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Study of Physical, Chemical, and Organoleptic Properties of Functional Drink Turkey Berry (*Solanum torvum swartz*) with the Addition of Butterfly Pea Flower (*Clitoria ternatea linn*) and *Emprit* Ginger (*Zingiber officinale var. Amarum*)

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Abstract

Turkey berry (Solanum torvum Swartz) is a wild plant often found in Indonesia and its usage is still limited. Turkey berry has a high potential as a source of antioxidants, which can be consumed as a functional drink. Ginger and butterfly pea flowers were selected as additional ingredients in composite drinks to enhance the quality of the functional drink in terms of function and sensory characteristics. This study aimed to determine the effects of variations in the concentration of turkey berry, butterfly pea flower, and ginger on the physical, chemical, and organoleptic characteristics. The design method used a Simple Randomized Block Design with four treatment combinations to be analyzed in three repetitions. Data were analyzed using Analysis of Variance (ANOVA) to determine the effects of the treatment. The results showed that turkey berry, in combination with ginger and butterfly pea flower, had a significant effect on the physicochemical and organoleptic characteristics, including pH, total phenolic content, total flavonoid content, antioxidants, color, aroma, taste, and preference.

Keywords: Turkey berry; Ginger; Butterfly Pea Flower; Antioxidants.

INTRODUCTION

Solanum torvum Swartz, also known as turkey berry in English, terung pipit, takokak, and pokak in Indonesia, Konsu swa in Ghana, Susumba in Jamaica, and Sunndakkai in India, is a wild plant commonly found in Indonesia and tropical and subtropical countries in Asia, the Caribbean, South America, and Africa (Regina *et al*., 2018). Although its usage is still limited in Indonesia, people in Ghana and some other countries utilize this plant for its medical and health benefits. Previous studies have shown that turkey berry fruit exhibits antioxidant activity (Sivapriya *et al*., 2007; Kusirisin, 2009), cardiovascular and antidiabetic properties (Mohan *et al*., 2009), and contains 171 chemical compounds, making it a potentially beneficial food ingredient for human health (Helilusiatiningsih, 2021). Kusirisin (2009) found that Solanum torvum Swartz is a natural source of antioxidants and polyphenols, which can act as an antidote to free radicals in lipid peroxidation and superoxide anions in diabetic patients. Consumption of polyphenol-rich foods can reduce oxidative stress and serve as a valuable source of antioxidants (Annuzzi et al., 2014).

Helilusiatiningsih (2020) examined turkey berry as a brewed drink in the form of herbal tea, using the same brewing techniques as green tea and black tea. The results of this study indicated that the herbal brewed drink contained nutrients and minerals that functioned as natural antioxidants. However, there were still some deficiencies in terms of taste and color in the management of turkey berry functional brewed drinks. Therefore, it is necessary to add other ingredients that can enhance the taste, color, and overall acceptability of the brewed drinks. Teye's research (2017) investigated turkey berry as a functional brew with the addition of ginger and roselle flowers to improve its physicochemical, sensory, and organoleptic evaluations. The study also found that the inclusion of roselle and ginger flowers increased the nutritional and mineral values. Ginger and roselle flowers are known to possess high antioxidant content (Hopkins, 2013; Akoto, 2015).

Butterfly pea flowers contain high levels of antioxidants and pigments, specifically anthocyanins, which can increase the overall antioxidant levels. Anthocyanins are natural dyes with antioxidant properties found in plants (Sutanto, 2012). Research

conducted by Sofiah et al. (2022) discovered that a functional brewed drink made from butterfly pea flowers and ginger exhibited an antioxidant activity of up to 57.03%. Based on the aforementioned explanations, the development of turkey berry into a functional brewed drink with the addition of ginger and butterfly pea flowers is expected to enhance the nutritional value of the beverage. Functional brewed drinks offer an alternative way to process turkey berry fruit into food products.

The purpose of this study was to determine the effects of variations in the concentration of functional brewed drinks made from turkey berry, butterfly pea flower, and ginger on their physical and chemical qualities, as well as their sensory characteristics. Furthermore, the study aimed to identify the best formulation for the turkey berry brew from both functional and sensory perspectives when combined with ginger and butterfly pea flower.

MATERIALS AND METHODS

Procedures

This research was conducted at the Food Technology Laboratory, University of Muhammadiyah Malang. The materials used are turkey berry fruit, *emprit* ginger, and butterfly pea flowers. The materials used for analysis were obtained from the UMM Food Technology laboratory, including 2,2 diphenyl-1-picrylhydrazyl DPPH solution (himedia), 70% ethanol (p.a, merck), 98% ethanol (p.a, merck), 99% methanol (p.a, merck), distilled water, Ascorbic acid ($C_6H_8O_6$), Folin Ciocalteau reagent, Sodium Carbonate (Na_2CO_3) (p.a, merck), Gallic acid ($C_7H_6O_5$), quercetin ($C_{15}H_{10}O_7$), Aluminum chloride ($AlCl_3$).

The tools used were knife, basin, aluminum pan, aluminum foil, stopwatch, ruler, 80 mesh sieve, 10 mL and 25 mL volumetric flask, Erlenmeyer, spatula, test tube, dark bottle, vial, 1 measuring pipette. mL and 5 mL, filler pipette, 1000 µL micropipette, 200 µL micropipette, yellow tip micropipette and blue tip micropipette, rubber bulb, breaker glass, thermometer, hot plate Maspion, showcase Polytron, Pioneer Ohaus PA413 analytical balance, Eutech pH meter, Konica Minolta Cr10 color reader, Multiplex Fume Hood fume hood, dryer cabinet, Philip blender, Genesys 20 thermos spectronic type spectrophotometer.

