Physical properties and chemical composition of banana blossom sheaths with different skin colors and its application as a raw material for healthy pasteurized banana blossom juice

Kankanit Jongrattanavit
Suan Dusit University
Panyapathk Pinkaew (panyapathk_pin@dusit.ac.th)
Suan Dusit University

Research Article

Keywords: Banana blossoms, Total phenolic compounds, Antioxidant properties, Healthy pasteurized banana

Posted Date: January 15th, 2024

DOI: https://doi.org/10.21203/rs.3.rs-3846909/v1

Additional Declarations: No competing interests reported.

Abstract

The objectives of this research were to study the physical properties, chemical composition of banana blossom sheaths, and microbial quality of its juices. Banana blossom sheaths have different skin colors; the inner is light-yellow, and the outer is pink red. It was found that the light-yellow inner banana blossom sheaths were a source of protein (24.12 g/100 g of sample) and total phenolic compounds (13.58 mg of gallic acid equivalents (GAE)/g dry weight), and the pink-red outer sheaths of banana blossoms were a source of fibers (27.39 g/100 g of sample) and total anthocyanin content (6.43 mg). The healthy pasteurized banana blossom juices produced from the inner and the outer sheaths of banana blossoms are sources of phenolic compounds (254 and 124 mg GAE/100 mL), total anthocyanin contents (0.19 and 15.01 mg cyanidin-3-glucoside equivalent (CGE)/100 mL), and antioxidant properties using the DPPH method (2,280.49 and 2,156.53 µmol of Trolox equivalents/100 mL), respectively.

RESEARCH HIGHLIGHTS

1. Banana blossom sheaths could be used as functional raw materials for healthy pasteurized banana blossom juice.

2. The total phenolic compounds of inner banana blossom sheath was 3.09 times higher than the outer sheath of banana blossom.

3. The total anthocyanin content of outer banana blossom sheath (6.43 mg cyanidin-3-glucoside equivalent/1 g dry weight of the sample) was similar to Riceberry rice (6.67 mg cyanidin-3-glucoside equivalent/1 g dry weight of the sample).

4. The inner (232.12 µmol equivalents of Trolox/ 1 g of dry weight sample) and outer and (240.17 µmol equivalents of Trolox/ 1 g of dry weight sample) banana blossom sheaths have antioxidant properties using DPPH.

INTRODUCTION

Banana flower or Banana blossom is a waste material after harvesting and processing processes. It is considered as agricultural byproduct that is edible and has high nutritional value. The banana blossom is the part of the inflorescence that does not develop into fruit. It consists of real flowers that are wrapped in large bracts. The inner bracts are light-yellow, and the outer bracts are pink red, arranged tightly overlapping each other. Tall lotus bud shape Banana blossoms are classified as herbal vegetables, which are eaten only in the inner sheaths that are light yellow and has a soft texture. Raw banana blossoms have an astringent taste, but if cooked they have a sweet and creamy taste (Lau et al., 2020). Banana blossoms have been used as a raw material for cooking for a long time. It can be used to produce a variety of beverage products, especially food and drinks that are nourish in milk because its properties that make milk flow well, such as banana blossom curry, banana blossom salad, pasteurized banana blossom juice mixed with herbs, banana blossom tea, and powdered banana blossom drinks, etc. They are mostly consumed in many Asian countries such as Thailand, Sri Lanka, Malaysia, Indonesia, the Philippines, Burma, and India (Mathew and Negi, 2017; Ramírez-Bolaños et al., 2021; Soni and Saxena, 2021). In terms of nutritional value, banana blossoms are rich in 70% dietary fiber, 53.78% carbohydrates and 19.60% protein (Ramu et al., 2017). They are a source of important primary and secondary minerals, including potassium, sodium, phosphorus, calcium, magnesium, zinc, and iron (Sheng et al., 2010; Elaveniya and Jayamuthunagai, 2014), with the highest amount of potassium, followed by calcium, magnesium, phosphorus, and sodium, respectively (Ramu et al., 2017). Banana blossoms have 4 times more calcium than ripe bananas and 4–5 times less energy than bananas due to low carbohydrates. Banana blossoms are also rich in vitamin A, vitamin C, vitamin E, and quality protein. and unsaturated fatty acids (Sheng et al., 2010; Sharma et al., 2019). In addition, banana blossoms are a source of various bioactive phytochemical substances such as beta-carotene, tannins, phenolic acids (caffeic acid, ferulic acid, synaptic acid, paracoumaric acid and gallic acid), and water-soluble flavonoid compounds (quercetin and anthocyanins) (Sumathy et al., 2011; Zehla et al., 2018; Sharma et al., 2019; Ramírez-Bolaños et al., 2021). These compounds have antiviral, antimicrobial, anti-inflammatory, and antioxidant properties. Therefore, it is involved in the prevention of various chronic diseases such as heart disease, stroke, neurological diseases, diabetes, and cancer (Lau et al., 2020). In addition, tannins in banana blossoms extracted with water also influences increasing the level of prolactin in the blood, resulting in increased breast milk production (Yimyam, 2018). Importantly, banana blossom is a source of lactagogum that has the property of stimulating the production of oxytocin and prolactin, which are important hormones in the production of breast milk (Aisya et al., 2020). The trend of ready-to-drink banana blossom juice is popular in breastfeeding mother because its properties of helping to expel breast milk. They are usually sold in glass bottles or plastic bottles or cans with various flavors such as banana blossom alone or mixed with other herbs including galangal, honey, ginger, and mulberry leaves, etc. It is an option to help mothers to be healthy and able to produce milk as needed.

However, there has been no study and research on the differences in nutritional values, total phenolic compound content, total anthocyanin content, and the anti-oxidation properties of the inner and the outer sheathes of banana blossom with different skin colors. Therefore, this research is interested in studying the physical properties and chemical composition of banana blossom sheaths which are waste materials after harvesting in Suphanburi province in order to be able to select parts of banana blossom sheaths with different skin colors to be used in the food industry for maximum benefit, minimum food waste, and further use such as a raw material for meat substitutes for vegan food products. Moreover, it may be used as an ingredient in a variety of functional food products in the future because it has high production yield, easy to find, cheap, and has health benefits. Banana blossom sheaths with different skin colors are also used as raw materials in the production of pasteurized banana blossom sheath juice beverage products for health. and study the physical properties chemical composition and the microbiological quality of the health-producing pasteurized banana blossom juice beverage products. Thus, the objectives were to study physical properties and the chemical composition of two types of banana blossom sheaths with different skin colors: inner banana sheaths that are light yellow; and the outer sheaths of banana blossoms that are pink to red, and to study physical properties chemical composition and the microbial quality of the healthy pasteurized banana blossom juice beverage product produced from two types of banana blossom sheaths with different skin colors.

MATERIAL AND METHODS

Namwa banana blossom (*Musa sapientum* Linn.) used in this study was a waste material after harvesting bananas in Bang Ta Then subdistrict, Song Phi Nong District, Suphanburi Province during June 2021. The banana blossom was cleaned and then separated only the sheaths that cover the banana blossoms. Banana sheaths were classified into 2 types depended on the sheath skin color; the inner sheath of banana blossom which is light-yellow (Fig. 1a) and the outer sheath that is pink to red (Fig. 1b).

