Effects of Various Drying Methods on the Physicochemical Properties of Telang Flower (*Clitoria ternatea* L.)

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Abstract. Telang flower is a biopharmaceutical horticulture commodity known as a functional food source since it contains rich nutrients. The drying methods influence the physicochemical properties of this flower. This study aimed to investigate the physicochemical properties of telang flowers using the sun and oven drying methods. The standard procedures were used to determine water, pH, anthocyanin content, free radical inhibitory activity, and IC_{50}. This study used a randomized design with one treatment factor: drying methods, including sun drying, sun drying with black cloth cover, and oven drying. The fresh telang flower served as the control. Furthermore, the best drying treatment was also evaluated using the De Garmo effectiveness index test. The results revealed that all drying procedures significantly differed in water content, pH, anthocyanin content, and IC_{50} values ($p < 0.05$). Meanwhile, all treatments' free radical inhibitory activity did not differ significantly ($p > 0.05$). It was found that all treatments had IC_{50} values in the range of 36.48–49.67 ppm of antioxidant activity. Telang flowers were found to be very potent antioxidants. As a result of the effectiveness index test, the sun drying using a black cloth cover provided the best treatment with the characteristics of water content, pH, anthocyanin content, free radical inhibitory activity, and IC_{50} of 17.47%, 7.03, 0.085 mg/mL, 85.51%, and 49.67 ppm, respectively.

Keywords: Clitoria ternatea · Anthocyanin · Free radical inhibition · Antioxidant · Drying

1 Introduction

The COVID-19 pandemic has increased public awareness of the importance of safe, healthy food that can positively impact the body. Indonesia is a country rich in plants that have potential as biopharmaceuticals. People generally have traditional knowledge of the use of medicinal plants for specific consumption.

Telang *(Clitoria ternatea)* is a biopharmaceutical product derived from flowers with functional qualities. Telang grows in woodlands, yards, and along the edges of rice fields.

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According to the nutritional analysis of this flower, it contains 0.32% of protein, 2.1% of fibre, 2.2% of carbohydrate, and 2.5% of fat, respectively [1]. The telang flower has smooth branches and complex leaves. Flower pigments are flavonoids, carotenoids, and betalains [2]. Telang flower is a popular beverage ingredient because of its appealing colour, unusual flavour, and high antioxidant content [3].

Telang flowers may be used as a functional food or medicinal supplement/drug mixed with commercial medications to increase patient treatment effectiveness. These flowers include anthocyanins, quercetin, and kaempferol glycosides, which have been associated with numerous health benefits. The antioxidant activity of telang flower has been studied extensively in various ways, including chemical tests, cellular assays, and even in vivo experiments. Telang flower contains many phytochemicals with powerful antioxidant, antimicrobial, anti-diabetic, anti-inflammatory, and antiproliferative/anticancer activities [1]. Consuming telang flower extract/beverage has been demonstrated to offer possible antioxidant and anti-hyperglycemic benefits in human subjects [1].

Increasing the shelf-life and convenience of the flowers can be accomplished by drying the extract and converting it to powder form [4, 5]. Drying can affect both the bioactive components and the nutrients included in a substance. Inadequate drying might result in a loss of bioactive components. Several different drying procedures can be employed in the process of manufacturing herbal tea flowers, including sun drying, indoor air drying (water drying), oven drying (oven drying), cold drying, and roasting [4–7].

The process of drying flowers produces dried flowers with a unique set of chemical and sensory properties. Thus, it is necessary to investigate the best drying processes for producing the highest-quality dried flower. The study aimed to investigate the physicochemical properties of telang flowers using the sun and oven drying methods. The physicochemical properties in this research were water content, pH, anthocyanin content, free radical inhibitory activity, and IC50.

2 Materials and Methods

2.1 Material

The raw material used for this research was telang (Clitoria ternatea) flowers. The flowers were obtained from Kulonprogo Regency, Yogyakarta, Indonesia. It was collected in the morning from the five-month-old plant and immediately transported to the following study phase. The chemical reagent used DPPH, methanol, ethanol, buffer solution, chloric acid, acetic acid. All reagents were analytical grade.

2.2 Drying Procedure

The fresh telang were washed three times and drained. The drying treatment were divided into three treatment, namely sun drying method (TM), sun drying with clothes (TMT), and 500C of oven drying (TO).

