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Research Article

Characterization of Soymilk-Wedang Ginger Drinks with the Addition of Butterfly Pea Flower Extract (*Clitoria ternatea*)

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Abstract

Background and Objective: The development of functional food is necessary to achieve a better quality of life. Soymilk-wedang ginger has been developed as a functional drink but still has limitations such as an unattractive appearance. This study aimed to determine the effect of adding butterfly pea extract on the characteristics of soymilk-wedang ginger and to determine the best addition of butterfly pea extract based on organoleptic, physical and chemical tests on soymilk-wedang ginger. **Materials and Methods:** The research design used was a Completely Randomized Design (CRD) with five treatments and three replications. The treatments given in this study were A (ginger drink without the addition of butterfly pea flower extract and soymilk), B (without the addition of butterfly pea extract), C (addition of 2% butterfly pea extract), D (addition of 2.5% butterfly pea extract), E (addition of 3% butterfly pea extract) and F (addition of 3.5% butterfly pea extract). The research data were statistically analyzed using One-way Analysis of Variance (ANOVA) and continued with Duncan's New Multiple Range Test (DNMRT) analysis at the 5% level. **Results:** The adding butterfly pea extract significantly affected color analysis, antioxidant activity, anthocyanin levels, total plate count and organoleptic color of ginger soymilk ginger drink. However, it did not significantly affect the pH value, protein content and organoleptic taste and aroma. The best treatment based on organoleptic tests and physical, chemical and microbiological analysis of soymilk-wedang ginger with the addition of butterfly pea extract was treatment F. **Conclusion:** The quality of the product produced was good overall, thus it can be developed further on a commercial scale.

Key words: Butterfly pea extract, ginger drink, wedang ginger, antioxidant, anthocyanin

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Functional foods are regular food items that offer additional health benefits beyond their basic nutritional value. Liquor format functional food contains herbs famous in Indonesia called "Jamu". Hence, since the Jamu taste is full of bitter and appetizing-breakers, Jamu is losing its famous in the middle of society¹. Ginger (*Zingiber officinale*) is one of the rhizome herbs usually for spices in Indonesian food and drink. Ginger for drink keeps the body warm and is believed to be medicine for coughs, diarrhea and others². In Indonesia, the ginger-boiled substrate is served as a drink named "Wedang Ginger". The wedang ginger is a traditional drink from Yogyakarta-Indonesia, usually hot and served like tea.

Ginger has bioactive compounds like ginerol, shogaol and zingerone. Furthermore, ginger also contains antioxidants and anti-inflammation. In pharmacies, ginger is used as an analgesic and anti-cancer. Natural bioactive compounds like antioxidants act against free radicals³. Ginger is bitter because the bioactive compounds contained need an extra flavor, like milk, to increase the taste of ginger products like wedang ginger. Cereal, like soy, contains high protein, suitable as a nutrient intake for drinks like soymilk. The advantages of soymilk over dairy milk are that it is non-lactose, cholesterol free, low fat, nutritious, low budgeting served and simple technology⁴. Cholesterol-free soymilk contains lower fat for 2.5 g/100 g is suitable to consume by those applicate low-fat-diet. Furthermore, soymilk contains phosphor and calcium to support teeth and bone growth⁵. Soymilk become an alternative to dairy nutrition for a cheaper price⁶.

Soymilk-wedang ginger generally has an extra composition to manipulate white-yellow gradating color. The common natural extra composition to coloring the formula is the butterfly pea (*Clitoria ternate* L.), also known as the Telang flower in local people. Some others are called Asian Pigeonwings, Bluebellvine, Blue pea, Cordofan pea, or Darwin pea. The butterfly pea generally donates blue, purple and red colors to the dyeing subject⁷. The butterfly pea has the potential to become good antioxidant because of anthocyanin consist of it. Anthocyanin is a pigment from the flavonoid group dissolved in water and red to blue color⁸. Anthocyanin in butterfly pea's has great potential to counteract free radicals⁹. Therefore, in this research, the development of a health drink product made from ginger wedang with a combination of soymilk treated with the addition of butterfly pea flower extract has been carried out. Observations of the characteristics of the products produced were carried out to obtain product data that can be developed commercially further.