Figure 1. Turkey berry (*Solanum torvum*).

This study used the RAK (Simple Randomized Block Design) design method and four treatment combinations to be analyzed in three replications. The formulation level is as follows:

Table 1. Turkey berry brewed drink formulation with the addition of butterfly pea flower and ginger in grams.

Sample	Formula Sample (g)			
	Turkey berry	Ginger	Butterfly pea	Total
A	0.50	1.00	0.50	2.00
B	0.75	0.75	0.50	2.00
C	1.00	0.50	0.50	2.00
control	2.00	-	-	2.00

The process of making turkey berry simplicia was carried out based on research by Helilusiatiningsih (2021). The collected trees are sorted to select good fruit with bright green color and not rotten. Turkey berry then cleaned using water and then drained. The cleaned turkey berrys were then cut into two and were dried in a cabinet dryer for 18 hours at 60^{o}C. After the turkey berry fruit is dry, it was grinding with a blender. Then the simplicia was sieved using an 80-mesh sieve. Simplisia that had been refined was stored in a closed place in dry conditions. The same process was carried out for ginger and butterfly pea flowers.

Samples were done by preparing simplicia from the ingredients that had been prepared. Then all the ingredients were weighed with an analytical balance. Then put it in a brewed drink bag and close it. Samples were brewed with distilled water instead of hot water at 80^{o}C for 2 minutes. The brewed drink was left to stand at room temperature. Samples were analyzed with chemical properties test parameters (Antioxidants, Phenols, Flavonoids), physical properties tests (Color, pH), and sensory properties tests (Color, Taste, Aroma).

Color Analysis (Color Reader) (Soewarno, 2022)

The material was placed on a flat surface and the color reading lens was directed at the material. Press the button to read the color. After the tool emits light, the tool was lifted and the results are seen. The value of L indicates brightness, a indicates bluishness, and b indicates greenishness.

pH analysis

The pH meter was turned on and then rinsed with the electrode and the temperature probe used distilled water and drained. Then calibrate the pH meter electrode by dipping the electrode in a buffer solution (pH 7) and acid (pH 4) and rinsing with distilled water and then drying. The electrode was immersed in the sample, by pressing the Ar (hold) and Enter keys then waiting for the reading on the stable layer and the autolock indicator appears on

the screen. The results of the pH meter were recorded according to the scale displayed by the pH meter.

Antioxidant Activity (%) analysis (Selvi et al, 2003)
First, the DPPH solution was prepared by taking 2 mg of DPPH (1,1 diphenyl-2-pikrihidrazyl) and 10 mL of ethanol was added then the solution was put in a bottle, shaken and stored in the refrigerator. Second, 1 mL of sample was taken and 9 mL of ethanol was added. Third, each 4 mL of sample and 1 mL of DPPH was put in a test tube. Fourth, the sample is allowed to stand for 10 minutes until it turns yellow. Then a spectrophotometer with a wavelength of 517 is used to read the sample results. Antioxidant activity is calculated by the formula:

$$Aktivitas\ Antioksidan\ (\%) = 1 - \frac{absorbansi\ sample}{absorbansi\ blanko} \text{ x } 100\%$$

Antioxidant Analysis IC50 Radical Scavenging Activity Method (Khare, 2019)
The most well-known antioxidants are β-carotenoids, ascorbic acid, and tocopherols and phenolic compounds, therefore ascorbic acid was used in this analysis. DPPH (2,2- Diphenyl-1- Picrylhydrazyl) is a stable organic radical which has the capacity to react with reagents. This decolorization method measures the antioxidant capacity that directly reaches the DPPH radical, which can be seen from the absorbance at a wavelength of 517 nm using a spectrophotometer (Jain, 2011). The reactive rate and ability to react with radical molecules depend on the rate and peak value of the loss of DPPH (Gulcin, 2006).

First, DPPH solution was prepared by mixing 4 mg of DPPH simplicia and 100 mL of 99% methanol. Mixing is done in a dark bottle and stored in a dark place and allowed to stand for 20 minutes. Second, a standard solution of ascorbic acid was prepared by mixing 2 mg of ascorbic acid with 2.5 mL of distilled water to form a standard solution of ascorbic acid with an initial concentration of 800 µg/mL. From the main concentration, the concentration variations were made to 20 µg/mL, 40 µg/mL, 60 µg/mL, 80 µg/mL, and 100 µg/mL. Third, a sample solution was prepared from each treatment sample by adding 1 mL of sample to 9 mL of methanol. Then each sample was varied in concentration to 20 µg/mL, 40 µg/mL, 60 µg/mL, 80 µg/mL, and 100 µg/mL.

