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Effect of Red Ginger Addition and Drying Temperature Variations on Quality Characteristics and Antioxidant of Cat's Whiskers Leaf Teabags

Rizki Putri Sari Manik*, *Ismed Suhaidi*, *Sentosa Ginting

Department of Food Science, Faculty of Agriculture, Universitas Sumatera Utara, Indonesia

Abstract. Tea is a type of beverage that is widely consumed in various countries due to its high antioxidant content and its beneficial for health. This study was conducted to determine the effect of the addition of red ginger and variations in drying temperature on the quality characteristics and antioxidant content of cat whisker leaf tea bags. The study used a factorial Completely Randomized Design (CRD) method consisting of two factors, the addition of red ginger (10%, 20%, 30%, and 40%) and variations in drying temperature (40ºC, 50ºC, and 60ºC). The results show that the addition of red ginger had a highly significant effect on water content, ash content, water-soluble ash content, crude fiber content, pH, antioxidant content, aroma hedonic value, taste hedonic value, and general acceptance hedonic value. Variations in drying temperature had a highly significant effect on water content, ash content, water-soluble ash content, fiber content, and antioxidant content. This variation of drying temperature also had no significant effect on pH, hedonic aroma value, taste hedonic value, color hedonic value, and general acceptance hedonic value. The best results showed that the addition of ginger at 40% and a drying temperature of 60ºC resulted in the best quality tea bags.

Keywords: antioxidant, cat's whiskers leaf, herbal tea, red ginger, temperature

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1. Introduction

Exploration and utilization of medicinal plants are being intensively carried out in the present. Medicinal plants are in demand due to the bioactive compounds in them that have a good effect on the body's health. Medicinal plants are commonly used by the community for disease prevention, cure diseases, and as guardians of body healthiness [1]. Cat whiskers and red ginger are herbal plants that are widely used. In general, the extract of cat whiskers is usually used as an anti-inflammatory, uric acid reduction, for the cure of diabetes, and as an anti-hypertension. Cat whiskers contain flavonoid compounds that have benefits as antioxidants [2]. Ginger contains

*Corresponding author at: Department of Food Science, Faculty of Agriculture, Universitas Sumatera Utara, Jl. Prof. Sofyan No. 3 Kampus USU, Medan, Indonesia, 20155

E-mail address: rizkiputrimanik@gmail.com

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essential oils, zingiberene, zingiberol, sineol, barneol, gingerin, folandren, zingiberin, kamfer, vitamins (A, B1, and C), carbohydrates, resin, and organic acids. Besides being an antimicrobial, ginger is also high in antioxidants [3]. Antioxidant compounds have a function as anti-inflammatory, besides antioxidant compounds can also be used as immunostimulators [2].

Currently, functional foods are widely developed, the most functional food development is food that contains antioxidants. Antioxidants have the function of warding off free radicals to protect the body. Antioxidants work by inhibiting the process of destroying cells attacked by free radicals by giving electrons to free radicals. Antioxidant compounds cannot be produced in the body but can be found easily in foods that contain antioxidants [3]. Tea is a type of beverage that is widely consumed in various countries due to its high antioxidant content and its beneficial for health. Moreover, during a pandemic like today, the level of public consumption of foodstuffs that are herbal and have antioxidants is increasing, so cat whiskers and red ginger are used in making herbal tea as functional drinks. Herbal tea is a functional drink that is widely developed because it can maintain the immune system and has good health effects. The purpose of this study was to determine the antioxidant content of the cat's whisker leaf teabags added with red ginger and the use of temperature variations to increase the antioxidant content of the cat's whisker leaf teabags.

2. Materials and Methods

The raw materials used in this research are cat's whiskers leaf from Patumbak 1, Dusun 1, Desa Patumbak, Kecamatan Patumbak, Kabupaten Deli Serdang and red ginger from Desa Bukit Baru, Kecamatan Pegagan Hilir, Kabupaten Dairi, Sumatera Utara. The chemicals used for chemical analysis of cat's whisker leaf and red ginger teabag were aquadest, sulfic acid, sodium hydroxide, ethanol, buffer solution pH 4 and pH 7, and DPPH (2,2-diphenyl-1-picrylhydrazyl).