Banana blossom sheaths powder preparation

Color values L* a* b* and h° of fresh banana blossom sheaths with different skin colors were measured on the surface. Then, samples of powdered banana blossom sheaths were prepared according to the method of Krishnan and Sinija (2016) by taking 2 types of fresh banana blossom sheaths with different skin colors and washing them with clean water to remove rubber. Then reduce the size to 1 cm in length and soaked in th citric acid solution to inactivate enzymatic browning reaction. Rinse the sample with clean water two more times and let it drain on a sieve. Then spread it evenly on the baking tray. Dried using a hot air dryer at a temperature of 60 C for a long time until the moisture content decreased to 10% (approximately 5 hours). Then the samples were ground finely with a grinder. The dried powder was blended and sieved through a 40-mesh sieve. The resulting powdered banana blossom sheath samples were placed in a tightly sealed aluminum bag and stored in a freezer at -40 C until used.

Chemical composition of banana blossom sheaths powder

The two types of powdered banana blossom sheaths with different skin colors were analyzed to determine the amount of moisture, fat, protein, crude fiber, ash, and total carbohydrates (calculated by 100 - (moisture (%) + fat (%) + Protein (%) + ash (%)) according to AOAC (2000) method.

Banana blossom sheaths powder extraction

Samples were extracted using an extraction method modified from that of Kim and Lee (2002) and Rodriguez-Saona and Wrolstad (2005), and acid-adjusted solvent type was selected for extraction modified from Nuchsuk (2018) and Ove et al. (2019) by taking 1 gram of each type of powdered banana blossom sheath sample and placing it in a centrifuge tube. Add a 95% ethanol solution containing 0.01% hydrochloric acid to a volume of 20 ml. and mix until homogeneous (model T10 basic Uitra-turrax, IKA® Staufen, Germany). Cool with ice. for 2 minutes, vibrated with a sound wave system (brand CREST Ultrasonic, model CP 360T, Malaysia) at a temperature of 4 C for 20 minutes, then centrifuged to separate the sediment with a temperature-adjusted centrifuge (Thermo fisher, model Sorvall RC 6-Plus, Thermo Scientific, Germany) speed 11,000 rpm at a 4 C for 30 minutes, separate the clear portion into a volume adjusting flask. Adjust the final volume to 25 ml. Store the extract in an amber glass bottle and stored in a freezer at -40 C.

Estimation of total phenolic content

The total phenolic contents of blossom sheaths powder extracted were determined by spectrophotometrically using Folin-Ciocalteu reagent method modified from Maizura et al. (2011). For measuring, 0.4 mL of blossom sheaths powder extracted (Diluted) were transferred into a test tube and then mixed with 2 mL of 10% (v/v) Folin-Ciocalteu reagent. After mixing for 4 min, 1.6 mL of 5% (w/v) sodium carbonate was add. The mixtures were agitated with a vortex mixer (Vortex-2 Genie, Model G-560 E, U.S.A) then allowed to stand for a further 30 min in dark. The absorbance was measured at 765 nm (UV-visible spectrophotometer, Model T60 U, PG instrument, England). Results were calculated using regression equation of gallic acid (0-100 ppm). The total phenolic contents were expressed as milligrams of gallic acid equivalents per gram of dry weight (mg GAE/g DW).

Estimation of total anthocyanin content

The total anthocyanin contents of blossom sheaths powder extracted were determined using pH-differential spectrophotometric method modified from Giusti and Wrolstad (2005). Absorbance was measured by using a spectrophotometer (Model T60 U, PG instrument, England) at 510 and 700 nm in a 0.025 M potassium chloride buffer (pH 1.0) and 0.4 M sodium acetate buffer (pH 4.5). The absorbance (A) of the diluted sample was then calculated as follows: A = [(A510-A700) pH 1.0 - (A510-A700) pH 4.5]. The total anthocyanin contents were expressed as milligrams of cyaniding-3-glucoside equivalents per gram of dry weight (mg cy-3-glu/g DW). Calculated via the following formula:

Anthocyanin content (mg/l) = "A × MW × DF × 1,000" /"ε × L"

MW = cyanidin-3-glucoside molecular weight (449.2); DF = dilution factor;" ε" = cyanidin-3-glucoside molar absorptivity (26,900); L = cell pathlength (1 cm).

DPPH radical scavenging assay

Free radical scavenging activity in blossom sheaths powder extracted were determined by spectrophotometrically using the highly stable free radical 2,2-Dipheny l-1-picrylhydrazyl (DPPH), which has an intense violet color. This method modified from Du et al. (2009). For measuring, 1 mL of blossom sheaths powder extracted (Diluted) were transferred into a test tube and then mixed with 1 mL of DPPH radical solution (200 μM in 50% (v/v) ethanol) then allowed to stand for a further 30 min in dark. The absorbance was measured by using a spectrophotometer (Model T60 U, PG instrument, England) at 515 nm. Results were calculated using regression equation of Trolox (0-100 μmol). The scavenging activity was expressed as μmol of Trolox equivalents per gram of dry weight (μmol TE/g DW).

Production of pasteurized banana blossom juice

The pasteurized banana blossom juice samples were produced. The mixture consists of 65.97 g of water, the inner of the banana blossom sheath (light- yellow). or banana blossom outer sheaths that are pink to red in color, 32.99 g, 0.99 g of brown sugar, and 0.05 g of salt, using the pasteurization method of heating before packing in sealed containers modified from Rabie et al. (2014), which has the production process of pasteurized banana blossom juice beverage products for health, shown in Fig. 2. Samples were stored in a refrigerated cabinet at a temperature of 4 C until used.

Pasteurized banana blossom juice properties

A sampling of healthy pasteurized banana blossom sheath beverage products produced from two types of banana blossom sheaths with different skin colors were analyzed for physical properties, including color values L* a* b* C. * and h° according to the above method. Chemical composition was analyzed including acidity-alkalinity (pH) according to the method of AOAC (2000) with a digital pH meter (model Orion 2 Star benchtop, Thermo Scientific, U.S.A.). Total soluble solids were analyzed according to the method of AOAC (2000) with a Hand-Held Refractometer 0–33 Brix (brand ATAGO, model Master-M, Japan). The amount of total phenolic compounds is reported as milligram equivalents of gallic acid per 100 mL of sample (mg GAE/100 mL). Total anthocyanin contents are reported as equivalent milligrams of cyanidin-3-glucoside per 100 mL of sample (mg cy-3-glu/100 mL). Anti-oxidative properties using the DPPH method are reported as equivalent micromoles of Trolox per 100 mL of sample (μmol TE/100 mL). Microbiological quality was analyzed according to the standard criteria of the Ministry of Public Health Announcement No. 356 B.E. 2013 regarding beverages in sealed containers. and according to the standard criteria of the Notification of Ministry of Public Health (No. 416). (2020) regarding determining quality or standards. Terms and Conditions and methods for analyzing food in terms of pathogenic microorganisms (Notification of Food Division, Food and Drug Administration, 2020) including the total microbial amount (Total Plate Count) according to the standard method specified in BAM online Chap. 3 (2001a), the amount of yeast and mold (Yeasts and Molds) according to the standard methods specified in BAM online Chap. 18 (2001b) *E. coli* (*Escherichia coli*) and coliform (Coliform) using the Multiple-tube Fermentation Technique (MPN) (APHA, 2017) Salmonella (*Salmonella* spp.) according to the standard method ISO 6579:2002 *S. aureus* (*Staphylococcus aureus*) standards specified in BAM online Chap. 12 (2016c) *B. cereus* (*Bacillus cereus*) according to the standard method specified in BAM online Chap. 14 (2001d) and *C. Perfringens* (*Clostridium perfringens*) according to the standard method specified in BAM online Chap. 16 (2001e).