Preparation of the standard standard curve, begins with the addition of 2 mL of ascorbic acid concentration into a test tube that has been coated with aluminum foil. Then the DPPH solution that was ready was added to the solution as much as 2 mL. After that, the standard standard solution was homogenized using a vortex and covered with aluminum foil and incubated for 30 minutes in a dark room. Just like the standard standard solution, the sample solution that is ready with a predetermined concentration is added to the test tube and the DPPH solution is added. control samples were prepared from adding 2 mL of methanol with 2 mL of DPPH solution. After the standard ascorbic acid solution, sample, and control had been incubated, the wavelength absorption was read with a UV Vis spectrophotometer at λ = 517 nm. The absorbance value is recorded and calculated by the formula:

$$\%\ Inhibition\ =\ [(AC\ 517\ nm\ -\ AS\ 517\ nm/\ AC\ 517\ nm)\ x\ 100\%]$$

Note,
AC : Absorbance control
AS : Sample absorbance

Then to determine the IC50 value a relationship curve was made between extract concentration and inhibition percentage which would form a linear regression equation (Khare, 2019).

Phenol analysis (Siddiqui, 2017)
The test was carried out using the Folin Ciocalteau reagent. First, a solution of 7.5% concentration of Sodium Carbonate (Na2CO3) was prepared by adding 7.5 g of powdered Sodium Carbonate (Na2CO3) and 100 mL of distilled water. Second, a solution of Gallic Acid was prepared by dissolving 0.5 g of gallic acid with 10 mL of ethanol and then diluting it with 100 mL of distilled water. Then gallic acid solutions were made with various concentrations, namely 50 µg/mL, 100 µg/mL, 250 µg/mL, and 500 µg/mL. Third, dilution of the sample solution was carried out from each treatment sample by adding 1 mL of sample to 9 mL of ethanol. Prepared test tubes covered with aluminum foil. Mixing 3.16 mL of distilled water, 0.2 mL of Folin ciocalteu reagent, 0.6 mL of sodium carbonate (Na2CO3) solution, 40 µL of sample or gallic acid as standard curve solution was carried out.

In the control sample, gallic acid solution or sample was not added. After all the solutions have been added, the test tube is homogenized with a vortex. Incubation was carried out in a dark room at room temperature for 2 hours. After incubation, the solution was read for wavelength absorption with a UV Vis spectrophotometer at λ= 765 nm. The absorbance value was recorded and calculated to obtain the gallic acid absorbance curve. The graph plots between % inhibition and different concentrations of gallic acid. Then do the calculation of the total phenol content with the formula

$$KTFe\ =\ (\ V\ *\ X\ *\ FP\ )\ /\ Weight$$

Note,
V : Volume (mL)
X : Absorbance (mg/mL)
FP : Dilution Factor
Weight : Sample weight (g)

Flavonoid Level Test (Stankovic, 2011)

First, a quercetin standard curve was made with 10 mg of quercetin dissolved in 100 mL of ethanol to obtain a concentration of 100 ppm. From a 100 ppm quercetin standard solution, several concentrations were made, namely 10 ppm, 20 ppm, 30 ppm, 40 ppm and 50 ppm. From each concentration of quercetin standard solution in a 1 mL pipette. Then 1 mL of 2% AlCl3 was added, 1 mL of 5% acetic acid, and 2 mL of distilled water. Samples were incubated for one hour at room temperature. The absorbance was determined using the UV-Vis spectrophotometer method at a maximum wavelength of 435 nm (Stankovic, 2011).

Second, the determination of the total flavonoid content of brewed beverage samples was carried out by taking 1 mL of the sample and dissolving it in 9 mL of ethanol, to obtain a concentration of 1000 ppm. Pipette 1 mL of this solution and then add 1 mL of 2% AlCl3 solution and 1 mL of 120 mM potassium acetate. Samples were incubated for one hour at room temperature. The absorbance was determined using the UV-Vis spectrophotometer method at a maximum wavelength of 435 nm. Samples were made in three replications for each analysis and the average absorbance value was obtained (Stankovic, 2011).

RESULTS AND DISCUSSION

Total Flavonoid Content

Based on the results of the analysis of variance, it was shown that the sample of turkey berry drinks with the addition of butterfly pea flower and ginger had a very significant effect on total flavonoid levels at the 5% level. The results of the analysis can be seen in Table 2.

Table 2. Total flavonoid content of turkey berry drinks with the addition of ginger and butterfly pea flower.

Sample Formulation	Total Flavonoid Levels (mgQE.g^{-1})
K (turkey berry 100%)	17.37 ^{b}
A (turkey berry 25% + ginger 50% + butterfly pea flower 25%)	12.97 ^{a}
B (turkey berry 37.5% + ginger 37.5 % + butterfly pea flower 25%)	18.75 ^{c}
C (turkey berry 50% + ginger 25% + butterfly pea flower 25%)	21.90 ^{d}

Note: the numbers followed by different lowercase letters show significantly different based on the DMRT test (α = 5%).

Based on table 2, the total flavonoid of each samples has different values. The highest value of flavonoid content is 21.90 mg QE/g was owned by sample C which had a mixture of 50% turkey berry, 25% ginger and 25% butterfly pea flower. While the lowest was 12.97 mg QE/g which was owned by sample A with a composition of 25% turkey berry, 50% ginger and 25% butterfly pea flower. Meanwhile, sample B with the addition of 37.5% turkey berry, 37.5% ginger and 25% butterfly pea flower had a flavonoid content of 18.75 mg QE/g which was slightly higher than sample 100% turkey berry, which is 17.37 mg QE/g.

