± 0.01), T2 (3.52 ±

Table 4. The protein content of the beef meatball added with the butterfly pea flower powder.

No.	Formulation	Protein content (%db)
1	T0	14.66 ± 0.17a
2	T1	15.00 ± 0.20a
3	T2	15.07 ± 0.54a
4	T3	15.25 ± 0.18a

According to Duncan's test, the numbers in the column followed by different letters show a significant difference at the level of $\alpha < 0.05$.

Table 5. Parameter values for the aroma of beef meatballs added with the butterfly pea powder.

No.	Formulation	Aroma
1	T0	3.84 ± 0.03b
2	T1	3.16 ± 0.02a
3	T2	3.2 ± 0.01a
4	T3	3.12 ± 0.00a

According to Duncan's test, the numbers in the column followed by different letters show a significant difference at the level of $\alpha < 0.05$.

0.01), and T3 (3.24 ± 0.01). The T2 formulation (4.04 ± 0.01) was significantly different from T0 (4.04 ± 0.01), T1 (3.36 ± 0.02), and T3 (3.24 ± 0.01). The T3 formulation (3.24 ± 0.01) was significantly different from the other three formulations, namely, T0 (4.04 ± 0.01), T1 (3.36 ± 0.02), and T2 (4.04 ± 0.01). The highest taste parameter value in the T0 formulation was without treatment. The panelists' preference level for the beef meatball product added to the butterfly pea flower powder was primarily similar to the meatballs without adding butterfly pea flower powder. According to Rosita et al. (2015), the sense of taste can distinguish four main types of taste: salty, sour, sweet, and bitter. Several factors, such as chemical compounds, their concentration, and their interactions with other components, influence the taste.

3.2.3 Texture

Information regarding the texture parameter values of beef meatballs added with the butterfly pea flower powder is shown in Table 7. The test results showed that the addition of the butterfly pea flower powder has no significant differences in the texture of the meatballs. Meatballs with formulations T1 (3.52 ± 0.01), T2 (3.2 ± 0.00), and T3 (3.12 ± 0.01) were significantly different from T0 (3.64 ± 0.04). The highest value in texture was obtained in the formulation without adding butterfly pea flower powder (control), namely, T0 (3.64 ± 0.04). Addition of the butterfly pea flower powder to beef meatballs affected the preferences of different panelists. Each formulation has a different texture, as does the level of preference that the panelists are interested in. Coagulation of protein, gelatinization of collagen, release of water, swelling, and gelatinization of starch influence the change in texture. Rosita et al. (2015) stated that the level of filler addition aims to improve the elasticity of the final product and form a dense texture. Thus, administering butterfly pea flower powder has a positive impact on meatballs.

Table 6. The taste and parameter value of beef meatballs' taste added with the butterfly pea flower powder.

No.	Formulation	Taste
1	T0	4.04 ± 0.01d
2	T1	3.36 ± 0.02 b
3	T2	3.52 ± 0.01c
4	T3	3.24 ± 0.01a

According to Duncan's test, the numbers in the column followed by different letters show a significant difference at the level of $\alpha < 0.05$.

Table 7. Texture parameter values of beef meatballs added with the butterfly pea flower powder.

No.	Formulation	Texture
1	T0	3.64 ± 0.04b
2	T1	3.52 ± 0.01ab
3	T2	3.2 ± 0.00a
4	T3	3.12 ± 0.01a

According to Duncan's test, the numbers in the column followed by different letters show a significant difference at the level of $\alpha < 0.05$.

3.2.4 Color

Information about the color parameter values of beef meatballs added with the butterfly pea flower powder is shown in Table 8. The addition of butterfly pea flower powder showed no significant difference in the color of the meatballs. The highest values obtained in the T0 formulation were 3.32 ± 0.01, and the T3 formulation was 3.32 ± 0.00. The addition of the butterfly pea flower powder had no significant effect. The amount of butterfly pea flower powder added to the meatballs was not too much so that it had an impact on the panelists' preference level for the color found in the beef meatballs added with the butterfly pea flower powder.