Statistical analysis

Compare the differences between the means of 2 independent samples using t-test for independent samples and analyze statistical variance with Analysis of variance (ANOVA) using the statistical computer program SPSS for Windows at the level 95 percent confidence.

RESULTS AND DISCUSSIONS

Physical properties and chemical composition of banana blossom sheaths with different skin colors

From the study of physical characteristics, including the color values L* a* b* and h° on the surface of two types of banana blossom sheaths with different skin colors, namely the inner banana blossom sheaths that are light yellow and the outer sheaths that are pink to red. As shown in Table 1, it was found that banana blossom sheaths with different skin colors resulted in significantly different color values L* a* b* and h° ($p < 0.05$). When considering L* values (brightness), it was found that the inner banana blossom sheaths that are light yellow have a higher brightness value than the outer banana blossom sheaths that are pink to red. This may be because pigmentation of anthocyanin in the inner sheaths of banana blossoms is low, while the outer sheath of the banana blossom is high of anthocyanin pigments. As a result, the outer sheaths of the banana blossom are opaquer than the inner sheaths. This is consistent with the color value a* (red) that the outer sheath of banana blossom was found to have red color 5.08 times greater than the inner sheath of the banana blossom. This information is consistent with Sujithra and Manikkandan (2019) who confirmed that the red outer sheath of the banana blossom comes from the pigment anthocyanin. Most of which are cyanidin-3-rutinoside. (Cyanidin-3-rutinoside). When considering the b* (yellow) color value, it was found that the inner banana blossom sheath has a yellow color value up to 6.67 times higher than the outer banana sheath. This may be due to the inner banana blossom sheath being in the raw stage. Meanwhile, the outer sheath of the banana blossom is the part that is approaching maturity or increasing in age, so it changes color to red. This is consistent with Serradilla et al. (2011) who found that the synthesis of Anthocyanin increases as plants approach maturity. When considering the value h°, which is a value that represents the color shade, it was found that both the inside and outside of the banana blossom sheaths had shades in the range of red to yellow (0-90^{o} has shades of red to yellow), indicating that the inside of the banana blossom sheaths had a color value in the range. The color values were more yellow than red (82.26) and the outer sheaths were in shades of red more than yellow (4.65). The h^{o} values of both types of banana sheaths corresponded to the color that appeared on the surface of the sheaths that covered the banana blossoms. Both the inside and outside when viewed with the naked eye are the inner banana blossom sheaths that are light yellow and the outer banana blossom sheaths that are pink to red.

Table 1

Physical properties and chemical composition of two types of banana blossom sheaths with different skin colors: inner banana sheaths that are light-yellow; and the outer sheaths of banana blossoms that are pink to red

Properties	**Banana blossom sheaths**	
	Inner (light-yellow)	**Outer (Pink to red)**
Color		
L	$71.92^{a} \pm 1.36$	$31.24^{b} \pm 0.79$
a*	$2.79^{b} \pm 0.88$	$14.16^{a} \pm 1.22$
b*	$31.01^{a} \pm 0.61$	$4.65^{b} \pm 0.27$
h	$82.26^{a} \pm 4.01$	$18.26^{b} \pm 1.02$
Chemical composition		
Moisture ^{ns} (%)	6.90 ± 0.09	6.97 ± 0.06
Lipid ^{ns} (%)	4.17 ± 0.13	3.44 ± 0.27
Protein (%)	$24.12^{a} \pm 0.59$	$12.36^{b} \pm 0.04$
Crude fiber (%)	$13.50^{b} \pm 0.25$	$27.39^{a} \pm 10.57$
Ash (%)	$13.65^{a} \pm 10.29$	$10.29^{b} \pm 0.01$
Total carbohydrate (by calculation) (%)	$51.16^{b} \pm 0.78$	$66.94^{a} \pm 1.54$
Total phenolic content (mg GAE/g DW)	$13.58^{a} \pm 1.02$	$4.40^{b} \pm 1.96$
Total anthocyanin content (mg cy-3-glu/g DW)	$1.20^{b} \pm 1.27$	$6.43^{a} \pm 0.30$
DPPH radical scavenging assay^{ns} (μmol TE/g DW)	232.12 ± 2.22	240.17 ± 5.21

Note: Mean ± standard deviation (n=2)

The letters a-b mean that the horizontal means are statically significantly different ($p \leq 0.05$).

The letter ns means that the horizontal means are not significantly different ($p > 0.05$).

Chemical composition of banana blossom sheaths powder

The chemical composition in terms of nutritional value, including moisture, fat, protein, crude fiber, ash, and total carbohydrates of the two types of banana blossom sheaths with different skin colors, shown in Table 1, it was found that the amount of protein, crude fiber, ash, and total carbohydrates were significantly different ($p < 0.05$). The inner banana blossom sheaths were a significantly higher source of protein and ash than the outer banana blossom sheaths. ($p < 0.05$), which corresponds to Wickramarachchi et al. (2005) and Berrill (2019) who found that the edible parts of the banana blossom sheaths (Inner banana blossom sheaths) both fresh and dried had a protein content of 20.54 and 21.01 grams per 100 grams of food sample, respectively, which is high quality protein because it contains essential amino acids for the body. Currently, it is commonly used to produce alternative protein in the production of plant-based food products as an alternative for consumers who eat a flexible vegetarian diet (Flexitarian) because the banana blossom sheaths have a texture similar to that of cooked fish. It has dense fibers and low energy content. In addition, the banana blossom sheaths are a source of primary and secondary minerals, including potassium, sodium, phosphorus, calcium, magnesium, zinc, and iron (Sheng et al., 2010; Elaveniya and Jayamuthunagai, 2014). The outer banana blossom sheaths are a source of crude fiber and total carbohydrates by having 2.03 and 1.31 times higher than the inner sheaths, respectively. The amount of crude fibers in the outer sheath corresponds to the hard texture. This is due to the high amount of crude fibers and strong fibers. Therefore, it is the reason that consumers do not like to eat it. This is often discarded as food waste in cooking and industrial processing. This is consistent with Wickramarachchi et al. (2005) who found that the edible part of the banana blossom sheaths, both fresh and dried, is a source of crude fiber (20.31 and 17.41 g/ 100 g of food sample, respectively) when comparing the crude fiber content of the outer banana blossom sheaths (27.39 g/ 100 g of food sample) and the inner banana blossom sheaths (13.50 grams per 100 grams of food sample) with fruits and vegetables. Other types: It was found that the outer and inner banana blossom sheaths had a higher amount of crude fiber than Namwa bananas, equal to 11.41 and 5.63 times, respectively (2.4 g/ 100 g of food sample) (Wongwaiwech et al., 2022), more than dragon fruit, equal to 12.80 and 6.31 times, respectively (2.14 grams per 100 grams of food sample), 14.65 and 7.22 times more than durian pulp, respectively (1.87 g/ 100 g of food sample) (Nitithan et al., 2004), and 2.77 and 1.37 times more than ginger, respectively (9.87 grams per 100 grams of food sample) (Madhu et al., 2017). It was found that the outer sheaths of banana blossoms were the source of crude fiber and total carbohydrates. This is consistent with Hardoko et al. (2022) who said that banana blossoms are classified as a food with a low glycemic index that is important for diabetic patients. This is because banana blossoms, especially the outer sheaths that are pink to red, are a source of complex carbohydrates that have a beneficial effect on increasing blood sugar levels to be stable and consistent. When considering the amount of moisture and fat It was found that the inside and outside of the banana blossom sheaths had similar moisture and fat content. Therefore, the quantities are not significantly different ($p > 0.05$).

