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Quality evaluation and antioxidant activity of snow-white chrysanthemum (*Chrysanthemum morifolium* (Ramat.) Hemsl.) flower infusion

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Abstract. Snow-white chrysanthemum flowers (*Chrysanthemum morifolium* (Ramat.) Hemsl.) are used in medicine as well as a popular drink. This flower contains phenolic compounds and antioxidants that support health. Even though chrysanthemum flowers are well known in Indonesia, their use as a daily functional food is still not optimal. This study aims to determine the quality and antioxidant activity of snow-white chrysanthemum flower tea (*Chrysanthemum morifolium* (Ramat.) Hemsl.). This research is an experimental study involving chemical, microbiological and antioxidant activity testing of snow-white chrysanthemum tea using the 2-2 diphenyl-1 picrylhydrazyl (DPPH) method using a UV-Visible spectrophotometer. Polyphenol content test results 5.4 mg GAE/g extract , water content 3.19%, extract content in water 32.7%, total ash content 7.97%, water soluble ash content 45.4%, acid insoluble ash content 0.16%, water soluble ash alkalinity 2.35%, crude fiber 15.5%, cadmium (Cd) <0.04 mg/kg, lead (Pb) <0.008 mg/kg, tin (Sn) <0.06 mg/kg, mercury (Hg) 0.000049 mg/kg, arsenic contamination (As) 0.000631 mg/kg, total plate count (ALT) 1.5x101 colonies, coliform bacteria 0 APM/g, mold <1; *Inhibitory Concentration* 50% (IC50) 66.0085 mg/ml. Overall, the quality parameters of snow-white chrysanthemum comply with the established standards for packaged dried tea and demonstrate strong antioxidant activity, supporting its potential as a functional beverage.

1. Introduction

Chrysanthemum flowers contain a wide range of bioactive compounds, including essential oils, terpenoids, flavonoids, and phenolic acids. Among these constituents, flavonoidsclassified as phenolic compounds exhibit strong antioxidant properties by effectively inhibiting free radicals. Despite their considerable potential for development, chrysanthemums are not yet widely recognized as medicinal plants. In addition to their prominence in floriculture and ornamental horticulture, chrysanthemums are also utilized in culinary, pharmacological, and medicinal applications, as well as in the formulation of biopesticides. In culinary contexts, the flowers are commonly used to make beverages. Beyond its role as an ornamental plant, the chrysanthemum flower exhibits promising medicinal properties. Moreover, nearly all parts of the chrysanthemum plant possess potential therapeutic value [1].

Recognized for centuries as a traditional Chinese medicinal herb, chrysanthemum is commonly consumed with warm water in daily practices. The flower contains antioxidant compounds, particularly flavonoid micromolecules, that play a significant role in eliminating oxygen free radicals produced by light-induced oxidative stress [2,3].

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An evaluation of white chrysanthemum (*Chrysanthemum morifolium* Ramat.) flowers dried using a cabinet dryer revealed that the resulting tea meets acceptable quality standards, although its antioxidant activity is relatively weak. This reduction in activity is attributed to the degradation of heat-sensitive antioxidant compounds with prolonged drying. Research on tea products derived from floral sources, particularly chrysanthemum, remains limited; therefore, the optimal quality characteristics of chrysanthemum flower tea have yet to be clearly defined [4].

Accordingly, this study aims to assess the quality of snow-white chrysanthemum flower tea through chemical, microbiological, and antioxidant activity analyses. Antioxidant activity will be determined using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay with a UV–Visible spectrophotometer.

2. Materials and Methods

2.1 Plant identification

The Snow-white chrysanthemum flowers were obtained from Berastagi District, Karo Regency, North Sumatra Province. Chrysanthemum plant identification was conducted at the Herbarium Bogoriense, Directorate of Scientific Collection Management, BRIN Cibinong.

2.2 Chrysanthemum flower processing technique

The snow-white chrysanthemum flowers used in this study were carefully selected and subjected to wet sorting, followed by washing until clean, draining, and weighing to determine their wet weight. The flowers were then dried at 60°C for 2 hours using a food dehydrator. Once dried, they were sorted again, ground into a coarse powder using a blender, and stored in tightly sealed plastic containers to maintain their quality [5].

2.3 Preparation of chrysanthemum flower infusion

A total of 50 g of coarse powder from snow-white chrysanthemum flowers was measured and infused in 500 mL of distilled water. The mixture was heated at 90°C for 15 minutes, followed by filtration through filter paper. The obtained filtrate, representing the chrysanthemum flower infusion, was then concentrated in a water bath until a thick extract was produced [5].