2.3 DPPH Analysis

The DPPH technique was used to assess the antioxidant activity; 1.0 mL of 0.4 mM DPPH was employed. The absorbance of a solution is determined at its maximum value using the scanning wavelength. The proportion of free radical scavenging is represented in terms of inhibition and is determined using the formula [8].

$$\% \, inhibition = \frac{absorbance\,(control) - absorbance\,(sample)}{absorbance\,(control)} \times 100\%$$

Description:
Absorbance control: absorbance without the sample
Absorbance sample: absorbance with sample

The amount of antioxidant activity is expressed by the IC50 value calculated from the standard linear regression curve between the concentration of the solution and the % inhibition.

2.4 Anthocyanin Analysis

Anthocyanin content analysis was carried out using the pH differential method [9]. A specified volume of telang flower extract is dissolved in two distinct buffer solutions. The first solution is dissolved in 0.025 M potassium chloride buffer pH 1.0, while the other solutions were dissolved in 0.4 M sodium acetate buffer pH 4.5. The number of samples utilized was determined, which results in the absorbance value at vis-max, which is within the linear range of the spectrophotometer. Additionally, scanning wavelengths between 200 nm and 750 nm were used to determine the anthocyanin content and viscosity of sample solutions in both buffers (KCl and Sodium Acetate). The absorbance of each solution was determined, and the result was calculated using the following equation.

$$A = (A_{540} - A_{700})_{pH1} - (A_{540} - A_{700})_{pH4.5}$$

Total monomeric anthocyanin from extract dried telang was estimated as cyaniding-3-glucoside based on the following equation.

$$MAP(mg/L) = [(A \times MW \times DF \times 1000/(\varepsilon)) \times 1]$$

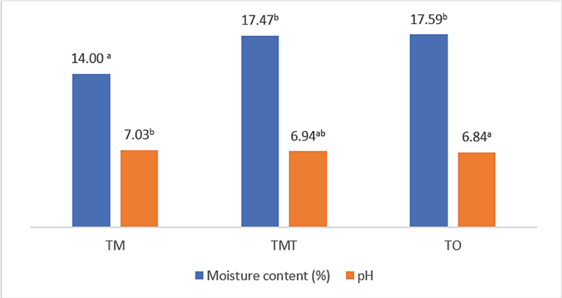
Description:

A: Absorbance of solution
MW: Molecular weight (molecular weight)
DF: Dilution factor (dilution factor)
ε: Molar absorptivity of cyaniding-3-glucoside
b: thickness of cuvette = 1
MAP: Monomeric Anthocyanin Pigment

Note:

MW and used are related to the dominant anthocyanin present in the sample, used anthocyanin pigment in acid solutions found in the literature. If the value of the significant pigment is not available, or if the composition of the sample is unknown, then the pigment was calculated as cyaniding-3-glucoside, with MW = 449.2 and = 26,900).

Next, the curve was created standard between concentrations (from extract volume tested) to the total number of monomeric.



TM: sun-drying method; TMT: sun-drying with black clothes method; TO: oven drying method. Data are mean ± standard deviation (n = 3). Mean values with different alphabet superscripts are significantly different ($p < 0.05$).

Fig. 1. Moisture content and pH of dried telang.

2.5 Moisture Content

Moisture content of samples were analyzed using AOAC Method (2005).

2.6 pH Analysis

Five grams of dried telang were homogenized in 50 mL of distilled water and the filtrate was filtered using filter paper. The pH was measured using a pH meter.

2.7 Statistical Analysis

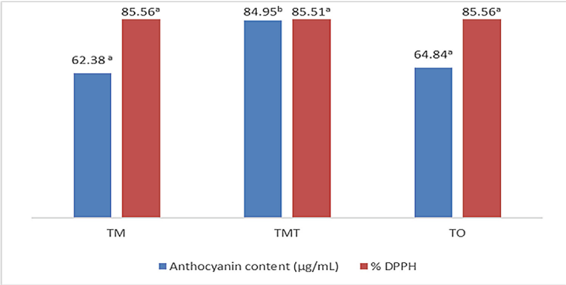
The data were analysed using one-way ANOVA and Duncans Multiple Range Tests (DMRT) using SPSS IBM 23. The significant difference was calculated using SPSS IBM 23 and a 95% confidence range.

3 Results and Discussion

3.1 Moisture Content and pH of Dried Telang

The drying of the flowers was carried out for two days in direct sunlight (TM) and with a black cloth cover (TMT). The water content of dried flowers was the lowest obtained from the data obtained by drying the flowers with direct sun drying (TM) with a value of 14%.