Total phenolic content

It was found that the banana blossom sheaths with different skin colors resulted in different amounts of total phenolic compounds. Statistically significant ($p < 0.05$), the inner banana blossom sheaths had higher total phenolic compounds than the outer banana blossom sheaths. This may be because the inner sheath of the banana blossom is in its raw stage. Most plants in the raw stage are rich in procyanidins or condensed tannins, which are substances that give plants an astringent taste and high antioxidant activity (Wang et al., 2009). The total phenolic compounds of inner banana blossom sheath were the highest with statistical significance ($p < 0.05$), which was 3.09 times higher than the outer sheath of banana blossom. However, the total phenolic compounds were analyzed using the method Folin-Ciocalteau reagent has a non-specific reaction only with phenolic compounds, it can also react with other compounds, such as vitamin C, which is an important substance found in banana blossom sheaths as well. When comparing the total amount of phenolic compounds in both the inner and outer banana blossom sheaths of the research obtained from Namwa bananas. It was found that the total amount of phenolic compounds was higher than the banana blossom sheaths obtained from MusaAAA “KluaiHom” (0.54 mg equivalent to Gallic acid per 1 g. dry weight sample) reached 25.15 and 8.15 times, respectively (Nuchsuk, 2018).

Total anthocyanin content

It was found that the banana sheaths with different skin color resulted in a difference in the total anthocyanin content. The outer banana blossom sheath had total anthocyanin content 5.36 times higher than the inner banana blossom sheath, which is consistent with Serradilla et al. (2011) who found that the synthesis of anthocyanin is increased when the plant approaches maturity or the immature stage increases. The outer sheath of the banana blossom is the part that has a longer period of maturity than the inner sheath of the banana blossom. In addition, anthocyanins have higher antioxidant properties than vitamin C and vitamin E (Bagchi et al., 1998). The total anthocyanin content of outer banana blossom sheath (6.43 mg cyanidin-3-glucoside equivalent/1 g dry weight of the sample) was similar to Riceberry rice (6.67 mg cyanidin-3-glucoside equivalent/1 g dry weight of the sample) (Petchlert and Sangprathum, 2020)

Antioxidant activity

The free radical scavenging activity of the blossom sheaths powder extracted has been tested by DPPH radical method. The study found that the inner sheath of the banana blossom was rich in all phenolic compounds and the outer sheath of the banana blossom was rich in total anthocyanin content. All these compounds have high antioxidant properties as well. As a result, both the inner and outer banana blossom sheaths have antioxidant properties using the DPPH method that are not significantly different ($p > 0.05$), consistent with Suffi et al. (2021) who said that banana blossoms are a source of bioactive compounds with high antioxidant properties, such as phenolic acids, flavonoids, tannins, saponins, and vitamin C, and corresponds to Amornlerdpison et al. (2021) who found that banana blossoms are a source of phenolic compounds, especially substances in the flavonoid group such as flavones, isoflavones, flavanones, catechins, isoquercetins and anthocyanins. These substances are considered secondary compounds that higher plants produce naturally which are necessary for plant growth, such as being used as odor, taste, color, reproduction, and as substances used to protect themselves from the external environment or other substances. Moreover, almost of these substances have medicinal properties. When comparing the antioxidant properties by DPPH method of the inner and outer banana blossom sheaths (232.12 and 240.17 μmol equivalents of Trolox/ 1 g of dry weight sample, respectively) with other traditional herbs, it was found that the inner and outer banana blossom sheaths and the outside had more antioxidant properties using the DPPH method than roselle, basil, mint, and butterfly pea flowers (21.21, 17.62, 16.56, and 4.47 μmol equivalents of Trolox/ 1 g dry weight of the sample, respectively) (Halee and Rattanapun, 201) which shows that both the inner and outer banana blossom sheaths have good antioxidant properties using the DPPH method compared to some local herbs. However, there were differences in the total phenolic compound content. Total anthocyanin content and the properties of antioxidants in plants have many factors that result in different amounts, such as species, type of plant, season, and maturity of harvest, storage conditions and post-harvest management, etc. (Jimenez-Garcia et al., 2013)

Pasteurized banana blossom juice properties

Physical property

As a resulted from Figure.2, the color values L (brightness), a* (red) and b* (yellow) of the pasteurized banana blossom sheaths juice are significantly different ($p < 0.05$), while the h° color value (shade) was not significantly different. Healthy pasteurized banana blossom juice produced from the inner banana blossom sheath were not significantly different. It has a higher L value than the healthy pasteurized banana blossom sheath juice produced from the outer sheath. And it was found that the healthy pasteurized banana blossom sheath juice produced from the outer banana blossom sheaths had higher a* and b* values than the pasteurized banana blossom sheath juice produced from inner sheath. Meanwhile, the healthy pasteurized banana blossom juice produced from two types of banana blossom sheaths with different skin colors had shades of color that were not significantly different ($p > 0.05$). In the range of red to yellow (0-90^{o} has shades of red to yellow), the color values L a* b* and h° of the healthy pasteurized banana blossom sheath juice produced from banana blossom sheaths, consistent with their appearance when viewed with the naked eye. In general, changes in the color values L a* b* and h° of juices are often greatly affected by thermal processing conditions and plant composition (Manzoor et al., 2020).