2.1. Experimental Design

This research used a factorial completely randomized design with 2 factors, namely the addition of red ginger (10%, 20%, 30%, and 40%) and variations in drying temperature (40^{o}C, 50^{o}C and 60^{o}C). Each treatment was conducted in 2 replications.

2.2. Data Analysis

The data obtained from the research was then analyzed using the one-way ANOVA method with Microsoft Excel application.

2.3. Making Cat Whisker Leaf Tea Powder

Preparing fresh cat whisker leaves picked with a count of 5 strands from the shoots and weighed by 5 kg and then sorted and cleaned. Then the leaves of the cat's whisker are arranged on a tampah for withering and draining water for about 15 minutes at room temperature. Then arranged on a 40x40 cm baking sheet and dried in a drying oven at a temperature of 50°C for 3 hours. Then the

dried leaves of the cat whiskers are cooled first for 5 minutes and then blended for 30 seconds. Then the cat whisker leaf tea powder was analyzed for water content, ash content, crude fiber content, antioxidant, and pH.

2.4. Making Red Ginger Powder

Preparing fresh red ginger that has been selected and then weighed as much as 300 g then cleaned and sorted again. Then peeled red ginger and washed it again to make it clean. Then slice the red ginger 3 mm thick using a slicer. After that, red ginger is arranged on a tampah and drained by letting the ginger stand at room temperature for 15 minutes. Then arranged on a 40x40 cm baking sheet and dried red ginger in a drying oven at a temperature of 40°C, 50°C, and 60°C for 8 hours. Then cool the red ginger for 5 minutes first then blend the dried red ginger for 30 seconds. Then the red ginger powder was analyzed for water content, ash content, crude fiber content, antioxidant, and pH.

2.5. Making Cat Whisker Leaf and Red Ginger Teabag

The powder of the leaves of the cat whiskers that have been obtained is weighed by 100 g. Then red ginger powder is added according to the treatment and then put in a jar and then stirred with a spoon until homogeneous. Weighed as much as 2 g of homogeneous tea powder then put the mixture of both powders into an empty teabag. After obtaining the teabag then brewed with 200 ml of hot water at a temperature of 80°C for 5 minutes.

2.6. Analysis

In this research, analyses were carried out on raw materials and the cat whisker leaf and red ginger teabag. The analysis of raw materials includes water content, ash content, crude fiber content, pH, and antioxidants. The analysis of cat whisker leaf and red ginger teabag is water content, ash content, water-soluble ash content, crude fiber content, water-soluble dietary fiber content, antioxidant, pH, and hedonic (aroma, taste, color, and general acceptance). The hedonic scale is transformed into a scale number according to the level of preference on a scale of 1-7.

3. Result and Discussion

3.1. Raw Materials Analysis of Cat Whisker Leaf and Red Ginger

In this study, 2 tests were carried out on raw materials, namely fresh raw materials and dried raw materials. As for the results, the analysis that had been carried out on the cat whisker leaf and red ginger is presented in Table 1 and Table 2.

Table 1. The Results of the Analysis of Fresh Raw Materials Cat Whiskers Leaf and Red Ginger

Parameters	Analysis Result	
	Cat Whisker Leaf	**Red Ginger**
Water content (%)	81.40	81.21
Ash content (%)	1.58	1.45
Crude fiber content (%)	13.36	17.45
Ph	6.47	5.78
antioxidant IC_{50} (µg/mL)	96.75	75.62

Note: The analysis was conducted in 2 replications

The moisture content in fresh raw materials for cat whiskers leaves averages 81.4018% while the moisture content in dried cat whiskers leaves averages 4.9507%. Based on standard SNI 03-3836-2012 for dry tea, the moisture content is a maximum of 8% [4], so that the dry leaves of cat whiskers obtained are still following the specified SNI standards. The drying temperature affects the resulting moisture content [5]. Fresh red ginger has moisture content with an average of 81.2050%. The moisture content of fresh red ginger is 86.2% from the analysis is lower than that of existing studies [6]. The moisture content in dried red ginger is 6.8749% with a drying temperature of 40°C, 6.0321% with a drying temperature of 50°C, and 5.1961% with a drying temperature of 60°C. Based on SNI 01-3393-1994 for dry ginger, the moisture content of dried ginger is a maximum of 12%[7]. This shows that the water content obtained from the analysis is following SNI.