Flavonoids as a group of phenolic compounds that are abundant in plant tissues can act as antioxidants (Redha, 2010). Flavonoid compounds are natural compounds that have a polyphenolic structure. Most of the flavonoid compounds are soluble in water and easily found in nature. But it is most often found in plants as glucose derivatives known as glycosides. The green components in the turkey berry fruit, and the coloring pigments in the fruits, flowers and seeds are caused by the presence of flavonoid compounds. Flavonoids are found in almost all parts of the plant, including fruits, roots, leaves, and the outer skin of the stem. Flavonoids are natural compounds that have potential as antioxidants that can counteract free radicals that play a role in the emergence of degenerative diseases through mechanisms of destruction of the body's immune system, oxidation of lipids and proteins (Rais, 2015).

In a previous study conducted by Abdulkadir *et al* (2016) using the Quersetin method and ethanol solvents found that the total flavonoid content in turkey berry fruit was 1.41 mgQE.g^{-1}. Whereas in the study of Gyingiri *et al* (2011) the flavonoid content was 8.46 mgQE.g^{-1} (water extract) and 1.05 mgQE.g^{-1} (ethanol extract). In this study, total flavonoid levels ranged from 12.966-21.896 mgQE.g^{-1}. Differences in levels can be influenced by many factors, including the solvent used, the method, and the type of fruit sample used. Research by Helilusiatiningsih (2021) explains that differences in locations for growing turkey berrys also affect the phytochemicals contained. turkey berry fruit obtained from Kweden Village, Mojokerto and from Batu City, Malang, showed differences in flavonoids, each of which had flavonoid levels ranging from 1.19 mgQE.g^{-1} to 2.18 mgQE.g^{-1}.

The addition of ginger and butterfly pea flowers also affects the total value of flavonoids because these plant species are known to contain flavonoid compounds. Flavonoid levels in ginger range from 0.14 mgQE/g (Widiyana *et al*, 2021). Ginger contains volatile compounds consisting of terpenoids, while non-volatile compounds consist of gingerols, shogaols, paradols, zingerones, flavonoids and polyphenols (Sari and

Rahayuningsih, 2014). One of the functional properties of ginger is as an antioxidant. Compounds that act as antioxidants are phenolic components consisting of gingerols and shagaols (Harahap, 2013). Whereas in the butterfly pea flower the total flavonoid content is 10.9 mgQE/g (Yumni, 2022). Butterfly pea flowers contain several phytochemical compounds, including pentacyclic triterpenoids such as taraxerol and taraxenon, ternatin, alkaloids, saponins, tannins, steroids, phenols, flavonoids, flavonol glycosides and anthocyanins (Manjula *et al*, 2013).

Dewi, *et al* (2021) added ginger *emprit* to the manufacture of bay leaf (*Syzygium polyanthum)* herbal drink. The results of this study indicated that the total flavonoid content in the herbal brewed bay leaf had a value range of 0.45 mgQE/g - 0.62 mgQE/g when 5% and 20% ginger was added. Meanwhile, in this study, the total value of flavonoids in the yield range was 12.966 mgQE/g - 21.896 mgQE/g. This shows that the turkey berry brewed drink with the addition of ginger and butterfly pea flowers has potential as a herbal brew with a high content of flavonoids.

Total Fenol Content

Based on the results of the analysis of variance, the sample of the turkey berry brewed drink with the addition of ginger and butterfly pea flower had a very significant effect on the total phenol content using the Folin-Ciocalteu method at a test level of 5%. The results of the analysis of the total phenol content can be seen in Table 3.

Table 3. Total phenol content of turkey berry brew with the addition of ginger and butterfly pea flower.

Sample	Total Phenol COntent (mgGAE.g^{-1})
K (turkey berry 100%)	65,20^{d}
A (turkey berry 25% + ginger 50% + butterfly pea flower 25%)	57,03^{a}
B (turkey berry 37.5% + ginger 37.5 % + butterfly pea flower 25%)	59,37^{b}
C (turkey berry 50% + ginger 25% + butterfly pea flower 25%)	60,87^{c}

Note: the numbers followed by different lowercase letters show significantly different based on the DMRT test (α = 5%).

Based on Table 3, it can be seen that the value of total phenol content with the Folin-Ciocalteu method obtained different results for each sample. The results of the analysis were carried out on the 100% turkey berry brewed drink sample is 65.20 mgGAE.g^{-1}, sample A with the addition of 25% turkey berry, 50% ginger, 25% butterfly pea flower is 57.03 mgGAE.g^{-1}, sample B with the addition turkey berry 37.5%, ginger 37.5% and butterfly pea flower 25% is 59.37 mgGAE.g^{-1}, sample C with the addition of 50% turkey berry, ginger 25%, and butterfly pea flower 25% is 60.87.mgGAE.g^{-1}.

In a previous study conducted by Dewi *et al* (2021) in making bay leaf drinks with the addition of ginger, it was found that the phenol levels in the samples ranged from 2.98 mgGAE.g^{-1} - 3.35 mgGAE.g^{-1}. To compared with this study, the smallest value was found in brewed drink sample A of 57.03 mgGAE.g^{-1} and the highest total phenol content was found in sample K of 65.20 mgGAE.g^{-1}. This shows that the turkey berry brewed drink with the addition of ginger and butterfly pea flowers has a higher phenol content. This could be caused by the addition of ingredients that are high in phenol content. Research by Helilusiatiningsih (2021) explains that differences in locations for growing turkey berrys also affect the phytochemicals contained. Turkey berry fruit obtained from Kweden Mojokerto village and from Batu city, Malang showed differences in phenol. Each level of flavonoids ranged from 32.15 mgGAE.g^{-1} and 35.45 mgGAE.g^{-1}.