2.4 Analysis evaluation of snow-white of chrysanthemum flower

Analysis evaluation of snow-white chrysanthemum flower infusion include polyphenol content, water content, extract content in water, total ash content, water-soluble ash, acid-insoluble ash, ash alkalinity, crude fibre, and metal contamination (cadmium, lead, tin, mercury, arsenic) [6].

2.5 Microbial contamination

Microbial contamination plays an important role in quality evaluation. It encompasses parameters such as total plate count, coliform bacteria count, and total mould and yeast count [6].

2.6 Antioxidant activity by DPPH method

2.6.1 Preparation of DPPH solution. Ten milligrams of DPPH crystals were weighed and dissolved in methanol in a 50 mL volumetric flask to a final volume of 50 mL, yielding a 200 µg/mL DPPH solution. Preparation the blanko is 1 mL aliquot of the 200 µg/mL DPPH solution was transferred to a 5 mL volumetric flask and diluted to the mark with methanol to obtain a 40 µg/mL DPPH solution [7].

2.6.2 Determination of maximum wavelength and incubation time. The maximum absorption wavelength was determined using the 40 µg/mL DPPH solution. The solution was homogenised, placed in a cuvette and scanned with a spectrophotometer; the maximum absorbance was

observed at 515 nm. The absorbance of the 40 μg/mL DPPH solution was measured at 515 nm using a UV–Vis spectrophotometer at regular intervals for 60 minutes. Measurements continued until the absorbance reached a stable value, establishing the appropriate reaction/incubation time [7].

2.6.3 Preparation of extract standard stock and test solutions. A stock solution of the extract was prepared by dissolving 10 mg of sample extract in methanol in a 10 mL volumetric flask to give 1000 μg/mL. Aliquots of 0.125, 0.25, 0.375, 0.5 and 0.625 mL of this stock were transferred to separate 5 mL volumetric flasks and diluted to the mark with methanol to produce test solutions of 25, 50, 75, 100 and 125 μg/mL, respectively. Each test solution was then mixed with 1 mL of 200 μg/mL DPPH solution and brought to volume with methanol, homogenised, and allowed to stand for 30 minutes before measurement. Absorbance was measured at 515 nm [7].

2.6.4 Preparation of quercetin standard solutions. A quercetin stock solution was prepared by dissolving 10 mg quercetin in methanol in a 100 mL volumetric flask to yield 100 μg/mL. Aliquots of 0.05, 0.1, 0.15, 0.2 and 0.25 mL of this stock were transferred to 5 mL volumetric flasks and diluted to the mark to prepare standards of 1, 2, 3, 4 and 5 μg/mL, respectively. Each standard was combined with 1 mL of 200 μg/mL DPPH solution, made up to volume with methanol, homogenised, and incubated for 30 minutes prior to absorbance measurement at 515 nm.

2.6.5 Analysis of antioxidant activity (DPPH assay). Percent DPPH radical inhibition was calculated as follows:

$$\% \text{ Inhibition} = ((A_{control} - A_{sample}) / A_{control}) \times 100 \quad (1)$$

where A_control is the absorbance of the control (DPPH with methanol) and A_sample is the absorbance of the sample or standard after incubation. Percent inhibit values were plotted against sample concentration and analysed by linear regression ($y = bx + a$), where y is percent scavenging and x is concentration. The IC50 (the concentration producing 50% radical scavenging) was obtained by solving the regression equation for x when $y = 50$, i.e. $x = (50 - a) / b$ [7].

3. Result and Discussion

3.1 Quality of snow-white chrysanthemum

The quality analysis of snow-white chrysanthemum flowers assessed multiple parameters, including polyphenol content, moisture content, water-extractable constituents, total ash, water-soluble ash, acid-insoluble ash, the alkalinity of the water-soluble ash, crude fibre, metal contaminants, arsenic levels, and microbial contamination. The results of these examinations are presented in table 1.

Based on the table 1, the polyphenol content in the snow-white chrysanthemum flower extract is 5.4 mg GAE/g extract. Polyphenols are widely distributed across nearly all plant families, with the highest concentrations typically found in leaf tissues, bark epidermis, flowers, and fruits. The drying time, as well as the contact time of the product with oxygen, affects the retention of polyphenols more intensely than the increase in temperature [8].

Analysis revealed that the moisture content of the white chrysanthemum flower herbal tea was 3.19%, in accordance with the SNI 3836:2013 regulation, which stipulates a maximum allowable moisture content of 8% for packaged dry tea [7]. Excessive moisture can enhance microbial activity, leading to reduced product stability and quality [9].

