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The Potency of Teter Leaf Herbal Tea as a Functional Beverage Based on Drying Time

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***Abstract*— The teter plant is an herbal plant cultivated in Taro Village, rich in bioactive components with various health benefits, especially in its leaves. Taro villagers process teter leaves into a product called 'loloh' don teter. However, this product has the disadvantage of a short shelf life and is less desirable to the general public. As a solution, teter leaves can be processed into herbal tea. One important aspect in making herbal tea is the drying time. This study aimed to determine the effect of drying time on the Teter Leaf Herbal Tea characteristics and to obtained the appropriate drying time in making Teter Leaf Herbal Tea and its potential as a functional beverage. A Completely Randomized Design (CRD) was used with the treatment of drying time at 4 levels (12; 18; 24; and 30 hours at 50ºC). The results showed that the drying time had a significant effect on the characteristics of Teter Leaf Herbal Tea. A drying time of 24 hours was the right time to produced herbal tea with a yield of 20.74%, moisture content of 7.21%, total phenols 40.71 mg GAE/g, total flavonoids 28.76 mg QE/g, total tannins 0.80 mg TAE/g, vitamin C 8.13 mg AAE/g, and antioxidant activity of 85.55%. Teter leaf has the potential to be developed into functional beverage.**

Keywords*— Drying Time, Functional Beverage, Herbal Tea, Teter Leaf

I. Introduction

Natural resources are one of the wealth owned by Indonesia, making Indonesia the country with the largest biodiversity in the world, especially in the type of medicinal plants spread in various regions in Indonesia, including the island of Bali. Bali is a favorite destination because of its unique features, including biodiversity. One area with traditional plant commodities that are used as abundant medicinal plants is Taro Village. The location of Taro Village is located in the northern part of Bali Island, with the main commodity being the Teter plant.

The teter plant (Solanum erianthum D. Don.) is a plant that is easy to cultivate because it can live in dry and humid environmental conditions. Leaves are the most commonly used part of the plant. The people of Taro Village generally utilize teter leaves by processing them into herbal drinks using a traditional method called 'loloh don teter'. "Loloh" is a traditional drink from Bali that is included in the class of herbal drinks by utilizing parts of plants generally the parts of the plant that are used are leaves, flowers to rhizomes from plants so that they are identical to the concentrated color that comes from the main ingredients used. Consuming 'loloh' can provide physiological effects, including increasing body immunity, increasing appetite, curing heartiness and headaches [1].

The processing of teter leaves into 'loloh' is done traditionally without using additives such as preservatives, so one of the disadvantages of 'loloh' is in terms of a short shelf life. This review can be the basic foundation in generating product development ideas from teter leaves that can be innovated as herbal tea. Herbal tea has a different definition from tea in general. Herbal tea is tea made from plant parts such as roots, stems, bark leaves, fruit, or all parts of plants from medicinal plant species that can provide good health benefits for the body [2]. Bioactive components contained in herbal tea ingredients can affect the physiological effects produced. Teter leaves have the potential to be processed into herbal tea because they contain bioactive components that have health functions. According to [3] venereal diseases, malaria, and leprosy can be overcome by consuming teter leaves that have been processed by boiling and can act as a diuretic drug to stimulate liver function. Teter leaves are known to contain various bioactive compounds, namely antioxidants, including alkaloids, flavonoids, phenolics, tannins, saponins, steroids, terpenoids, and vitamin C [4]. Based on research conducted by [5], extracts from teter leaves contained total flavonoids of 82.60 mg QE/g, total tannins of 12.30 mg TAE/g, vitamin C of 82.30 mg AAE/g, and total phenols of 175.151 mg GAE/g. However, the bioactive components of a material are generally sensitive and vulnerable to processing treatments such as the drying process, one of which is the drying time.

Herbal tea is produced through a drying process that aims to reduce the moisture content contained in raw tea materials to extend its shelf life. However, in the processing, the drying process can cause degradation to damage bioactive components if the drying time is not appropriate for the material used. According to research conducted by [6], the provision of drying treatment for 12 hours with a temperature of 70oC produced tabah bamboo leaf herbal tea with a total phenol content of 1114.5664 mg/100g. Furthermore, [7] reported that drying treatment for 3 hours with a temperature of 90oC on matoa fruit peel herbal tea produced the highest antioxidant of 61.739%. [8] also reported that Kersen leaf herbal tea at a drying time of 150 minutes produced the best results with 88.60% antioxidant activity. Several studies have shown that each material requires a different drying time, which can affect the bioactive components contained in the material.

Research related to the drying time of the bioactive components of Teter Leaf Herbal Tea has never been done. Further research is needed on the potential of herbal tea from teter leaves (Solanum erianthum D.Don.) as a functional beverage based on drying time to know the effect of drying time and obtaining the drying time treatment in making Teter Leaf Herbal Tea with the best characteristics and its potential as a functional beverage.

II. Material and Methods

A. Materials

Teter leaves with dark green leaf criteria were the main material in this study, precisely the third leaf to the ninth leaf from the top of the leaves obtained in Banjar Taro Kelod, Taro Village, Gianyar [5].

Chemicals used in this study were distilled water (Rofa, Indonesia), folin-ciocalteu reagent, sodium carbonate, Na_2CO_3, HCl, sodium phosphate, $NaNO_2$ 5%, follin denis reagent, sulfuric acid, 4% NaOH, and ammonium molybdate from (Merck, Germany), $AlCl_3$ 10% (Phyfo Technology Laboratories, USA), and DPPH pro analysis, gallic acid, quercetin from (Sigma-Aldrich, USA).