Phenolic compounds have the ability of antioxidant activity with the ability to reduce oxidation (Wahyuni, 2015). A previous study conducted by Abdulkadir *et al* (2016) showed that the total phenolic content in turkey berry fruit was around 16.15 mgGAE.g^{-1}. Meanwhile, in a study by Rahman *et al* (2020) the total phenolic content of the main phenols in water samples was around 13.6 mgGAE.g^{-1}. In the results of this study the phenol levels ranged from 57.03-65.20 mgGAE.g^{-1}. Differences in the content of total phenol values are influenced by internal and external factors in the form of the extraction method used, composition, and content of active compounds (Wahyuni, 2015; Brigitta *et al*, 2021).

The use of ginger and butterfly pea flowers also affects the total phenol levels in the turkey berry drinks. Compared to other types of ginger, emprit ginger has the highest total phenol content. The total phenolic component contained in the oleoresin from elephant ginger (*Zingiber officinale Rosc*.) is 4.40%, emprit ginger (*Zingiber officinale var. amarum*) is 6.90% and red ginger (*Zingiber Officinale Var Rubrum Rhizoma)* is 6.50% (Fakhrudin *et al*, 2015). Storage and drying time affect phenolic compounds. In this study, ginger (*Zingiber officinale var. amarum*) was used in the form of dried refined simplicia. Then stored in a dry place before being analyzed. The phenol oleoresin component of fresh ginger (without being stored in simplicia) was 6.9%, while the phenol oleoresin component of ginger which was previously stored in simplicia for 15 days was

5.5%, while for 30 days it was 4.4%. This indicates that there is a decrease in the phenolic component of ginger oleoresin stored in the form of simplicia. The longer it is stored in simplicia, the phenol component in ginger will decrease (Pamungkas *et al*., 2007).

Antioxidant Activity (IC50)

The results of the analysis of variance showed that the sample had a value that had a very significant effect on antioxidant levels using the IC50 method at 5% level. The results of the IC50 method antioxidant analysis can be seen in Table 4.

Table 4. Antioxidant IC50 of turkey berry brew with the addition of ginger and butterfly pea flowers.

Sample	Antioxidant activity (% inhibisi)	IC50 (µg/mL)
K (turkey berry 100%)	72.80	129.49 [c]
A (turkey berry 25% + ginger 50% + butterfly pea flower 25%)	76.50	116.30 [b]
B (turkey berry 37.5% + ginger 37.5 % + butterfly pea flower 25%)	78.80	109.66 [a]
C (turkey berry 50% + ginger 25% + butterfly pea flower 25%)	80.30	107. 32 [a]

Note: the numbers followed by different lowercase letters show significantly different based on the DMRT test (α = 5%).

Based on table 4 it can be seen that the value of the antioxidant activity of the IC50 method has different results. The IC50 values obtained ranged from 107.33 µg/mL - 129.49 µg/mL giving the result that the antioxidants in the samples were moderate. The highest value was obtained by sample K with 100% butterfly pea flower and the lowest value was obtained by sample C with a composition of 50% butterfly pea flower, 5% ginger and 25% butterfly pea flower. Meanwhile, the IC50 value of sample B was around 109.66 µg/mL and that of sample A was around 116.30 µg/mL.

Previous research conducted by Dewi *et al* (2021) showed that the IC50 content in a herbal brewed bay leaf drink with the addition of ginger had an increase in antioxidant content along with the addition of ginger. Bay leaf brewed drink with the addition of 20% ginger was able to produce an IC50 value of 640.99 ppm and with the addition of 5% it produced an IC50 of 1140.53 ppm. While the IC50 produced in the research on the turkey berry brew with the addition of ginger and butterfly pea flowers was able to produce IC50 values in the range of 107.32 - 116.30.

Gandhiappan *et al* (2012) showed that turkey berry or *Solanum torvum swartz* had stronger antioxidant activity than *Solanum ningrum*, *Solanum surratense*, *Solanum trilobatum* but lower than *Solanum pubesce* and *Solanum anguivi*. Antioxidant activity of DPPH (1,1-diphenyl-2-picrylhydrazyl radical) IC50 of turkey berry fruit or *Solanum torvum swartz* 125µg/mL (Badami *et al*. 2005). Previous research conducted on turkey berry fruit extract was able to capture free radicals by 33.0% which was analyzed by the DPPH method and 112 mM Fe(II)/g which was analyzed by the FRAP method (Abdulkadir, 2016). Meanwhile, the IC50 method used in Ramamurthy's research (2012) showed that the water extract of the turkey berry fruit reached 94 µg/mL. Differences in the results of antioxidant activity can be influenced by differences in solvent polarity, concentration, and environmental factors (Abdulrahman, 2016). All of the ingredients used in the brewed drink sample contain compound components that have antioxidant capabilities.

The IC50 values obtained in this study ranged from 107.323 µg/mL - 129.490 µg/mL giving the result that antioxidants are included in the moderate antioxidant group. The IC50 method divides the antioxidant power of each sample into several groups. The antioxidant group is very strong if it has an IC50 of less than 50 ppm (IC50 <50ppm), classified as strong if the value is 50-100 ppm (IC50 50-100 ppm), moderate if the value is 100-150 ppm (IC50 <100-150 ppm) and weak if the value is 150 - 200 ppm (IC50 150-200 ppm) (Rumagit *et al*, 2015). The high antioxidant activity in the samples was due to all the compounds contained in the turkey berry brew with the addition of ginger and butterfly pea flowers capable of acting as antioxidants (Rumagit *et al*, 2015).