The water-extract content of the white chrysanthemum flower raw material was 32.7%, which complies with the SNI 3836:2013 standard requiring a minimum of 32% for packaged dried tea [7]. Excessive drying temperature and extended drying duration may reduce the water-extract content. The total ash content of the snow-white chrysanthemum herbal tea was 7.97%, meeting

the SNI 3836:2013 specification that limits the total ash content of packaged dry tea to 8% [7]. Ash content analysis serves as an important quality indicator, as it reflects the mineral composition of the tea product.

Table 1. Quality Evaluation of Snow-white chrysanthemum

No	Parameter	Total	Requirements
1	Poliphenol	5,4 mg GAE/g	min. 5.2 %
2	Water Content	3,19%	max. 8.0 %
3	Extract Content in Water	32,7%	min. 32 %
4	Total Ash Content	7,97 %	max. 8.0 %
5	Ash Content in Water	45,4%	min. 45%
6	Ash Content Insoluble in Acid	0,16%	max. 1.0 %
7	The alkalinity of ash is soluble in water.	2,35%	1-3 %
8	Crude Fibre	15,5%	max. 16.5 %
9	Metal Contamination		
9.1	Cadmium (Cd)	<0,04 mg/kg	max. 0.2 mg/kg
9.2	Lead (Pb)	<0,008mg/kg	max. 2.0 mg/kg
9.3	Tin (Sn)	< 0,06 mg/kg	max. 40.0 mg/kg
9.4	Mercury (Hg)	0,000049	max. 0.03 mg/kg
10	Arsenic (As)	0,000631	max. 1.0 mg/kg
11	Microbial Contamination		
11.1	Total Plate Count	$1,5 \times 10^1$	max. $3x10^3$ koloni
11.2	Coliform	0	< 3 APM/g
11.3	Total Mould	**<1**	max. $5x10^2$

Analysis of the snow-white chrysanthemum flower raw material revealed a water-soluble ash content of 45.4%, satisfying the national standard requirement of at least 45% for packaged dry tea. The water-soluble ash fraction is a critical quality parameter, representing the mineral content that remains soluble in water and thus available during infusion [7].

The moisture content of the snow-white chrysanthemum flower herbal tea was determined to be 3.19%, which complies with the SNI 3836:2013 standard that specifies a maximum moisture level of 8% for packaged dry tea. Low moisture content is essential to inhibit microbial growth and maintain product stability. The infusion content of the raw material was found to be 32.7%, also meeting the minimum SNI requirement of 32% [7]. However, exposure to excessively high drying temperatures or extended drying times can degrade the extractable compounds and reduce the water-soluble extract yield.

The total ash content of the snow-white chrysanthemum flower herbal material was 7.97%, remaining below the SNI maximum limit of 8% for dry tea [7]. The Ash analysis serves as a critical indicator of tea quality, as it reflects the total mineral concentration in the product [10]. The water-soluble ash was 45.4%, which meets the national standard requiring a minimum of 45% for packaged dry tea. This fraction represents the portion of minerals soluble in water, signifying the availability of essential inorganic nutrients in the raw material. The acid-insoluble ash content was recorded at 0.16%, far below the SNI limit of 1% [7]. This parameter is used to assess the material's purity, since higher values often indicate contamination by extraneous matter such as sand or silica. The ash alkalinity value was found to be 2.35%, which lies within the acceptable SNI range of 1–3% [7]. Maintaining alkalinity within this range is crucial, as values above the threshold may suggest adulteration or the addition of non-permissible alkaline substances.

The crude fiber content of the chrysanthemum flower raw material was 15.5%, satisfying the SNI standard that allows up to 16.5% for tea products [7]. Crude fiber analysis quantifies the indigestible plant components resistant to hydrolysis by sulfuric acid and sodium hydroxide. Prolonged drying tends to reduce fiber content, likely due to partial thermal degradation of cellulose and hemicellulose fractions.

Analysis of heavy metal contamination revealed cadmium (<0.04 mg/kg), lead (<0.008 mg/kg), tin (<0.06 mg/kg), and mercury (0.000049 mg/kg) levels, all of which remain within the permissible limits defined by SNI for tea products [7]. The presence of heavy metals at trace levels may originate from soil or environmental pollution. Nonetheless, the recorded values confirm that the raw material is safe for consumption. Accumulation of these metals beyond regulatory thresholds can pose health risks to humans through long-term exposure. The arsenic (As) content was measured at 0.000631 mg/kg, which is well below the maximum allowable limit of 1.0 mg/kg established by SNI [7]. Elevated arsenic levels have been associated with chronic toxicity, kidney impairment, and carcinogenic effects; therefore, maintaining concentrations below the established limit is critical for consumer safety [11].