MATERIALS AND METHODS

Study area: The research was conducted between December, 2022 and September, 2023. The study was carried out at Andalas University's Laboratory of Phytonutrient, Department of Food and Agricultural Product Technology, Faculty of Agricultural Technology.

Raw material and equipment: Wedang ginger, sugar and salt were obtained from a traditional market, while soybeans and butterfly pea flowers were sourced from local marketplaces for use in this study. Chemicals for analysis were distilled water, DPPH, methanol, H₂SO₄, NaOH 50%, boric acid, HCl 0.02 N, PCA, buffer solution and selenium mix.

Equipment that used were hand refractometer, Gas Chromatography-Mass Spectrometry (GC-MS QP 2010, Shimadzu), HPLC (High-Performance Liquid Chromatography-LC 2010, Shimadzu), color reader (Color Flex-Hunter Labs), cawan petri, ultrasonic bath (Emma, S 10H), spectrophotometer UV-Vis (UV 1800, Shimadzu) and autoclave (HVE 50, Hirayama).

Research design: A completely randomized design was used in this research by six treatments (concentration of *Clitoria ternate* extract) support to triple repetition. The treatments were:

- A = Wedang Ginger without addition of butterfly pea flowers extract and soy milk
- B = Wedang Ginger without addition of butterfly pea flower extract
- C = Wedang Ginger with addition of 2 % butterfly pea flowers extract
- D = Wedang Ginger with addition of 2.5 % butterfly pea flower extract
- E = Wedang Ginger with addition of 3 % butterfly pea flower extract
- F = Wedang Ginger with addition of 3.5 % butterfly pea flower extract

Butterfly pea extraction¹⁰: The dried butterfly pea was sorted from impurities and then cleaned. Based on treatment (2.0, 2.5, 3.0 and 3.5 g), the butterfly pea was taken and warmed on 100 mL of aquadest for 10 min. The solution was filtered. The 10 mL of the substrate was taken for each treatment.

Soymilk-wedang ginger solution¹¹: Only good-physically-looked soybeans were used in this research. One part of the soybean was soaked in three parts of water for 12 hrs

Table 1: Formulation of soybean-wedang ginger

Ingredient	Treatment					
	A	B	C	D	E	F
Wedang ginger (g)	5	5	5	5	5	5
Soybean milk (mL)	0	90	90	90	90	90
Butterfly pea extract (mL)	0	0 (0%)	10 (2%)	10 (2.5%)	10 (3%)	10 (3.5%)

continued with soybean peeled separations, then cleaned. The peeled soybeans were boiled for 20 min with double the amount of water from the soybean. Separated the soybean from the boiled water. Afterward, the soybeans were blended with six parts of water then filtrate the formula to achieve the soymilk. The soymilk achieved was boiled for 10 min while mixed gradually. Added an extra 5 g ginger, 12 g sugar and 0.5 g salt. When it boiled, turn off the stove, then put an extract butterfly pea flower based on the treatments. The formula of soymilk-wedang ginger follows the recipe in Table 1. The soymilk consisted of soybean, water, sugar and salt with the composition as 20, 90, 12 and 0.5 g, respectively.

Observation

Raw material: The observation of butterfly pea flower was pH, anthocyanin and antioxidant activity. The observation of the wedang ginger formula was pH and antioxidant activity. Moreover, the soybean observation is antioxidant activity and protein content.

Soybean milk wedang ginger with butterfly pea extract: The observation of raw material and product of soymilk-wedang ginger was colour¹², total dissolved solid, pH¹³, antioxidant activity¹⁴, anthocyanin¹⁵, essential oil¹⁶, total colony¹⁷ and organoleptic analysis¹⁸. The obtained data was processed statistically by using Microsoft Excel.

Statistical analysis: Statistical analysis was executed using the SPSS package program version 11.5 (SPSS Inc., Chicago, Illinois, USA). The results were expressed using the triple samples' Mean \pm SD. A significance level of $p < 0.05$ was applied to the differences.