Table 2. The Results of the Analysis of Dried Raw Materials Cat Whiskers Leaf and Red Ginger

Parameters	Analysis result			
	Cat whisker leaf (50°C)	**Red ginger (40°C)**	**Red ginger (50°)**	**Red ginger (60°)**
Water content (%)	4.95	6.87	6.03	5.20
Ash content (%)	6.56	5.16	5.99	6.69
Crude fiber content (%)	10.27	6.94	8.20	11.35
pH	6.41	5.52	5.50	5.51
antioxidant IC_{50} (µg/mL)	118.89	100.97	109.13	115.51

Note: The analysis was conducted in 2 replications

The ash content on the leaves of fresh cat whiskers is 1.5822% while on dry cat whiskers leaves is 6.5649%. Based on SNI 03-3836-2012, the ash content for dry tea is a maximum of 8% [4], so the ash content obtained from the analysis follows SNI because it is lower than the specified standard. Fresh red ginger has an average ash content of 1.4490%. The ash content results from the analysis were higher than the results of previous research which was 0.3% [6]. The ash content for dry ginger with drying at 40°C, 50°C and 60°C is 5.1649%, 5.9930% and 6.6932%. The ash content for dry ginger according to SNI 01-3393-1994 is a max of 8% [7], from this analysis, the ash content obtained is lower than the maximum limit so that the dried ginger produced still follows the established standards.

Fresh cat whiskers leaves have an average crude fiber content of 13.3621% and dry cat whiskers leaves which is 10.2682%. According to SNI 01-3836-2013, the crude fiber content for dry tea is a maximum of 16.5% [4], indicating that the crude fiber content in this study is lower. Fresh ginger has a fiber content with an average of 17.4480% this result is higher than the result of fresh ginger crude fiber content according to the SNI 01-3393-1994 which is 7.53% [7]. The crude fiber content for dry ginger with drying temperatures of 40°C, 50°C and 60°C has an average fiber content of 6.9449%, 8.1953%, and 11.3456% where the content of this crude fiber is lower at a temperature of 40°C and higher when compared to the crude fiber content of dry ginger following the SNI 01-3393-1994.

The leaves of fresh cat whiskers have an average pH of 6.47 and for dry cat whiskers leaves have a pH of 6.41 which indicates the leaves of these cat whiskers have an acidic pH. Fresh red ginger has an average pH of 5.78 and for pH red ginger dried with a drying temperature of 40°C, 50°C and 60°C has an average pH of 5.52, 5.5, and 5.51 this also shows that the pH susceptible in red ginger is the same as cat whisker leaves have an acidic pH, but red ginger has a higher acidity than cat mustache leaves.

The result of the IC_{50} value of fresh cat whiskers leaves was an average of 96.7538 µg/mL where this result was not the same as in previous research which was 65.6251 µg/mL using 96% ethanol solvent [8]. The IC_{50} value on dry cat whiskers leaves is 118.8932 µg/mL. Fresh red ginger has an IC_{50} value of 75.6241 µg/mL which is lower than the previous research which has an IC_{50} value in red ginger extract of 57.14 µg/mL with an ethanol solvent of 96% [9]. The IC_{50} values for dried red ginger with drying temperatures of 40°C, 50°C and 60°C are 100.9676 µg/mL, 109.1315 µg/mL and 115.508 µg/mL. If the IC_{50} value shows that it is getting lower, it will show high antioxidant activity in the material, and vice versa [10]. In this study, it was shown that the IC_{50} value obtained was lower than in the previous study due to differences in solvents used to extract raw materials.

3.2. Effect of Red Ginger Addition on Quality and Sensory Characteristics of Cat Whiskers Leaf and Red Ginger Teabag

According to the results, it shows that red ginger has a highly significant effect on water content, ash content, water-soluble ash content, crude fiber content, pH, antioxidant content, hedonic value of aroma, taste, and general acceptance. However, the red ginger addition has no significant effect on the hedonic value of the color. The test results of these various parameters are presented in Table 3.