Microbial analysis of the snow-white chrysanthemum flower dried powder showed a total plate count (TPC) of 1.5×10^{1} CFU/g, coliform bacteria of 0 MPN/g, and mould counts of less than 1 CFU/g. These results demonstrate good sanitary handling during post-harvest processing and drying. Contamination is generally associated with unhygienic water or equipment use, which can introduce pathogenic microorganisms capable of causing gastrointestinal infections. The absence of *Escherichia coli* and the low mould count indicate that the drying and packaging conditions were appropriate. The TPC test determines the number of viable bacteria capable of forming colonies on a specific growth medium, reflecting the overall microbial load of the sample. In contrast, the total mould count measures fungal contamination, as moulds typically form visible, fibrous, cotton-like colonies due to their filamentous mycelial growth [7][12].

3.2 Antioxidant Activity

The antioxidant activity of quercetin, expressed as the IC_{50} value, is presented in Table 2. Quercetin exhibited an IC_{50} of 3.84 µg/mL, indicating very strong antioxidant potential. This compound was selected as a reference standard due to its abundance in plants and its well-documented ability to scavenge free radicals and reactive oxygen species, including superoxide anions and hydroxyl radicals, which underpin its potent antioxidant properties. In comparison, the antioxidant potential of *Chrysanthemum morifolium* observed in the present study was markedly higher, indicating its superior free radical–scavenging efficiency relative to broccoli extracts [13].

As shown in table 3, the snow-white chrysanthemum demonstrated notable antioxidant activity, with an IC_{50} value of 66.00 µg/mL, placing it within the strong antioxidant category. These findings are consistent with the observations of Hartanto (4), who reported that white chrysanthemum tea exhibited strong antioxidant activity at various drying temperatures, yielding IC_{50} values of 87.52 % at 60 °C, 86.64 % at 50 °C, and 84.62 % at 40 °C. The methanolic extract of the green aerial parts showed higher overall activity compared to its EtOAc fraction, except in the reducing power assay, where it displayed an EC_{50} value of 2020.5 ± 27.97 µg/mL. [14].

The results of the measurement of antioxidant activity of chrysanthemum infusion are expressed with an IC50 value is shown in Table 3.

Table 2. Antioxidant activity of quercetin

Quarcetin Concentration (µg/Ml)	Absorbance	% Inhibition	Average % of inhibition	IC50
0	0,9214	0	0	
	0,9211	0		3,84
	0,9210	0		mg/ml
1	0,6274	31,9079	31,8834	
	0,6273	31,8966		
	0,6277	31,8458		
2	0,5426	41,1113	41,1688	
	0,5417	41,1898		
	0,5415	41,2052		
3	0,3939	57,2498	57,2317	
	0,3938	57,2467		
	0,3942	57,1986		
4	0,2956	67,9183	67,9319	
	0,2954	67,9296		
	0,2952	67,9478		
5	0,2485	73,0301	73,6764	
	0,2487	73,9996		
	0,2487	73,9996		

Table 3. Antioxidant activity of snow-white chrysanthemum infusion using the DPPH method

Snow-white chrysanthemum flower tea extract (mg/ml)	Absorbance	% Inhibition	Average of Inhibition	IC50
0	0,9785	0	0	66,0005
	0,9789	0		µg/ml
	0,9792	0		
25	0,7222	26,1931	26,3025	
	0,7206	26,3867		
	0,7214	26,3276		
50	0,5921	39,4890	39,5865	
	0,5911	39,6158		
	0,5909	39,6548		
75	0,3984	59,2846	58,99	
	0,4030	58,8313		
	0,4029	58,8541		
100	0,2662	72,7950	73,0027	
	0,2641	73,0207		
	0,2625	73,1924		
125	0,1232	87,4092	87,7714	
	0,1184	87,9047		
	0,1175	88,0004		

4. Conclusions

The snow-white chrysanthemum (*Chrysanthemum morifolium* Ramat.) infusion met the quality requirements established by National Standardization Agency for packaged dry tea, confirming its compliance with national standards for moisture, ash, and extract content. Furthermore, the

extract demonstrated strong antioxidant activity, with an IC_{50} value of 66.0005 mg/mL against DPPH radicals. These findings indicate that snow-white chrysanthemum flowers possess considerable potential as a functional herbal ingredient and a promising natural source of antioxidants for health-promoting applications.

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