In meatball products, the meatballs are not purple but greenish blue. Butterfly pea flower powder contains anthocyanins. These anthocyanins are amphoteric, which can react with acids and bases. In acidic media, anthocyanins turn red, while in alkaline media, they turn purple and blue (Palimbong & Pariama, 2020). Dewi et al. (2019) explained that the higher the addition of butterfly peas, the lower the panelists' preference for color parameters. It is caused by the product formulation with higher levels of butterfly pea extract, causing the product color to become darker. Devina (2018) stated that the addition of 20% butterfly pea flower extract produced the best color in making ice cream. The color of cooked meat is generally gray, and the discoloration happens because of the denaturation of globin and the Maillard reaction. According to Rosita et al. (2015), apart from being driven by pigments, discoloration in cooked meat results from globin denaturation and is influenced by carbohydrate caramelization and Maillard reactions between reducing sugars and amino acids. Thus, further study is needed to obtain the best color composition for meatballs with the addition of the butterfly pea flower powder.

4 CONCLUSION

Based on the results of the research, it can be concluded as follows:

1. The formulation of beef meatballs added with the butterfly pea powder was similar in the proximate values of protein content, fat content, and antioxidant levels.
2. Differences in the formulation of beef meatballs added with the butterfly pea powder significantly affected the quality attributes of aroma, texture, taste, and color in the four treatments.

Table 8. Color parameter values of beef meatballs added with the butterfly pea flower powder.

No.	Formulation	Color
1	T0	3.32 ± 0.01a
2	T1	2.96 ± 0.06a
3	T2	3.24 ± 0.00a
4	T3	3.32 ± 0.00a

According to Duncan's test, the numbers in the column followed by different letters show a significant difference at the level of $\alpha < 0.05$.

REFERENCES

Abreu, M. L. C., Vieira, R. A. M., Rocha, N. S., Araujo, R. P., Gloria, L. S., Fernandes, A. M., de Lacerda, P. D., & Junior, A. G. (2014). *Clitoria ternatea* L. as a potential high quality forage legume. *Asian-Australasian Journal of Animal Sciences*, *27*(2), 169-178. https://doi.org/10.5713%2Fajas.2013.13343

Amrullah, M. (2017). *Addition of sago flour with different levels on the quality (Organoleptic) of chicken meatballs*. Thesis, Faculty of Science and Technology Alauddin State Islamic University Makassar.

Angriani, L. (2019). Potential of butterfly pea flower extract (*Clitoria ternatea*) as local natural colorant in various food industries. *Canrea Journal*, *2*(2), 32-37. https://doi.org/10.20956/canrea.v2i1.120

Bohrer, B. M. (2017). Review: Nutrient density and nutritional value of meat products and non-meat foods high in protein. *Trends in Food Science and Technology*, *65*, 103-112. https://doi.org/10.1016/j.tifs.2017.04.016

Cahyono, A., & Suryani, T. (2013). *Protein content and organoleptic tests of meatballs made from different compositions of beef and mushrooms (Volvariella Volvaceae)*. Doctoral Dissertation, University of Muhammadiyah Surakarta.

Devina, D. (2018). *Potential of butterfly pea flower extract (Clitoria ternatea L.) as a source of antioxidants and natural colorants in ice cream*. Doctoral Dissertation, UAJY.

Dewi, A. P., Setyawardani, T., & Sumarmono, J. (2019). The effect of butterfly pea (*Clitoria ternatea*) addition on syneresis and levels of pleasure of goat milk yoghurt. *ANGON: Journal of Animal Science and Technology*, *1*(2), 145-151. https://doi.org/10.20884/1.angon.2019.1.2.p145-151

Enaru, B., Dretcanu, G. D., Stanila, A., & Diaconease, Z. (2021). Anthocyanins: factors affecting their stability and degradation. *Antioxidants*, *10*(12), 1967. https://doi.org/10.3390/antiox10121967

Fatmawaty, Anggreni, N. G. M., Fadhil, N., & Prasasty, V. D. (2019). Potential In Vitro and In Vivo Antioxidant Activities from *Piper Crocatum* and *Persea Americana* Leaf Extracts. *Biomedical and Pharmacology Journal*, *12*(2). https://doi.org/10.13005/bpj/1686

Filio, Y. L., Maulana, H., Aulia, R., Suganda, T., Ulimaz, T. A., Aziza, V., Concibido, V., & Karuniawan, A. (2023). Evaluation of Indonesian butterfly pea (*Clitoria ternatea* L.) using stability analysis and sustainability index. *Sustainability*, *15*(3), 2459. https://doi.org/10.3390/su15032459

Firahmi, N., Dharmawati, S., & Aldrin, M. (2015). Physical and organoleptic properties of meatballs made from beef with different aging time. *Al-Ulum: Journal of Science and Technology*, *1*(1), 39-45.