RESULTS AND DISCUSSION

Analysis of raw material: Table 2 describes the raw analysis of the butterfly pea, ginger and soymilk. The value of pH was an indicator of the acidity or basicity of solutions. The pH of ginger and butterfly pea extract was 6.15 and 4.81, respectively. The pH of the sample was slightly acidic, which shows that the condition of the material is still fresh.

Making food products depends on the freshness of the raw materials¹⁹.

Antioxidant activity is the ability to prevent oxidation and inhibit free radical establishment. The antioxidant activity (on 1000 ppm) of three raw materials in this research were butterfly pea extract (45.87%), ginger (27.72%) and soymilk (23.83%). Several previous studies have shown results similar to those obtained. In the extraction process, several factors can influence the results, such as extraction temperature, time and type of solvent²⁰.

Anthocyanin is a known antioxidant bioactive compound and a pigment of the flavonoid-group that is dissolved in water. The butterfly pea extract used in this study detected an anthocyanin level of 14.25 mg/100 mL. Many factors, like flower variety, extraction temperature and solvent volume cause the difference in anthocyanin content. Moreover, the protein of soymilk was 32.16%. It is one of the macronutrients that act as cell growth support. Observing the quality of raw materials needs to be carried out to ensure that the character of the product that will be produced is by the hypothesis that has been developed.

Physical analysis

Color analysis: Color analysis of soymilk-wedang ginger was described in Table 3.

Analysis of variance following DNMR (5%) proof butterfly pea donates significant difference of color of soymilk-wedang ginger. The hue level is around 94.70 to 241.19. The hue at treatment A gives the original color of the ginger. Meanwhile, treatment B gives the color effect of soymilk used. The yellow-green on treatment C resulted from the white-yellow of soymilk and butterfly pea extract. Furthermore, treatments D, E and F belong on the levels 214.57 (pale blue) 234.16 (blue) and 241.19 (blue), respectively.

The research's hue level rises and the concentration of butterfly pea extract escalates. The butterfly pea extract contains anthocyanin, whose gradation color is red, blue and purple. The color gets darker and the increasing use of anthocyanin inclines to blue²¹. Anthocyanin types of butterfly pea flower extract include ternatin and contain delphinidin-3-O-glucoside, which react to acidity or basicity. The color becomes red on acid and blue on basicity condition.

Table 2: Results for raw materials analysis of butterfly pea flowers, ginger and soybeans

Parameter	Extract of butterfly pea flowers±SD	Extract of ginger t±SD	Soybean±SD
pH	4.81±0.01	6.15±0.07	-
Antioxidant activity (%)	45.87±0.82	27.72±0.71	23.83±1.23
Anthocyanin (mg/100 mL)	14.25±0.51	-	-
Protein (%)	-	-	32.16±0.11

:- Test was not done

Table 3: Color analysis of Wedang Ginger Soy Milk Drink with the addition of butterfly pea flower extract

Treatment	Color value (°hue) (Average±SD)	Notification
B	94.70±0.46 ^a	Yellow
A	126.35±2.21 ^b	Yellow green
C	160.19±0.34 ^c	Yellow green
D	214.57±2.08 ^d	Blue purple
E	234.16±0.20 ^e	Blue
F	241.19±0.09 ^f	Blue

Statistically significant differences are shown by different letters (p≤0.05)

Table 4: Total Dissolved Solids (TDS) of Wedang Ginger Soy Milk Drink with the addition of butterfly flower extract

Treatment	Rata-rata TDS (°Brix)±SD
A	12.83±0.72 ^a
C	16.07±0.23 ^b
D	16.27±0.12 ^b
F	16.27±0.12 ^b
E	16.47±0.12 ^b
B	17.47±0.12 ^c

Statistically significant differences are shown by different letters (p≤0.05)

Table 5: pH of Wedang Ginger Soy Milk Drink with the addition of butterfly pea flower extract

Treatment	pH value (average±SD)
C	6.21±0.19
E	6.22±0.19
F	6.22±0.19
D	6.22±0.19
B	6.27±0.14
A	6.37±0.06

Total dissolve solid: The total dissolved solid represents dispersed material content in the solution, like sugar. The analysis of variance exposure butterfly pea flower extract intercalated on soymilk-wedang ginger significantly (p<0.05) increased the dissolved total solid. The dissolved total solid of soymilk-wedang ginger was described in Table 4.