Chemical compositions

From studying the chemical composition, including the acidity-alkaline value (pH) and total soluble solids (^{o}Brix), of the healthy pasteurized banana peel juice drink product produced from Banana blossom sheaths with different skin colors for the two types are shown in Table 2. It was found that the values of acidity - alkalinity (pH) and the amount of total soluble solids (^{o}Brix) are very similar and therefore are not significantly different. Average pH and total soluble solids were in the range of 4.87–5.82 and 4.13–4.87 (^{o}Brix), respectively. It was found that the acid-alkaline (pH) value of healthy pasteurized banana blossom sheaths produced from banana blossom sheaths with different skin colors are classified as low-acid foods (pH > 4.6) (Notification of Food Division, Food and Drug Administration. (2020), which is different from Amornlerdpison et al. (2021) who found that a ready-to-drink banana blossom juice drink for breastfeeding mothers had an acidic-alkaline (pH) value of 3.54 and Kaweewong and Sombutma (2020) who found that the ready-to-drink banana blossom milk drink had an acidic-alkaline (pH) value in the range of 3.50–3.70, which the acidic-alkaline (pH) value was adjusted with citric acid in order to make the drink classified as highly acidic (pH < 4.6) and able to be stored at room temperature. Meanwhile, the total soluble solid content of the healthy pasteurized banana blossom juice drink produced from banana blossom sheaths with different skin colors was lower than that of apple juice (11.5^{o}Brix) Bananas (22.0^{o}Brix), grapes (16.0^{o}Brix), oranges (11.8 ^{o}Brix), mangos (11.8^{o}Brix) and pomegranates (16.0^{o}Brix) but with a higher amount of dissolved solids. It is similar to lemon juice (4.5 ^{o}Brix) (Clemens et al., 2015)

Table 2
Physical and chemical properties of pasteurized banana blossom juice from inner light-yellow sheath and outer pink to red color

Properties	**Banana blossom sheaths**	
	Inner (light-yellow)	**Outer (pink to red)**
Color		
L	24.56^{a} ± 0.44	20.74^{b} ± 0.46
a*	2.43^{b} ± 0.08	4.70^{a} ± 0.04
b*	18.34^{b} ± 0.67	24.32^{a} ± 1.29
h ^{ns}	79.41 ± 0.19	79.06 ± 0.27
Chemical		
pH^{ns}	4.87 ± 0.07	5.82 ± 0.06
Total soluble solod (Brix)^{ns}	4.87 ± 0.06	4.13 ± 0.12
Total phenolic content (mg GAE/100 mL)	254^{a} ± 0.12	124^{b} ± 0.38
Total anthocyanin content (mg cy-3-glu/100 mL)	0.19^{b} ± 0.23	15.01^{a} ± 0.35
DPPH radical scavenging assay^{ns} (μmol TE/100 mL)	2,280.49 ± 0.45	2,156.53 ± 0.78

Note: Mean ± standard deviation (n=2)

The letters a-b mean that the horizontal means are statically significantly different ($p \leq 0.05$).

The letter ns means that the horizontal means are not significantly different ($p > 0.05$).

Phytochemical properties

When considering the total amount of phenolic compounds, total anthocyanin content, and antioxidant properties using the DPPH method of healthy pasteurized banana blossom juice beverage products produced from the two types of banana blossom sheaths with different skin colors as shown in Table 2, it was found that all phenolic compounds and the total anthocyanin content was significantly different ($p < 0.05$), while the antioxidant properties using the DPPH method were not significantly different. This trend was similar to the total phenolic compound content, total anthocyanin content, and antioxidant properties using the DPPH method found in the inner and outer banana blossom sheaths used as main raw materials in production, consistent with Sheng et al. (2011) and Amornlerdpison et al. (2021) who found that beverages that has banana blossom extract is rich in total phenolic compounds (124 mg gallic acid equivalent per 100 mL sample) and has high antioxidant properties. By substances that have antioxidant properties that are soluble in water, most banana blossoms belong to the group of phenolic compounds. Flavonoid compounds have antioxidant potential, and it was found that the healthy pasteurized banana blossom juice drink product produced from the inner and outer banana blossom sheaths with different skin colors had higher amounts of total phenolic compounds (254 and 124 mg gallic acid equivalent per 100 mL sample, respectively) than black currant juice, rainbow and green tea (108 and 85 mg gallic acid equivalent per 100 mL sample, respectively), but had lower total phenolic compounds than commercial grape juice (10,241 mg gallic acid equivalent per 100 mL sample, respectively) (Zujko and Witkowska, 2014; Wern et al., 2016). Total anthocyanin content (0.19 and 15.01 mg cyanidin-3-glucoside equivalents per 100 mL sample according to order) than the drink from germinated black glutinous rice (0.05 milligrams equivalent of cyanidin-3-glucoside per 100 ml of sample) (Jongrattanavit et al., 2021) and has antioxidant properties using the DPPH method (2,280.49 and 2,156.53 micromole equivalents of Trolox per 100 mL sample, respectively) than fresh grape juice. and freshly squeezed guava juice (708.52 and 770.12 μmol of Trolox equivalent per 100 ml sample, respectively), but had lower antioxidant properties using the DPPH method than commercial pomegranate juice (2,705.01 μmol equivalent of Trolox per 100 ml sample). (Wern et al., 2016)

Microbial properties

From a study of the microbiological quality of the healthy pasteurized banana blossom sheath juice produced from two types of banana blossom sheaths with different skin colors according to the standard criteria of the Notification of Ministry of Public Health (No. 356). (2013). Regarding beverages in sealed containers and according to the standard criteria of the Ministry of Public Health Announcement (No. 416) B.E. 2020 regarding determining quality or standards. Terms and conditions and methods for analyzing food for pathogenic microorganisms as shown in Table 3, it was found that the healthy pasteurized banana blossom sheath beverage product produced from both the inside and outside of the banana blossom sheath has microbial quality that passes the specified standard criteria, and no pathogenic microbial contamination. This is in accordance with the standard criteria of the Notification of Ministry of Public Health (No. 356). (2013) regarding beverages in sealed containers. and according to the standard criteria of the Notification of Ministry of Public Health (No. 416). (2020) regarding determining quality or standards. Terms and conditions and methods for analyzing food for pathogenic microorganisms. It is specified that there must be a total amount of microorganisms (Total Plate Count, TPC) of not more than 1×10^4 colonies in 1 mL of sample. Coliform bacteria (Coliform) were detected less than 2.2 in 100 mL of sample by the MP method. Most Probable Number: MPN: *Escherichia coli* (*E. coli*) bacteria were not detected in 100 mL of sample. Less than 100 colonies of yeasts and molds were detected in 1 mL of sample and must not be found. Microorganisms that cause disease shall be in accordance with the announcement of the Ministry of Public Health regarding Food standards for microorganisms that cause disease in liquid beverage products with an acidity-alkaline value (pH) greater than 4.3, only those that have undergone a heat sterilization process using pasteurization or other equivalent methods, including *Salmonella spp*. No colonies must be found in 25 mL of sample. *Staphylococcus aureus* must not exceed 100 colonies in 1 mL of sample. *Bacillus cereus* must not exceed 100 colonies in 1 mL of sample and *Clostridium Perfringens* must not exceed 100 colonies in 1 milliliter of sample. This indicates that the healthy pasteurized banana blossom sheath juice drink product produced from skin-colored banana blossom sheaths from both types are different and have a hygienic production process. As can be seen from the microbial index that indicates good production hygiene within the specified criteria, such as Coliform, *E. coli*, yeasts, and molds, etc., and there is a process Sterilize with heat that can destroy pathogenic microorganisms. As a result, the healthy pasteurized banana blossom sheath juice produced from two types of banana blossom sheaths with different skin colors has microbiological quality that meets the specified standard criteria. and is safe for consumers.