Table 3. Effect of Red Ginger Addition on Quality and Sensory Characteristics of Cat Whiskers Leaf and Red Ginger Teabag

Parameters	Addition of red ginger			
	P_1 (10%)	**P_2 (20%)**	**P_3 (30%)**	**P_4 (40%)**
Water content (%)	5.67	5.82	5.96	6.22
Ash content (%)	8.04	8.31	8.77	8.91
Water-soluble ash content (%)	51.19	54.03	55.55	57.17
crude fiber content (%)	15.44	16.94	18.34	19.25
pH	6.30	6.28	5.80	5.62
Antioxidant IC_{50} (µg/mL)	117.73	116.46	113.06	110.58
Hedonic aroma	5.65	5.70	5.85	5.93
Hedonic taste	5.77	5.83	5.92	6.07
Hedonic color	5.67	5.65	5.76	5.79
General acceptance	5.15	5.25	5.36	5.56

3.3. Effect of Variations in Drying Temperature on Quality and Sensory Characteristics of Cat Whiskers Leaf and Red Ginger Teabag

In this study, variations in drying temperature had a highly significant effect on water content, ash content, water-soluble ash content, fiber content, and antioxidant content. But, has no significant effect on other test parameters such as pH, hedonic value of aroma, taste, color, and general acceptance. The results of the tests are presented in Table 4.

Table 4. Effect of Variations in Drying Temperature on Quality and Sensory Characteristics of Cat Whiskers Leaf and Red Ginger Teabag

Parameters	Variations in drying temperature		
	T_1 (40°C)	**T_2 (50°C)**	**T_3 (60°C)**
Water content (%)	6.94	5.68	5.12
Ash content (%)	7.11	8.66	9.75
Water-soluble ash content (%)	45.44	53.33	64.69
crude fiber content (%)	12.57	16.74	23.16
pH	6.02	6.00	5.99
Antioxidant IC_{50} (µg/mL)	108.32	113.59	121.47
Hedonic aroma	5.76	5.76	5.83
Hedonic taste	5.89	5.91	5.89
Hedonic color	5.70	5.72	5.74
General acceptance	5.34	5.31	5.34

The relation of the interaction of red ginger addition and variations in drying temperature to the quality and sensory characteristics of cat whiskers leaf and red ginger teabag is shown in Figure 1.