The drying process is influenced by external elements such as temperature, humidity, air movement, and the dried substance's material attributes such as surface features, chemical composition, physical structure, size, and form [5]. Direct sun drying was able to lower water content faster because it was not obstructed by a black cloth covering the product's surface. Drying using a 50 °C oven for 6 h has a relatively similar water content to drying using sunlight plus a cover. In Fig. 1, the drying method has no significant effect



TM: sun-drying method; TMT: sun-drying with black clothes method; TO: oven drying method. Data are mean ± standard deviation (n = 3). Mean values with different alphabet superscripts are significantly different ($p < 0.05$).

Fig. 2. Anthocyanin content and antioxidant activity.

on the pH of the dried flower. The pH of the flower is reported to influence the stability of its antioxidant properties. The results of previous research showed that it is the most potent antioxidant activity in the extract of dried flowers pH 6 with antioxidant activity of 344.17 ppm. The primary study results of telang flower extract have 12 anthocyanins, 18 flavonols, and 11 flavons [2].

3.2 Antioxidant Activity and Anthocyanin Content of Dried Telang

Based on Fig. 2, it is seen that the anthocyanin content of dried flowers ranges from 62.38–84.95 µg/mL. The drying method exerts a significant influence on the anthocyanin content of dried flowers ($p < 0.05$) but does not have a significant effect on free radical inhibition activity ($p > 0.05$). Interestingly, the free radical inhibition activity in dried flowers of three different drying treatments is relatively the same, although late sun-dried flowers plus coverings provide a higher anthocyanin content. This study's free radical inhibition activity was analyzed using the DPPH method, where inhibition activity is measured based on total antioxidants that can inhibit free radicals. The free radical commonly used as a model in measuring free radical capture power is 1,1-diphenyl-2-pikrihidazil (DPPH). DPPH is a stable free radical compound, so when used as a reagent in free radical capture tests, it is pretty dissolved and stored in a dry state with excellent and stable storage conditions for many years. DPPH absorbance values range from 515–520 nm [10, 11]. The DPPH free radical damping method reduces a methanol solution of DPPH free radicals coloured by inhibition of free radicals. When the purple DPPH solution meets the electron donor material, the DPPH will be reduced, causing the purple colour to fade and be replaced by the yellow colour derived from the pikri group [11]. DPPH measures the inhibition of free radicals from whole telang materials that have antioxidant properties. The higher the inhibition activity of free radicals, the higher the antioxidant content.

It was found that all drying treatments exhibited IC_{50} values in the range of 36.48–49.67 ppm of antioxidant activity. From these data, it can be stated that telang flowers were found to be very potent antioxidants [3].

Table 1. Total effectivity index

Effectivity Score (ES)						Weight *ES					
Treatment	pH	Antocyanin	Inhibition	IC_{50}	Water Content	pH, 1	Antocyanin, 2	Inhibition, 3	IC_{50}, 4	Water Content, 2	Total Effectivity Index
TM	0,19	0,62	2,91	0,88	0,58	0,93	1,86	4,00	1,77	9,14	9,14
TMT	0,96	0,61	2,90	0,04	0,94	4,82	1,82	4,00	0,09	11,66	11,66
TO	0,27	0,62	2,91	0,01	0,21	1,35	1,86	4,00	0,03	7,45	7,45

TM: sun-drying method; TMT: sun-drying with black clothes method; TO: oven drying method.

3.3 Selection of the Best Treatment

The best treatment selection was conducted using the method of De Garmo by providing weighing on the research attributes. Weighting is carried out in anthocyanin, Ic50, free radical inhibition, moisture content and pH with consecutive weights of 5, 4, 3, 2 and 1. Based on the effectiveness value in Table 1, dried flowers with sunlight drying treatment using black covering cloth provide the best treatment, with an effective value of 11.66.

4 Conclusion

Telang flowers in this research can be concluded as very potent antioxidants because IC_{50} values were in the range of 36.48–49.67 ppm. As a result of the effectiveness index test, the sun drying using a black cloth cover provided the best treatment with the characteristics of water content, pH, anthocyanin content, free radical inhibitory activity, and IC_{50} of 17.47%, 7.03, 0.085 mg/mL, 85.51%, and 49.67 ppm, respectively.

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