Based on several studies that have been conducted by (Tomsone *et al*., 2012; Alothman *et al*., 2009; Yao *et al*., 2010; Agbor *et al*., 2005; and Li *et al*., 2009) indicate that there is a strong relationship between total phenolic content with DPPH free radical scavenging activity from plant extracts. The antioxidant activity that is found on the test results comes from all the antioxidant components of the materials used. DPPH free radicals will detect antioxidant compounds present in the test sample without specific components including flavonoids and phenolic compounds. The detected antioxidant compounds came from the non-enzymatic group of secondary antioxidants. The mechanism of action of the non-enzymatic antioxidants themselves is by capturing fat-soluble and water-soluble free radicals and then preventing reactivity (Salmiyah and Baharuddin, 2020). The DPPH radical scavenging process of the phenolic hydroxy group will capture the DPPH radical via the donor hydrogen atom on the free radical and then stabilized by the delocalization of an unpaired electron. A sign that the free radicals are completely reduced is the color change from purple to yellow (Fauziah, 2021).

pH

The results of the analysis of variance at the 5% level showed that the sample had a significant effect on the pH value based on the results of the ANOVA (Analysis of Variance) test. The average results of the pH analysis of turkey berry brewed drinks with the addition of ginger and butterfly pea flowers can be seen in Table.

Table 5. The pH value of the turkey berry brew with the addition of ginger and butterfly pea flowers.

Sample	pH
K (turkey berry 100%)	5.55 [a]
A (turkey berry 25% + ginger 50% + butterfly pea flower 25%)	5.77 [b]
B (turkey berry 37.5% + ginger 37.5 % + butterfly pea flower 25%)	5.88 [b]
C (turkey berry 50% + ginger 25% + butterfly pea flower 25%)	5.78 [b]

Note: the numbers followed by different lowercase letters show significantly different based on the DMRT test (α = 5%).

Based on Table 5 the results of the highest pH with a low level of acidity were found in sample B with a concentration of 37.5% turkey berry, 37.5% ginger and 25% butterfly pea flower, which was 5.88, while the lowest pH value with slightly higher acidity was found in sample K. with a turkey berry concentration of 100%, namely 5.55. The difference in the pH value of each sample is affected by the pH of each material as indicated by the value of the material and product samples which are at relatively the same number. The lower the pH value, indicates the high acid content in a material (Kurniawan *et al*., 2016). As the pH increases, more carbinol and chalcone base compounds are formed which are associated with the resulting color (Sari *et al*., 2005). Based on the pH value, beverage products are grouped into low-acid drinks with a pH value ≥ 4.6 and acidic drinks with a pH <4.6 (Hariyadi, 2020). According to Reddy *et al* (2016) brewed drinks have a pH between 2.85-5.18. This pH range makes the brewed drink belong to the acidic category because it is at a value of less than 7 and is not in the alkaline drink category. The samples in this study had a pH range between 5.55-5.88 where the results of this pH can be classified in low acid drinks and the acid content is lower when compared to the pH of brewed drinks in general.

Color Intensity

Brightness Level (L)

Based on the results of the analysis of variance with a 5% level of confidence, it showed that there was no interaction between each treatment of the turkey berry brewed drink with the addition of butterfly pea flower and ginger to the brightness level value. The average color intensity analysis results at the brightness level can be seen in Figure 2.

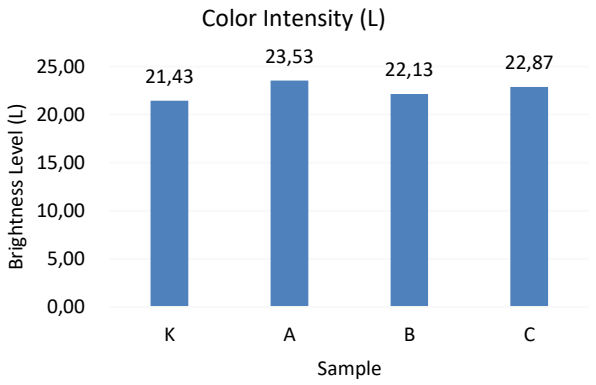

Figure 2. Brightness level (L) of turkey berry brew with the addition of ginger and butterfly pea flowers.

Factors that cause low brightness intensity depend on each material which has a different color. The high percentage of butterfly pea flower filtrate makes the color of the sample darker, this is influenced by the anthocyanin pigments contained in the pigments of the turkey berry fruit and butterfly pea flowers. Anthocyanin pigments range from red to blue which tend to appear dark in color (Marpaung, 2018). According to Cavalcanti (2011) the increasing concentration of anthocyanins causes anthocyanin stability to increase and will make the color of the product more concentrated and darker. Meanwhile, the color of ginger is determined by the oleoresin compound. According to Prasetyo (2015) the oleoresin value in ginger tends to be dark brown so that the brightness produced is also low. According to Satriyanto *et al* (2012) brightness is the basic color spectrum, adding another color to an object will reduce the brightness value of the product.

Treatment Level of Redness (a+)

turkey berry has a yellow color as a natural dye (Helilusiatiningsih, 2021). If ginger is added, the composite brew will turn bright yellow. This is because the ginger contains an oleoresin compound which produces a yellowish color so that the more the ginger powder is added to the product, the more the brew will mix with a yellow color. This is also supported by the research of Pebiningrum *et al* (2018) that the oleoresin content in ginger affects the color of ginger kombucha. Chemically, all anthocyanins are derived from a single aromatic structure, namely "cyanidin" (cyanidin), and all are formed from cyanidin pigments by adding or removing hydroxyl groups or by methylation or glycosylation, so that anthocyanin compounds have polar groups.