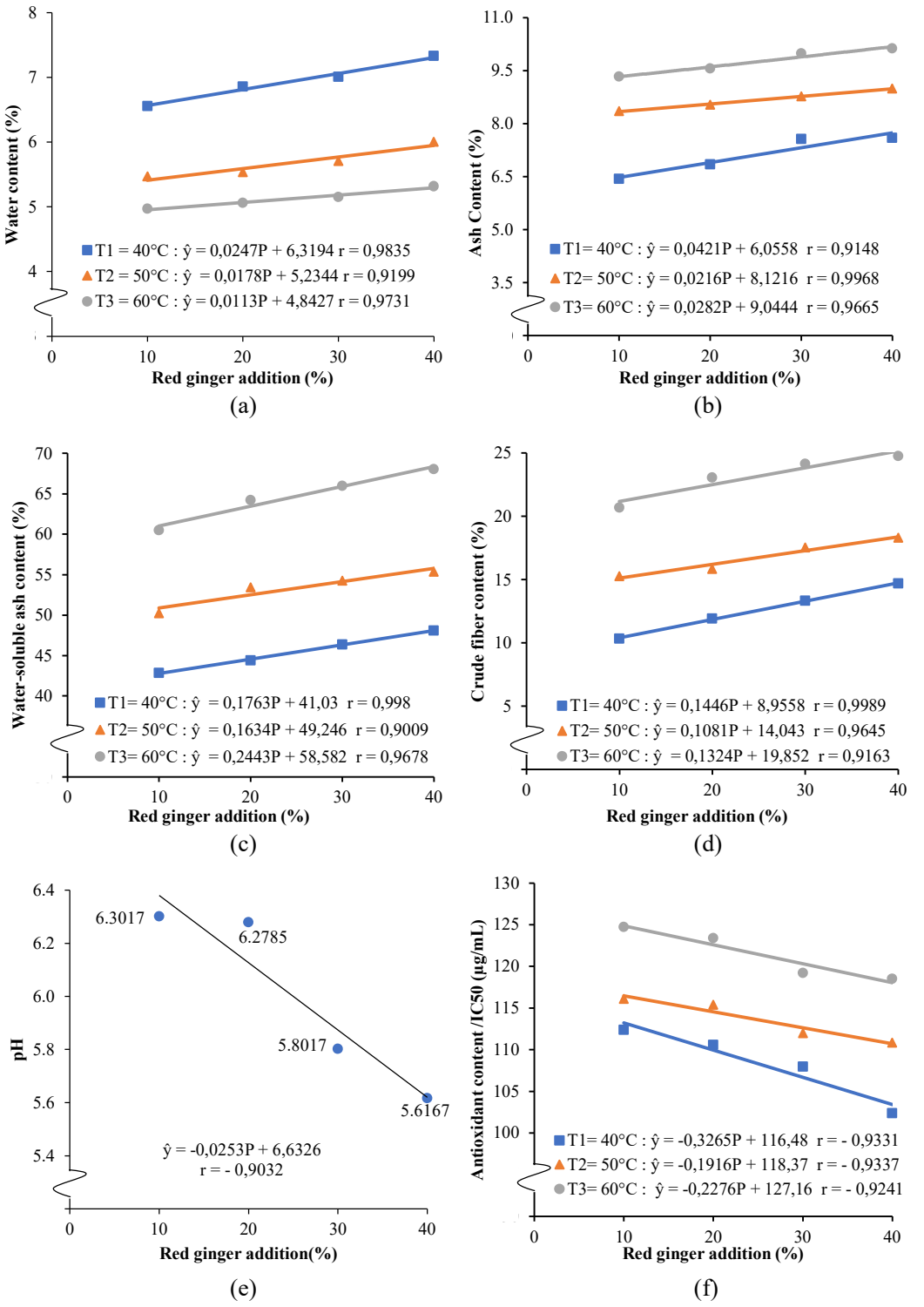

Figure 1. Relation of Interaction of Red Ginger Addition and Variations in Drying Temperature to The Quality and Sensory Characteristics of Cat Whiskers Leaf Teabag

Note:

(a) Relation of interaction of red ginger addition and variations in drying temperature to the water content of cat whiskers leaf teabag

(b) Relation of interaction of red ginger addition and variations in drying temperature to the ash content of cat whiskers leaf teabag

(c) Relation of interaction of red ginger addition and variations in drying temperature to the water-soluble ash content of cat whiskers leaf teabag

(d) Relation of interaction of red ginger addition and variations in drying temperature to the crude fiber content of cat whiskers leaf teabag
(e) Relation of interaction of red ginger addition and variations in drying temperature to the pH of cat whiskers leaf teabag
(f) Relation of interaction of red ginger addition and the pH of cat whiskers leaf teabag
(g) Relation of interaction of red ginger addition and variations in drying temperature to the antioxidant content of cat whiskers leaf teabag

3.4. Water Content

The interaction of red ginger addition and variations in drying temperature has a highly significant effect on the water content of cat whiskers leaf and red ginger teabag. The highest water content is in the P_4T_1 treatment which is 7,3270% and the lowest is P_1T_3 at 4,9702%. The relation of the interaction of red ginger addition and variations in drying temperature to the water content is presented in Figure 1 (a).

The results showed that the more red ginger and the lower the temperature used, the higher the water content of the red ginger cat whiskers leaf teabags. This is because the moisture content of red ginger is higher than that of cat whiskers. High temperatures produce heat and then are carried away by the air res lting in a large amount of water evaporating [11].

3.5. Ash Content

The interaction of red ginger addition and variations in drying temperature has a highly significant effect on the ash content of cat whiskers leaf and red ginger teabag. The highest ash content is in the P_4T_3 treatment which is 10,1282% and the lowest is P_1T_1 at 6,4317%. The relation of the interaction of red ginger addition and variations in drying temperature to the ash content as presented in Figure 1 (b).