Table 5 portrays the dissolved total solid on soymilk-wedang ginger around 12.83-17.47°Brix. The highest value belongs to treatment B (none butterfly pea extract-17.47°Brix). On the contrary, the lowest point at treatment A (none butterfly pea extract and soymilk-12.83°Brix), an extra butterfly pea extract affected on dissolved total solid because increasing the volume of water was a main component of the extract. The dissolved total solid in treatments C, D, E and F were relatively similar due to an equal amount of butterfly pea flower extract additions (10 mL). The difference only happened in the concentration of the butterfly pea extract as raw material.

Sugar has characteristics of binding water (hygroscopic) which causes the decreasing dissolved total solid²². A higher proportion of sugar reduced the solubility as more solvent was added. Soymilk requires a minimum dissolved total solid of 11.50°Brix therefore the dissolved total solid in the study qualified as a derivate soymilk product.

Chemical analysis

pH value: The pH value describes the acidity or basicity of the solutions and represents the concentration of hydrogen ion in the solvent. Analysis of variance exposure butterfly pea additions to soymilk-wedang ginger insignificantly (p<0.05) change the pH of the solution. The pH of several treatments was shown in Table 5.

The pH of soymilk-wedang ginger was around 6.21 to 6.37. The highest pH belongs to treatment A (none butterfly pea extract and soymilk) at a level of 6.37. Meanwhile, the lowest belongs to treatment C (2% of butterfly pea extract soymilk-wedang ginger) at level 6.21. The addition of butterfly pea flower extract results in a decrease in pH. The butterfly pea flower extract has a lower pH than soymilk besides. The pH is affected by several factors like dissolved oxygen microorganism activity and temperature. The pH value also affected to color of the product. The anthocyanin color faded and the pH increased²³. The acidity condition led to anthocyanin (as an antioxidant) in the optimum condition and stabilized the pigment²⁴.

Antioxidant activity: Antioxidants are responsible for inhibiting oxidation by preventing free radical forming, leading to postpone cell body break. Oxidation in the body could happen excessively²⁵, leading to the breaking of the structure and function of body cells. Analysis of variance shows butterfly pea extract addition significantly (p<0.05)

Table 6: Antioxidant activity of Wedang Ginger Soy Milk drink with the addition of butterfly pea flower extract

Treatment	Antioxidant activity (%) \pm SD
B	36.37 \pm 0.27 ^a
C	36.83 \pm 0.13 ^a
D	37.54 \pm 0.36 ^a
E	38.86 \pm 0.68 ^a
F	40.03 \pm 0.49 ^a
A	57.17 \pm 10.72 ^b

Statistically significant differences are shown by different letters ($p \leq 0.05$)

Table 7: Total anthocyanin content of Wedang Ginger Soy Milk drink with the addition of butterfly pea flower extract

Treatment	Anthocyanin content (mg/100 mL) \pm SD
A	0.39 \pm 0.26 ^a
B	1.78 \pm 0.54 ^a
C	8.85 \pm 1.45 ^b
D	10.19 \pm 0.17 ^{bc}
E	11.19 \pm 0.17 ^c
F	11.69 \pm 2.26 ^c

Statistically significant differences are shown by different letters ($p \leq 0.05$)

Table 8: Total plate number of wedang ginger soymilk drink with the addition of butterfly flower extract

Treatment	TPC (CFU mL ⁻¹)
B	2.2 \times 10 ³
C	2.1 \times 10 ³
A	1.8 \times 10 ³
D	1.6 \times 10 ³
E	1.6 \times 10 ³
F	1.5 \times 10 ³

increasing antioxidant activity on soymilk-wedang ginger. The antioxidant activity of the research object was described in Table 6.