Butterfly pea flowers which have a purplish blue color are added to give an attractive color to the yellow composite brewed drink. The difference in the natural color of anthocyanin pigments is influenced by hydroxylation and methylation, hydroxylation will

increase the blue color, while methylation increases the red color (Kumalaningsih 2006).

Redness Level (a+)

Based on the results of the test of variance at the 5% level of confidence, it showed that the turkey berry brewed drink with the addition of ginger and butterfly pea flowers had a significant effect on the redness level. The average greenness of the turkey berry brew with the addition of ginger and butterfly pea flowers can be seen in Table 6.

Table 6. The average value of the redness and greenness of the turkey berry brew with the addition of ginger and butterfly pea flowers.

Sample	Redness Level (a^+)
K (turkey berry 100%)	0.90 [b]
A (turkey berry 25% + ginger 50% + butterfly pea flower 25%)	0.60 [a]
B (turkey berry 37.5% + ginger 37.5 % + butterfly pea flower 25%)	0.80 [ab]
C (turkey berry 50% + ginger 25% + butterfly pea flower 25%)	0.90 [b]

Note: Numbers followed by different letters show significant differences according to Duncan's test α=5%.

Based on the results of the DMRT test at the 5% level, the sample treatment had a significant difference. The redness value (a^+) was obtained on average ranging from 0.6 to 0.9. The Axis parameter (a^*) represents the level of green to red with a range of -100 to +100 where negative values (-) indicate a tendency to green while positive values give a tendency to red (Lawless and Heymann, 1998).

The results of the analysis of the initial reddish (a^+) value yielded a positive value which indicated that the dark brown ginger oleoresin color also contained a red color in it. The highest level of redness was 0.9 in the 50% turkey berry treatment with the addition of 37.5% ginger and 25% butterfly pea flower, this indicated that this treatment tended to be more red than the other treatments. Março *et al* (2011) stated that at pH 1-2 the dominant anthocyanin is in the form of flavilium cations which are red in color, at pH <6 they turn into carbinol and some of them become quinonoidals which are blue in color so they turn purple. According to Brouillard (1982) anthocyanins change color from red to reduced color in weak acids.

Blue Level (b-)

Based on the results of the test of variance with a 5% level of confidence, it is known that the interaction between the sample of turkey berry brew and the addition of ginger and butterfly pea flower has a significant effect on the bluish and yellowish levels. The average level of blueness (b-) can be seen in Table 7.

Table 7. The average value of the bluish and yellowish levels of turkey berry brew with the addition of ginger and butterfly pea flower flower.

sample	Blue Level (b^-)
K (turkey berry 100%)	-0.07[a]
A (turkey berry 25% + ginger 50% + butterfly pea flower 25%)	-1.10[a]
B (turkey berry 37.5% + ginger 37.5 % + butterfly pea flower 25%)	-0.57[a]
C (turkey berry 50% + ginger 25% + butterfly pea flower 25%)	0.17[a]

Note: Numbers followed by different letters show significant differences according to Duncan's test α=5%

The results of the analysis showed that the initial yellowness average value ranged from -1.100 to 0.167. The Axis parameter (b*) represents the level of blue to yellow with a range of values from -100 to +100 where a negative value (-) indicates a tendency towards blue while a positive value (+) indicates a tendency towards yellow (Lawless and Heymann, 1998). The results obtained the resulting value is a positive value. This shows that the color of the oleoresin in ginger is dark brown and the anthocyanin in turkey berry and butterfly pea flower also contains a yellow color.

The highest level of yellowness was 0.167 in the 50% turkey berry treatment with the addition of 37.5% ginger and 25% butterfly pea flower which tended to have a darker color than the other treatments. Anthocyanins will change color to red to orange at an acidic pH so that the measured anthocyanins are monomeric anthocyanin levels (Tonutare *et al*., 2014). The butterfly pea flower plant has the anthocyanin type delfinidin in its flower parts, which makes the flower color bluish (Lijon *et al*, 2017).

Organoleptic Test

Organoleptic assessment of turkey berry brewed drinks with the addition of ginger and butterfly pea flowers in this study used a preference test (Hedonic Scale Scoring). In the preference test, the panelists will be given all the samples of the turkey berry brewed drink with the addition of ginger and butterfly pea flower, then the panelists will be asked to drink it and give responses to the sample drink. Like. The hedonic scale obtained from the questionnaire will then be transformed into a numerical scale from the lowest to the highest number. The scale is used to determine the difference in the level of preference between existing treatments. This observation was carried out by 40 panelists and the panelists will provide responses starting from color, taste, aroma and preferences.

Aroma

The results of the analysis of variance on the organoleptic aroma test on the turkey berry brewed drink with the addition of ginger and butterfly pea flowers showed very significant interaction results. The average results of the aroma organoleptic test can be seen in Table 8.