The results showed that the increasing addition of red ginger as well as the use of high drying temperatures leads to high ash content. This is because the addition of red ginger causes the dry mass in the teabag to increase so it will increase its ash content. High drying temperatures result in high ash content. The high ash content can be affected by material selection, material harvesting, different processing methods, and drying temperatures as well as the plant used [12].

3.6. Water-soluble Ash Content

The interaction of red ginger addition and variations in drying temperature has a highly significant effect on the water-soluble ash content of cat whiskers leaf and red ginger teabag. The highest water-soluble ash content is in the P_4T_3 treatment which is 68,0331% and the lowest is P_1T_1 at 42,8769%. The relation of the interaction of red ginger addition and variations in drying temperature to the water-soluble ash content is presented in Figure 1 (c).

The results showed that the increasing addition of red ginger and drying temperature made the water-soluble ash content increase. This also shows that several treatments in this study are following SNI based on SNI 01-3753-1995 for black teabags, the water-soluble ash content is at

least 45% [13]. This also shows that some of the treatments on the red ginger cat whiskers teabags produced are of fairly good quality.

The higher the value of the water-soluble ash content indicates that the better the quality of the tea product. The value of high water-soluble ash content indicates that the higher the quality of tea where this is because the more mineral content in tea that can dissolve in the addition of water [14].

3.7. Crude Fiber Content

The interaction of red ginger addition and variations in drying temperature has a highly significant effect on the crude fiber content of cat whiskers leaf and red ginger teabag. The highest crude fiber content is in the P_4T_3 treatment which is 24,7483% and the lowest is P_1T_1 at 10,3443%. The relation of the interaction of red ginger addition and variations in drying temperature to the crude fiber content is presented in Figure 1 (d).

The results showed that the more addition of red ginger and the higher the drying temperature results in high fiber content in the cat whiskers leaf teabags. This is because the addition of red ginger increases the mass of the cat whiskers leaf teabags produced and the increase in temperature results in low moisture content so the fiber content increases.

3.8. pH

The red ginger addition has a highly significant effect on the pH of cat whiskers leaf and red ginger teabag. The highest pH is in the P_1 treatment which is 26,3017 and the lowest is P_4 at 5,5167. The relation of red ginger addition to the pH is presented in Figure 1 (e).

The results showed that the more addition of red ginger, the pH of the teabag will be low, and the higher the acid strength of the teabag. The reason is that the pH of red ginger tends to be more acidic than the leaves of a cat's mustache. The addition of ginger can cause a decrease in pH values caused by ginger having phenols that can release protons (H^+) in solution [15].

3.9. Antioxidant Content

The interaction of red ginger addition and variations in drying temperature has a highly significant effect on the antioxidant content of cat whiskers leaf and red ginger teabag. The highest antioxidant content is in the P_4T_1 treatment with the IC_{50} is 102,3623 µg/mL and the lowest in the P_1T_3 treatment with the IC_{50} is 124,4146 µg/mL. The relation of the interaction of red ginger addition and variations in drying temperature to the antioxidant content is presented in Figure 1 (f).

The results showed that the more red ginger added and the lower the drying temperature, the lower the IC_{50} value which indicates the higher the antioxidant teabag produced. The high number of antioxidants is because red ginger has a higher antioxidant content so the additions made can

increase the antioxidant content of teabags. The drying temperature results in a decrease in antioxidant content because antioxidants are susceptible to temperature.

Bioactive compounds in herbal ingredients are generally very sensitive to heat. The active compounds in the material are volatile so it should be dried at a temperature of 30-60°C, such as antioxidants that are damaged at a temperature of 55°C. The use of temperatures above 55°C is not good for antioxidant activity in the ingredients. The use of high temperatures causes low antioxidant activity [16].

The IC_{50} value in this study is categorized at a moderate level. The antioxidant level category based on IC_{50} (μg/mL) concentration of 100-250 is moderate [17]. Based on this, teabags have a fairly good quality because the antioxidant content in the teabag can ward off free radicals in the body.

3.10. Hedonic Value of Aroma

The red ginger addition has a highly significant effect on the hedonic value of the aroma of cat whisker leaf and red ginger teabag. The highest hedonic value of aroma is in the P_4 treatment which is 5,93 and the lowest is P_1 at 5,6467 as shown in Table 3.