Table 6 describes the antioxidant activity (100 ppm) of soymilk-wedang ginger with extra butterfly pea extract around 36.37-57.17%. The highest antioxidant activity was located in treatment A (none butterfly pea extract and soymilk) which is 57.17%. On the other hand, the lowest antioxidant level included 36.37% in treatment B (none butterfly pea extract). Table 6 exposure antioxidant activity increases as well as using butterfly pea extract.

The antioxidant activity could be from butterfly pea extract, ginger, or soymilk. The butterfly pea extract contains anthocyanin as an antioxidant responsible for reacting and neutralizing free radicals. Besides anthocyanin, butterfly pea extract contained other antioxidant bioactive compounds like kaempferol, myricetin, quercetin, phytosterol and tocopherol. The antioxidant activity is sky-high using butterfly pea extract²⁴.

Besides butterfly pea extract, ginger was also known to contain oleoresin antioxidant-like substantive. Oleoresin is a phenolic matter to prevents oxidative by binding free radical substances. Ginger has an abundance of natural antioxidant substances to bind free radical things²⁵. Ginger contains

gingerol, shogaol and zingerone, which have pharmacological and physiological properties, including antioxidant effects. Furthermore, soymilk is a protein source and a functional food to prevent degenerative disease. The antioxidant substance found in soy is isoflavone²⁶.

Anthocyanin analysis: Anthocyanin is a pigment substance with basic colors red, blue and purple generally found on flowers, fruits and leaves. The anthocyanin pigment would be degraded while heating up that effect to change the color²⁷. Analysis of variance proofed utilizing butterfly pea extract to soymilk-wedang ginger significantly sky-high anthocyanin content. The anthocyanin content of variance treatment is described in Table 7.

Table 7 shows the anthocyanin content of the soymilk-wedang ginger with extra butterfly pea extract which belongs to 0.39-11.69 mg/100 mL. The highest anthocyanin content was 11.69 mg/100 mL on treatment F (extract butterfly pea extract 3.5%). Conversely, the lowest anthocyanin level was located on treatment A (none butterfly pea extra and soymilk) at the level of 0.39 mg/100 mL. Based on Table 7 the anthocyanin content increased in utilizing of butterfly pea extract. The butterfly pea extract contained poliasilil anthocyanin named ternatin. Ternatin is poliasilasi derivate from delphinidin 3,3,5-triglyceride. The instability of anthocyanin and the heat process would change the persistency of anthocyanin pigment, leading to bioactive compound breaking. Hence, pH also affected anthocyanin stability that more stable in alkaline conditions. Anthocyanin has colors from red to blue to purple and a pH setting. Anthocyanin stability is based on several factors like concentration, temperature, light intensity, co-pigmentation existence and others^{28,29}.

Total plate count: Total plate count to determine entire microorganism growth on soymilk-wedang ginger with extra butterfly pea extract. The total plate count was represented in Table 8.

Table 8 reflects the total microorganism consisting of soymilk-wedang ginger butterfly pea extract around 1.5 \times 10³-2.2 \times 10³ CFU mL⁻¹. The highest total plate count had faced to treatment A (none soymilk and butterfly pea extract) at 2.2 \times 10³, on the other hand, the lowest total plate count belonged to treatment E (extra butterfly pea extract 3.5%) at level 1.5 \times 10³. The total plate count of soymilk-wedang ginger with an extra butterfly pea extract required the standard Indonesian National Standard at a maximum of 5 \times 10⁴ and announces that safe to consume.