Table 3
Microbial properties of pasteurized banana blossom juice from inner light-yellow sheath and outer pink to red color

Microbial properties	**Banana blossom sheaths**	
	Inner (light-yellow)	**Outer (pink to red)**
Total plate count (CFU/ mL)	< 1	< 1
Yeasts/ Molds (CFU/ mL)	< 1	< 1
Escherichia coli (MPN/100 mL	N.D.	N.D.
Coliform (MPN/100 mL)	< 1.1	< 1.1
Salmonella spp. (in 25 mL sample)	N.D.	N.D.
Staphylococcus aureus (CFU/ mL)	< 1	< 1
Bacillus cereus (CFU/ mL)	< 1	< 1
Clostridium Perfringens (CFU/ mL)	< 1	< 1

Note: Mean ± standard deviation (n=2)

CONCLUSIONS

The two types of banana blossom sheaths have different skin colors, including the inner banana blossom sheaths that are light yellow. and the pink to red outer sheaths of banana blossoms influence the change in color value L* a* b* h° protein, crude fiber, ash, total carbohydrates Total phenolic compound content and the total anthocyanin content was significantly different ($p < 0.05$) and had no significant influence on the change in moisture content, lipids, and antioxidant properties using the DPPH method. In addition, the results of the study also showed that the light yellow inner sheath of the banana blossom, which is the part that is commonly eaten, is a source of protein, ash, and a statistically significant amount of total phenolic compounds ($p < 0.05$) while the outer sheath of the banana blossom is pink to red, which is the part that is not commonly eaten, and is often discarded as food waste in cooking and industrial processing, it is a source of crude fiber, total carbohydrates, and the total anthocyanin content was statistically significant ($p < 0.05$). However, Banana blossom sheaths with different skin colors, both the inner and outer sheaths, had similar antioxidant properties using the DPPH method, which were not significantly different. Healthy pasteurized banana blossom sheath juice produced from two types of banana blossom sheaths with different skin colors, with color values L* a* b* and total phenolic compound content and the total anthocyanin content were significantly different ($p < 0.05$) while the color value h°, pH, total soluble solid content (^{o}Brix) and the antioxidant properties using the DPPH method were not significantly different. Importantly, the health-friendly pasteurized banana blossom sheath juice drink product was produced from skin-colored banana blossom sheaths. They have different microbial quality according to the specified standard criteria.

Declarations

FUNDING:

School of Culinary Arts, Suan Dusit University, Bangkok, Thailand.

CONFLICT OF INTEREST:

This has reference to our manuscript all the authors involved in this paper declare that they have no known competing financial interests or personal relationship that could have appeared to influence the work reported in this paper.

AVAILABILITY OF DATA AND MATERIAL:

Data generated in this study are provided in the main manuscript. Additional data may be provided upon reasonable request by the corresponding author.

ACKNOWLEDGEMENTS

The author would like to acknowledge School of Culinary Arts, Suan Dusit University for kind support and providing a facility for the study.

References

1. Aisya, M.W., Zakaria, F., & Daud, W. (2020). The Effects of Banana Blossom *(Musa Acuminate Colla)* Consumption on Increased Breast Milk Production in the Work Area of Talaga Jaya. *Journal La Lifesci,* 1(4), 1-7.

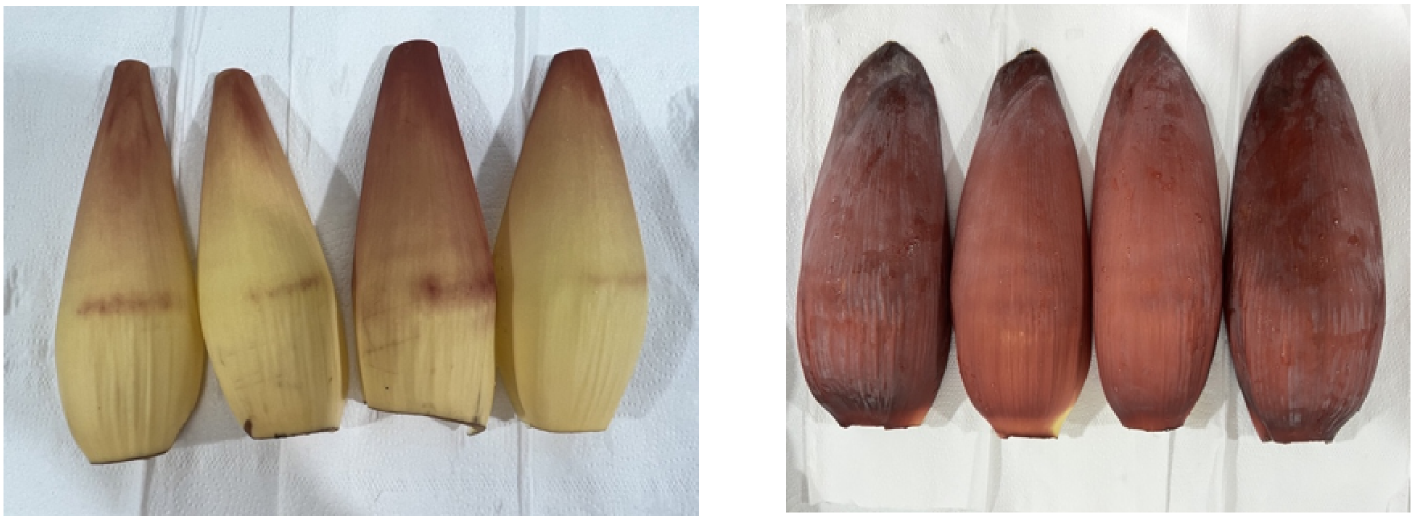
2. American Public Health Association (APHA). (2017). *Standard Methods for the Examination of water and Waste Water,* American Public Health Associa- tion, American water works Association, Water Environment Federation, Washington, DC, 23rd edition
3. Amornlerdpison, D., Choommongkol, V., Narkprasom, K. & Yimyam, S. (2021). Bioactive Compounds and Antioxidant Properties of Banana Inflorescence in a Beverage for Maternal Breastfeeding. *Applied Science,* 11(1), 343. doi:10.3390/app11010343.
4. AOAC. (2000). Official Method of Analysis of AOAC International. 17th ed. Arligition. Va: Associaltion of Official of Analyical Chemists. Inc.
5. Bagchi, D., Garg, A., Krohn, R.L., Bagchi, M., Bagchi, D.J., Balmoori, J. & Stohs, S.J. (1998). Protective effects of grape seed proanthocyanidins and selected antioxidants against TPA-induced hepatic and brain lipid peroxidation and DNA fragmentation, and peritoneal macrophage activation in mice. *General Pharmacology: The Vascular System,* 30, 771–776.
6. Berrill, A. (2019). A Banana blossom: The next vegan food star with the texture of fish. The Guardian, January 28nd, 2022, Retrieved from https://www.theguardian.com/food/2019/mar/16/banana-blossom-vegan-food-fish-texture-sainsburys.
7. Clemens, R., Drewnowski, A., Ferruzzi, M.G., Toner, C.D. & Welland, D. (2015). Squeezing Fact from Fiction about 100% Fruit Juice. *Advances in Nutrition*, 6(2), 236S-243S.
8. Du, M., Li, M., Ma, F. & Liang, D. (2009). Antioxidant capacity and the relationship with polyphenol and vitamin C in Actinidia fruits. *Food Chemistry,* 113, 557-562.
9. Elaveniya, E. & Jayamuthunagai, J. (2014). Functional, physicochemical and antioxidant properties of dehydrated banana blossom powder and its incorporation in biscuits. *International Journal of Chemical Technology and Research*, 6(9), 4446-4454.
10. Giusti, M.M. & Wrolstad, R.E. (2005). Characterization and Measurement of Anthocyanins by UV-Visible Spectroscopy, pp. 19-31. *In* R.E. Wrolstad, T.E. Acree, E.A. Decker, M.H. Penner, D.S. Reid, S.J. Schwartz, C.F. Shoemaker, D. Smith and P. Sporns, eds. Handbook of Food Analytical Chemistry, Wiley-Interscience, Hoboken, New Jersey.
11. Halee, A. & Rattanapun, B. (2017). Study of antioxidant efficacies of 15 local herbs. *KMUTT Research and Development Journal,* 40(2), 283-293.
12. Hardoko, Suprayitno, E., Sulistiyati, T.D., Sasmito, B.B., Chamidah, A., Panjaitan, M.A.P., Tambunan, J.E., & Djamaludin, H. (2022). Banana blossom addition to increase food fiber in tuna (*Thunnus* sp.) floss product as functional food for degenerative disease's patient. *IOP Conf. Series: Earth and Environmental Science*, 1036(012095), 1-8.
13. Jimenez-Garcia, S.N., Guevara-Gonzalez, R.G. Miranda-Lopez, R., Feregrino-Perez, A.A., Torres-Pacheco, I. & Vazquez-Cruz, M.A. (2013). Functional properties and quality characteristics of bioactive compounds in berries: Biochemistry, biotechnology, and genomics. *Food Research International,* 54, 1195-1270.
14. ISO (International Organization for Standardization). (2002). *ISO 6579:2002, Detection of Salmonella spp. January 22nd, 2022, Retrieved from*