The results showed that the more addition of red ginger, the more the ginger aroma will be felt in the cat whiskers leaf teabag. The highest hedonic value is found in the addition of ginger as much as 40%. This is because ginger contains essential oils and contains zingiberen and zingiberol compounds which function to give a distinctive aroma of ginger. Red ginger contains zingiberen and zingiberol compounds that produce a fragrant aroma [18].

Ginger has 2 main components in it, namely Volatile Oil and Non-Volatile Oil. Volatile oils are often called evaporated oils or essential oils and function in giving a distinctive aroma of ginger. Dried ginger contains 1-3% essential oil. The most essential oil content found in red ginger is followed by small white ginger and elephant ginger [19]. Based on this, the teabags produced have a distinctive aroma of ginger that is felt.

3.11. Hedonic Value of Taste

The red ginger addition has a highly significant effect on the hedonic value of the taste of cat whisker leaf and red ginger teabag. The highest hedonic value of taste is in the P_4 treatment which is 6,0667 and the lowest is P_1 at 5,7667 as shown in Table 3.

The results showed that the more red ginger additions were made, the more ginger tasted in the cat whiskers leaf teabags. This is because the panelists liked the distinctive taste produced by red ginger. Red ginger gives a spicy taste and gives a warm aftertaste to the throat. The hedonic value of the flavor with the addition of ginger 40% is still acceptable and liked by the panelists. The

increasing concentration of ginger will result in a better tea taste [15]. Red ginger contains gingerol and shogaol compounds causing a spicy taste [18].

3.12. Hedonic Value of General Acceptance

The red ginger addition has a highly significant effect on the hedonic value of general acceptance of cat whiskers leaf and red ginger teabag. The highest hedonic value of general acceptance is in the P_4 treatment which is 5,5567 and the lowest is P_1 at 5,1533 as shown in Table 3.

The results showed that the more the addition of red ginger, the hedonic value of the general acceptance increases. The addition of 40% red ginger to African leaf herbal tea increases the hedonic value of taste and the addition of ginger 100% increases the hedonic value of aroma because the increase in ginger added will produce herbal tea with a distinctive aroma and a better taste [15]. So with the increase in the hedonic value of taste as well as aroma, the hedonic value of general acceptance also increases because the hedonic value of general acceptance is a combination of judgments of hedonic aroma, taste, and color.

3.13. Selection of Red Ginger Additions and Drying Temperature Variations that Produce the Best Quality Cat Whiskers Leaf and Red Ginger Teabags

Based on the results of testing the quality characteristics of cat whiskers teabags carried out with the addition of red ginger and variations in drying temperature, the selection of red ginger additions and drying temperature variations was carried out based on the results of the best proximate and hedonic analysis obtained. Based on the test parameters that have been carried out, the best treatment was obtained, namely the P_4T_3 treatment (40% red ginger and 60°C drying temperature) because this treatment has the highest average value. Therefore, it was then continued to test water-soluble dietary fiber in the cat whiskers leaf and red ginger teabag.

Based on the test results, the level of water-soluble dietary fiber in cat whiskers teabag is 7.04% where the content of water-soluble dietary fiber is quite higher than the previous research which states that green tea powder has a water-soluble dietary fiber content of 6.53%[20], according to [21] the content of soluble dietary fiber in green tea is 4.07%, and as demonstrated in [22] Tenggulun leaf tea contains 2.53% water-soluble dietary fiber.

4. Conclusion and Recommendation

The addition of red ginger has a highly significant effect on water content, ash content, water-soluble ash content, crude fiber content, pH, antioxidant content, hedonic value of aroma, taste, and general acceptance. It has no significant effect on the hedonic value of color. The more red ginger is added, the water content, ash content, water-soluble ash content, fiber content, pH, antioxidant content, hedonic value of aroma, taste, and general acceptance of cat whisker leaf teabags produced will increase. Based on the results of the study, the best treatment was obtained, namely the P_4T_3 treatment (40% red ginger and 60°C drying temperature).

It is recommended that subsequent researchers examine the shelf life of cat whiskers teabag and the effect of the shelf life on the quality characteristics of the tea.

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