Table 8. Average aroma of turkey berry brew with the addition of ginger and butterfly pea flowers

Sample	Aroma
K (turkey berry 100%)	2.38 [a]
A (turkey berry 25% + ginger 50% + butterfly pea flower 25%)	2.43 [a]
B (turkey berry 37.5% + ginger 37.5 % + butterfly pea flower 25%)	3.90 [b]
C (turkey berry 50% + ginger 25% + butterfly pea flower 25%)	3.70 [b]

Note: The average value followed by the same letter is not significantly different according to Duncan's test α = 5%
Assessment criteria = 1 (very dislike); 2 (dislike); 3 (somewhat dislike); 4 (rather like); 5 (likes); 6 (like very much); 7 (very much like)

The organoleptic test was tested in the aroma aspect, the results with the lowest score range were 2.38 from the 100% turkey berry sample and the highest score was 3.90 from the 37.5% turkey berry sample with the addition of Ginger 37.5% and butterfly pea flower 25 %. The sample score is classified from not sharp to sharp enough, which means sample K has a non-sharp odor and sample B has a fairly sharp odor.

The aroma of ginger is caused by essential oils, while the oleoresin causes a spicy taste. Essential oils are volatile components that play a role in providing a distinctive aroma for each type of spice. While the non-volatile components consist of gum and resin for each spice. The highest essential oil content was in red ginger followed by emprit ginger and the lowest in elephant ginger. Essential oils in emprit ginger range from 1.5% - 3.5% (Sutanto, 2016).

Flavor

Taste Treatment

The results of the analysis of variance on the organoleptic taste test on the turkey berry brewed drink with the addition of ginger and butterfly pea flowers showed that the results of the interaction between the treatments were very significant. The average results of the organoleptic taste test can be seen in Table 9.

Table 9. The average taste of turkey berry brew with the addition of ginger and butterfly pea flower flower.

Sample	Flavor score
K (turkey berry 100%)	1.95 [a]
A (turkey berry 25% + ginger 50% + butterfly pea flower 25%)	2.43 [b]
B (turkey berry 37.5% + ginger 37.5 % + butterfly pea flower 25%)	2.78 [b]
C (turkey berry 50% + ginger 25% + butterfly pea flower 25%)	2.65 [b]

Note: The average value followed by the same letter is not significantly different according to Duncan's test α = 5%
Assessment criteria = 1 (very dislike); 2 (dislike); 3 (somewhat dislike); 4 (rather like); 5 (likes); 6 (like very much); 7 (very much like)

From the organoleptic tests that have been tested, in the aspect of aroma, the results obtained with the lowest score range were 1.95 from the 100% turkey berry sample and the highest score was 2.78 from the 37.5% turkey berry sample with the addition of Ginger 37.5% and butterfly pea flower 25%. The sample scores are classified in somewhat dislike to dislike. Taste is one of the determining factors in the level of panelist acceptance of a food product. Taste relates to material components that can be captured by one's sense of taste. The average value of the panelists' preference for the taste of the turkey berry brew with the addition of ginger and butterfly pea flower ranged from 2.38 to 3.70.

Preference

Favorite Treatment

The results of the analysis of variance on the organoleptic preference test on the turkey berry brewed drink with the addition of ginger and butterfly pea flowers showed that the results of the interaction between the treatments were very significant. The average results of the preference organoleptic test can be seen in Table 10.

Table 10. The average preference for turkey berry brews with the addition of ginger and butterfly pea flowers.

Sample	Preference
K (turkey berry 100%)	2.73 [a]
A (turkey berry 25% + ginger 50% + butterfly pea flower 25%)	2.70 [a]
B (turkey berry 37.5% + ginger 37.5 % + butterfly pea flower 25%)	2.78 [a]
C (turkey berry 50% + ginger 25% + butterfly pea flower 25%)	2.95 [a]

Note: The average value followed by the same letter is not significantly different according to Duncan's test α = 5%
Assessment criteria = 1 (very dislike); 2 (dislike); 3 (somewhat dislike); 4 (rather like); 5 (likes); 6 (like very much); 7 (very much like)

From the organoleptic tests tested in the aroma aspect, the results obtained with the lowest score range, namely 2.70 from sample A (25% turkey berry with the addition of 50% ginger and 25% butterfly pea flower) and the highest score, 2.95 from sample C (turkey berry 50% with the addition of 25% ginger and 25% butterfly pea flowers. The sample scores are classified into somewhat dislike and dislike. Likeability is one of the values in the organoleptic test, which evaluates all aspects including color, aroma and taste. The assessment was carried out based on the opinion of the panelists on the samples tested. The scoring for preference is influenced by the organoleptic assessment of taste and aroma, therefore the results obtained do not differ from one another.

CONCLUSIONS

Based on the results of the research data analysis and discussion, it can be concluded that the turkey berry brewed drink with the addition of ginger and butterfly pea flower had a significant effect on physicochemistry and organoleptic pH, total phenolic content, total flavonoid content, antioxidants, aroma, taste, and preference. Meanwhile, it has no significant effect on color. From a functional point of view, the best formulation of the turkey berry drink with the addition of ginger and butterfly pea flowers was found in sample C with a composition of 50% turkey berry, 25% ginger and 25% butterfly pea flower with an antioxidant IC50 value of 107.323 µg/mL. Total phenol level 60.87.mgGAE.g^{-1}. The highest value of flavonoid content was 21.896 mg QE/g; pH 5.782; aroma score 3.7; taste 2.6; favorite 2.95. While the best formulation based on the sensory assessment of turkey berry brewed drink with the addition of ginger and butterfly pea flower is treatment A with a composition of 25% turkey berry, 50% ginger and 25% butterfly pea flower.

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