Fizriani, A., Quddus, A. A., & Hariadi, H. (2021). Effect of addition of butterfly pea flower extract on chemical and organoleptic properties of cendol beverage products. *Journal of Food Science and Agricultural Products*, *4*(2), 136-145. https://doi.org/10.26877/Jiphp.V4i2.7516

Handito, D., Basuki, E., Saloko, S., Dwikasari, L. G., Triani, E., Mataram, U., Medicine, F., & Mataram, U. (2022). Composition analysis of butterfly pea flowers (*Clitoria ternatea*) as natural antioxidants in food products. *SAINTEK Proceedings*.

Ikhlas, B., Huda, N., & Noryati, I. (2008). Chemical composition and physicochemical properties of meatballs prepared from mechanically deboned quail meat using various types of flour. *International Journal of Poultry Science*, *10*(1), 30-37. https://doi.org/10.3923/ijps.2011.30.37

Kumar, V., & Prabha, R. (2018). Extraction and analysis natural dye. *Journal of Natural Product and Plant Resources*, *8*(2), 32-38.

Martini, N. K. A., Ekawati, I. G. A., & Ina, P. T. (2020). The effect of temperature and drying time on the characteristics of telang flower tea (*Clitoria ternatea* L.). *Journal of Food Science and Technology*, *9*(3), 327.

Melati, R., & Rahmadani, N. S. (2020). Diversification and preference for processed food from natural dyes of butterfly pea flower (*Clitoria ternatea*) in Ternate city. *Proceedings of the National Seminar on Agribusiness* (Vol. 1, No. 1).

Mukherjee, P. K., Kumar, V., Satheesh Kumar, N., & Heinrich, M. (2008). The Ayurvedic medicine *Clitoria ternatea*-From traditional use to scientific assessment. *Journal of Ethnopharmacology*, *120*(3), 291-301. https://doi.org/10.1016/j.jep.2008.09.009

Neda, G. D., Rabeta, Mohd, S., & Ong, M. T. (2013). Chemical composition and anti-proliferative properties of flowers of *Clitoria ternatea*. *International Food Research Journal*, *20*(3), 1229-1234.

Nurhasanah, Hindersah, R., Suganda, T., Concibido, V., Sundari, & Karuniawan, A. (2023). The first report on the application of issr markers in genetic variance detection among butterfly pea (*Clitoria ternatea* L.) accession in North Maluku Province, Indonesia. *Horticulturae*, *9*(9), 1059. https://doi.org/10.3390/horticulturae9091059

Odeyinka, S. M., Hector, B. L., Ørskov, E. R., & Newbold C. J. (2004). Assessment of the nutritive value of the seeds of some tropical legumes as feeds for ruminants. *Livestock Research for Rural Development*, *16*(9).

Palimbong, S., & Pariama, A. S. (2020). Potential of telang flower extract (*Clitoria ternatea* Linn) as a colorant on sticky rice tapai products. *Journal of Science and Health*, *2*(3), 228-235. https://doi.org/10.25026/jsk.v2i3.147

Prasetyo, H., Padaga, M. Ch., & Sawitri, M. E. 2013. Study of the physico-chemical quality of beef in the Malang city market. *Journal of Animal Products Science and Technology*, *8*(2), 1- 8.

Riansyah, A., Supriadi, A., Nopianti, R. (2013). The effect of differences in temperature and drying time on the characteristics of Siamese salted fish (*Trichogaster pectoralis*) using an oven. *Fishtech Journal*, *2*, 53-68.

Rosita, F., Hafid, H., & Aka, R. (2015). Cooking loss and organoleptic quality of beef meatballs with the addition of sago flour at different levels. *JITRO*, *2*(1), 14-20.

Siswara, H. N., Erwanto, Y., & Suryanto, E. (2022). Study of meat species adulteration in indonesian commercial beef meatballs related to halal law implementation. *Frontiers in Sustainable Food Systems*, *6*, 882031. https://doi.org/10.3389/fsufs.2022.882031

Vidana-gamage, G. C., Yau, Y. L., & Wee, S. C. (2021). Anthocyanins from *Clitoria ternatea* flower: biosynthesis, extraction, stability, antioxidant activity, and applications. *Frontiers in Plant Science*, *12*, 792303. https://doi.org/10.3389/fpls.2021.792303

Wahdania, Porodjia, F., & Nurkamiden, S. (2021). Protein test with chemical solution in identifying nutrient content in food material. *Journal of Health, Technology and Science*, *2*(4), 22-30.