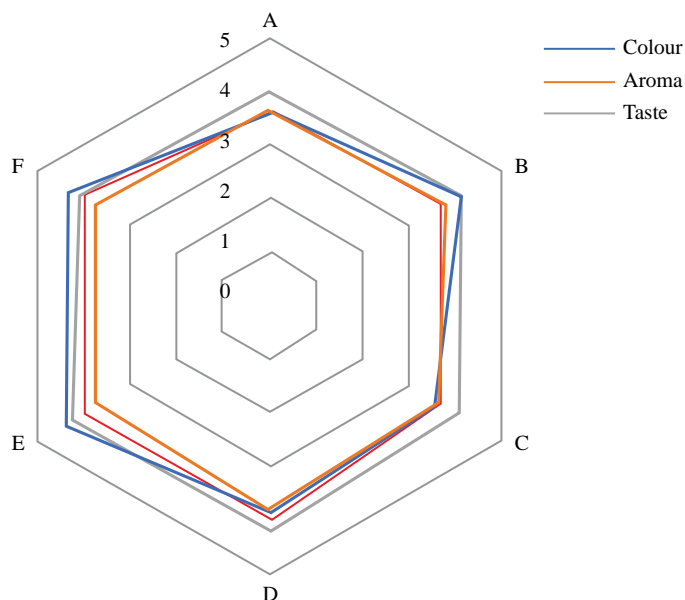


Fig. 1: Organoleptic data of soymilk-wedang ginger

Butterfly pea extract contains several potent bioactive compounds that interest pharmacologists, such as antioxidants, antimicrobials, anti-diabetic agents and potential anti-cancer properties³⁰. The butterfly pea extract filtrate has growth inhibitors for four indicator strains like *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Bacillus subtilis* and *Escherichia coli*. In addition to butterfly pea extract, ginger has been documented to contain bioactive compounds such as flavonoids, phenolics, terpenoids and essential oils that act as bacteriophages³¹.

Organoleptic test: An overview of the organoleptic data of the tea products produced was shown in Fig. 1. Overall, the best formula was selected for formula F. Particularly, for the colour the most liked color by panelists belonged to treatment E (butterfly pea extract 3%) on a scale of 4.43 (liked by panelist); meanwhile, the lowest response of panelists on treatment C (butterfly pea extract 2%) at a scale of 3.57 (liked by panelist). Treatments E and F exhibited similar gradation, with only a darker hue. The range of panelist evaluations still fell within the "like" category, indicating that all treatments were deemed acceptable by the panelists. The color gradation of anthocyanin pigment consisted of butterfly pea extract showing blue spectrum color at certain concentrations³².

For the flavour, the panelist rated object flavor on a scale of 3.63-3.80, the highest appraisal belonged to treatment D (2.5% butterfly pea extract) at a scale of 3.8. On the other hand, the lowest rate was given by the panelist on

treatment C (2% butterfly pea extract) at a scale of 3.63. The appraisal taken from panelists was categorized as liked. Unlike butterfly pea's tea, the flavor of soymilk-wedang ginger with an extra butterfly pea extract was flavorless. The butterfly pea extract contained a volatile compound, creating a light aroma and sweet after-taste.

For the taste, the highest panelist response belonged to treatment E (3.0% butterfly pea extract) at the rate of 4.23; meanwhile, the lowest scale was given by panelists in treatment A (only wedang ginger) at the rate of 4.00 all panelists liked all of the treatments. The research treatment supplied a similar amount of sugar (12 g) as a tea without any additives. The butterfly pea was tasteless and tended to be bitter as an effect of phenolic and flavonoid compounds. Extra sugar is often added to mask the bitter taste. A similar opinion by Campbell *et al.*³³ stated that a butterfly pea extract only affects the color but does not affect the taste.

Volatile secondary metabolites (GC-MS): At treatment, F as the best treatment, soymilk-wedang ginger with butterfly pea extract 3.5% had identified several volatile metabolites. The highest component in the treatment F with ethanol solvent was n-hexadecanoic acid, with a percentage ratio of 33.94%. Furthermore, the second most prominent peak was 9-octadecenoic, with a percentage area of 27.16%. The presence of fatty acid was more dominant in the product due to the high portion of wedang ginger and soymilk.

CONCLUSION

The beverage product made from soymilk-wedang ginger drink with the addition of butterfly pea extract has been developed. The addition of this extract has provided sensory value, especially color appearance. The taste of the product was influenced by the components of the ginger drink. The good organoleptic characteristics of the product developed along with its physico-chemical value make the value of this product even better.

SIGNIFICANCE STATEMENT

This research developing a functional beverage product made from a mixture of soybean milk and wedang ginger as the main raw material. The novelty in this research is the anthocyanin fortification of butterfly pea flower extract. Adding this extract can increase the sensory value and functionality of the existing drink. The treatment in this research has increased the added value of existing products so that the industrialization process can be achieved with several more improvements.

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