15. Jongrattanavit, K., Pothinuch, P., Pichaiyongvongdee, S., Nukit, N. & Bangsiri, N. (2021). Product Development of Germinated Black Glutinous Rice Drink in a Sachet as Affected by Roasting and Brewing Time. *Journal of Food Health and Bioenvironmental Science*, 14(1), 9-19.
16. Kaweewong, K. & Sombutma, B. (2020). Effects of Using Citric Acid to Reduce Browning Reaction of Banana Blossom Milk Drink. *RSU National Research Conference 2020,* 104-113.
17. Kim, D.O. & Lee, C.Y. (2002). Extraction and isolation of polyphenolics. Current Protocols in Food Anlytical Chemistry, R.E. Wrolstad. New York, Wiley: 11.2.1-11.2.12.
18. Krishnan, A. S. & Sinija, V.R. (2016). Proximate Composition and Antioxidant Activity of Banana Blossom of Two Cultivars in India. *International Journal of Agriculture and Food Science Technology*, 7(1), 13-22.
19. Lau, B.F., Kong, K.W., Leong, K.H., Sun, J., He, X., Wang, Z., Mustafa, M.R., Ling, T.C., & Ismail, A. (2020). Banana inflorescence: Its bio-prospects as an ingredient for functional foods. *Trends in Food Science & Technology*, 97, 14-28.
20. Madhu, C., Krishna, K.M., Reddy, K.P., Lakshmi, P.J. & Kelari, E. (2017). Estimation of Crude Fiber Content from Natural Food Stuffs and its Laxative Activity Induced in Rats. International Journal of Pharma Research and Health Sciences, 5(3), 1703-1706.
21. Maizura, M., Aminah, A. & Wan Aida, W.M. (2011). Total phenolic content and Antioxidant capacity of kesum (*Polygonum minus*), ginger (*Zingiber officinale*) and turmeric (*Curcuma longa*) extract. *International Food Research Journal*, 18, 529-534.
22. Manzoor, M.F., Ahmad, N., Ahmed, Z., Siddique, R., Mehmood, A., Usman, M. & Zeng, X.A. (2020). Effect of dielectric barrier discharge plasma, ultra-sonication, and thermal processing on the rheological and functional properties of sugarcane juice. *Journal of Food Science,* 85, 3823-3832.
23. Mathew, N.S. & Negi, P.S. (2017). Traditional uses, phytochemistry and pharmacology of wild banana (*Musa acuminata* Colla): A review. *Journal of Ethnopharmacology*, 196, 124-140.
24. Nitithan, S., Komindr, S. & Nichachotsalid, A. (2004). Phytate and fiber content in Thai fruits commonly consumed by diabetic patients. *Journal* of the *Medical Association* of *Thailand,* 87(12), 1444-6.
25. Notification of Food Division, Food and Drug Administration. (2020). (No. 416). (2020). Issued by virtue of the Food Act 1979. Re: Prescribing the quality or standard, principles, conditions, and methods of analysis for pathogenic microorganisms in foods.
26. Notification of Ministry of Public Health (No. 356). (2013). Re: Beverages in Sealed Container.
27. Notification of Ministry of Public Health (No. 416). (2020). Issued by virtue of the Food Act 1979. Re: Prescribing the quality or standard, principles, conditions, and methods of analysis for pathogenic microorganisms in foods.
28. Nuchsuk, C. (2018). Antioxidant Activity of Crude Extract from Banana Flower of MusaAA cv. “KluaiKhai”, MusaABB cv. “KluaiNamwa” and MusaAAA “KluaiHom”. *Science and technology Nakhon Sawan Rajabhat University Journal,* 10(12), 1-10.

29. Ove,T.A., Kamal, M.M., Nasim, S.M.N.I., Momin, M.M.I. & Mondal, S.C. (2019). Extraction and Quantification of Anthocyanin from Banana Bracts Using Different pH and Solvent Concentration. *International Journal of food and nutrition sciences*, 4(2), 060-064.
30. Petchlert, C. & Sangprathum, T. (2020). Comparison of phenolic and anthocyanin content among four differences of raw and cooked rice. *Naresuan Phayao Journal,* 13(2), 36-41.
31. Rabie, M.A., Soliman, A.Z., Diaconeasa, Z.S. & Constantin, B. (2014). Effect of pasteurization and shelf-life on the physicochemical properties of Physalis (*Physalis peruviana* L.) juice. *Journal of Food Processing and Preservation*, 39, 1051-1060.
32. Ramírez-Bolaños, S., Pérez-Jiménez, J., Díaz, S. & Robaina, L. (2021). A potential of banana flower and pseudo-stem as novel ingredients rich in phenolic compounds. International *Journal of Food Science and Technology*, 56(11), 5601-5608.
33. Ramu, R., Shirahatti, P.S., Anilakumar, K.R., Nayakavadi, S., Zameer, F., Dhananjaya, B.L. & Nagendra Prasad, M.N. (2017). Assessment of nutritional quality and global antioxidant response of banana *Musa* sp. CV. Nanjangud Rasa Bale pseudostem and flower. *Pharmacognosy Research*, 9(1), S74.
34. Rodriguez-Saona, L.E. & Wrolstad, R.E. (2005). Extraction, isolation, and purification of anthocyanins, pp. 7-17. *In* R.E. Wrolstad, T.E. Acree, E.A. Decker, M.H. Penner, D.S. Reid, S.J. Schwartz, C.F. Shoemaker, D. Smith and P. Sporns, eds. Handbook of Food Analytical Chemistry, Wiley-Interscience, Hoboken, New Jersey.
35. Serradilla, M.J., Lozano, M., Bernalte, M.J., Ayuso, M.C., Lopez-Corrales, M. & Gonzalez-Gomez, D. (2011). Physicochemical and bioactive properties evolution during ripening of 'Ambrunés' sweet cherry cultivar. *LWT-Food Science and Technology*, 44, 199-205.
36. Sharma, V., Shukla, K.V. & Golani, P. (2019). Traditional and Medicinal Effect of Banana Blossom. *International Journal of Scientific Development and Research*, 4(5), 377-381.
37. Sheng, Z.W., Ma, W.H., Gao, J.H., Bi, Y., Zhang, W.M., Dou, H.T. & Jin, Z.Q. (2011). Antioxidant properties of banana flower of two cultivars in China using 2,2-diphenyl-1-picrylhydrazyl (DPPH) reducing power, 2,2'-azinobis-(3-ethylbenzthiazoline-6- sulphonate (ABTS) and inhibition of lipid peroxidation assays African. *Journal of Biotechnology*, 10(21), 4470-4477.
38. Sheng, Z.W., Ma, W.H., Jao, Z.Q., Bi, Y., Sun, Z.G., Don, H.T., Gao, J.H., Li, J.Y. & Han, H.T. (2010). Investigation of dietary fiber, protein, vitamin E and other nutritional compounds of banana flower of two cultivars grown in China. *African Journal of Biotechnology*, 9(25), 3888-3895.
39. Soni, D. & Saxena, G. (2021). Complete nutrient profile of banana flower. *The Journal of Plant Science Research*, 37(2), 433-437.
40. Suffi, N.S.M., Mohamed, E., Camalxaman, S.N., Rambely, A.S. & Haron, N. (2021). The medicinal benefits, phytochemical constituents and antioxidant properties of banana blossom: A mini review. *Healthscope,* 4(1), 113-118.
41. Sujithra, S. & Manikkandan, T.R. (2019). Extraction of Anthocyanin from Banana (*Musa paradisiaca*) Flower Bract and Analysis of Phytochemicals, Antioxidant Activities and Anthocyanin Content. *Journal of Chemical and Pharmaceutical Sciences*, 12(3), 102-104.

42. Sumathy, V., Lachumy, S.J., Zakaria, Z. & Sasidharan, S. (2011). In vitro bioactivity and phytochemical screening of Musa acuminata flower. *Pharmacology. online*, 2, 118-127.
43. U.S. Food and Drug Administration. Bacteriological Analytical Manual. (2001a). *Chapter 3 “Aerobic Plate Count”*(Online) January 22nd, 2022, Retrieved from https://www.fda.gov/ food/laboratory-methods-food/bam-chapter-3-aerobic-plate-count.
44. U.S. Food and Drug Administration. Bacteriological Analytical Manual. (2001b). *Chapter 18“Yeasts, Molds and Mycotoxins”*(Online) January 22nd, 2022, Retrieved from https://www.fda.gov/food/laboratory-methods-food/ bam-chapter-18-yeasts-molds-and-mycotoxins.
45. U.S. Food and Drug Administration. Bacteriological Analytical Manual (BAM). (2001c). Chapter 12 *“Staphylococcus aureus”* (Online) January 22nd, 2022, Retrieved fromhttps://www.fda.gov/food/laboratory-methods-food/bam-staphylococcus-aureus.
46. U.S. Food and Drug Administration. Bacteriological Analytical Manual (BAM). (2001d). *Chapter 14 “Bacillus cereus”*(Online) January 22nd, 2022, Retrieved from https://www.fda.gov/food/laboratory-methods-food/bam-chapter-14-bacillus-cereus.
47. U.S. Food and Drug Administration. Bacteriological Analytical Manual (BAM). (2001e). *Chapter 16 “Clostridium perfringens”*(Online) January 22nd, 2022, Retrieved from https://www.fda.gov/food/laboratory-methods-food/bam-clostridium-perfringens.
48. Wang, S.Y., Chen, C.T., & Wang, C.Y. (2009). The Influence of Light and Maturity on Fruit Quality and Flavonoid Content of Red Raspberries. *Food Chemistry***,** 112, 676-684.
49. Wern, K.H., Haron, H. & Keng, C.B. (2016). Comparison of Total Phenolic Contents (TPC) and Antioxidant Activities of Fresh Fruit Juices, Commercial 100% Fruit Juices and Fruit Drinks. *Sains Malaysiana*, 45(9), 1319–1327.
50. *Wickramarachchi K.S.* & *Ranamukhaarachchi, S.L.* (2005). Preservation of Fiber-Rich Banana Blossom as a Dehydrated Vegetable. *Science Asia*, 31, 265-271.
51. Wongwaiwech, D., Kamchonemenukool, S., Ho, C.T., Li, S., hongsook, T., Majai, T., Premjet, D., Sujipuli, K. & Weerawatanakorn, M. (2022). Nutraceutical Difference between Two Popular Thai Namwa Cultivars Used for Sun Dried Banana Products. *Molecules*, 27, 5675.
52. Yimyam, S. (2020). Galactagogue Herbs. *Nursing Journal*, 45(1), 133-145.
53. Zehla, P.F., Vijayalakshmi, D., Suvarna, V.C., & Yatnatti, S. (2018). Processing of Banana Blossom and its Application in Food Product**.** *International Journal of Current Microbiology and Applied Sciences*, 7(8), 1243-1250.
54. Zujko, M.E., & Witkowska, A.M. (2014). Antioxidant Potential and Polyphenol Content of Beverages, Chocolates, Nuts, and Seeds.*International Journal of Food Properties,*17, 86–92.

Figures



(a) (b)

Figure 1

The inner sheath of the banana blossom is light-yellow (a) and the outer sheath is pink to red (b)

(a) (b)

Figure 2

Pasteurized healthy banana blossom juice from inner light-yellow sheath (a) and outer pink to red color (b)