The tools used in this study include glassware (Pyrex), measuring cup (Pyrex), oven (Cole Parmer), analytical balance (Shimadzu), blender (Phillips), spectrophotometer (Biochrom 133467), 40 mesh sieve, stirrer, filter paper, glass, tablespoon, teabag, test tube (Pyrex), and tweezers.

B. Experimental Design

A Completely Randomized Design (CRD) was used with the treatment of drying temperature at 4 levels such as 12;18;24; and 30 hours and repeated 4 times.

C. Research Procedures

1) Preparation

Teter leaves were prepared, and then the sorting of raw materials continued by selecting teter leaves and removing stalks and damaged parts. Next, cut the leaves to reduce their size and then clean them to remove dirt on the surface of the leaves [5].

2) Blanching

The withering process refers to [9] using the steaming method at a steam temperature of 70°C for 2 minutes and cooling for 5 minutes at room temperature.

3) Drying

The drying process was conducted using the specified treatment referred to [10] with modification. Weighing 100 g for each treatment. To obtain teter leaf herbal tea powder, the dried leaves were blended and sifted through a 40-mesh sieve. To get a tea bag product, the powder was weighed 2 g and packed into a 6.5 cm x 5.5 cm tea bag.

D. Data Analyze

The data were analyzed statistically using variance analysis with Minitab 19, followed by Tukey's Difference Test [11].

E. Yield

The calculation of yield of teter leaf herbal tea can be calculated according to [10], using the formula:

Yield = W1/W2 x100%

Note :

W1 = weight of tea powder (g)

W2 = weight of teter leaves before drying (g)

F. Moisture Content

Determination of the moisture content using the Gravimetric method referred to [12] with modification. 2 g sample of teter leaf herbal tea was put into an aluminium cup that had been weighed. The sample was dried in an oven at 105°C for 4 hours, cooled in a desiccator for 15 minutes, and weighed. A drying process was repeated in 30 minutes, then cooled in a desiccator for 15 minutes and weighed. This treatment was repeated until a constant weight was reached. Moisture content can be calculated using the formula:

$$Moisture(\%) = \frac{initial\ weight(g) - final\ weight(g)}{initial\ weight\ (g)} x100\% \quad ..... (1)$$

G. Total Phenols

Determination of total phenols by the Folin-Ciocalteau method [13]. A 0.1 g of teter leaf herbal tea powder was diluted into 5 ml of 70% Ethanol. A 0.1 ml sample was pipetted, and 0.3 ml of 70% ethanol was added, followed by 0.4 ml of Folin-Ciocalteu reagent, and then incubated for 6 minutes. After incubation, 4.2 ml of 5% Na_2CO_3 was added, followed by vortexing and a 90-minute incubation. Absorbance was measured at 760 nm, and the results were compared to a gallic acid standard curve. The calculation of total phenol was calculated using the formula:

$$Total\ Phenols\ (mg\frac{GAE}{g}) = \frac{C\ x\ v\ x\ FP}{W} \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Notes:

C = Sample concentration from linear regression results (mg/L)

FP = Dilution factor

V = Sample volume (L)

W = Sample weight (g)

H. Flavonoids

Total flavonoids were determined with the AlCl3 method using spectrophotometry referred to [14]. Samples were weighed to 0.1 g and diluted to 5 ml with 70% ethanol solvent. A 1 ml sample was mixed with 4 ml of distilled water, and 0.3 ml of NaNO2 solution (10%) was added and incubated for 5 minutes. 0.3 ml of 10% AlCl3 solution and 2 ml of 1% NaOH were added and tested at a wavelength of 510 nm in a spectrophotometer. The results were compared to a quercetin standard curve. The calculation of total flavonoid was calculated using the formula:

$$Flavoid\ (mg\frac{QE}{g}) = \frac{C\ x\ v\ x\ FP}{W}\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(3)$$

Notes:
C = Sample concentration from linear regression results (mg/L)
FP = Dilution factor
V = Sample volume (L)
W = Sample weight (g)

I. *Tannins*

The determination of total tannins of teter leaf herbal tea was analyzed using the Folin-Denis method according to [15]. A 0.1 g sample was dissolved in 5 ml of hot distilled water. A 0.25 ml sample was placed into a test tube, followed by 0.25 ml of Folin-Denis reagent. The mixture was vortexed, and then 2 ml of 5% Na_2CO_3 was added. The solution was allowed to incubate for 30 minutes. Absorbance was measured at 725 nm using a spectrophotometer. The results were compared to a tannic acid standard curve. The calculation of total tannins was calculated using the formula:

$$Tannins\ (mg\frac{TAE}{g}) = \frac{C\ x\ v\ x\ FP}{W}\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(4)$$

Notes:
C = Sample concentration from linear regression results (mg/L)
FP = Dilution factor
V = Sample volume (L)
W = Sample weight (g)

J. *Vitamin C*

Samples were prepared by dissolving 0.1 g of the sample in 5 ml of distilled water, followed by the addition of 3 ml of reagent (a mixture of 500 ml of 0.6 M sulfuric acid, 5.3218 g of sodium phosphate, and 2.471 g of ammonium molybdate) to 0.3 ml of the sample solution. The mixture was incubated at 95°C for 90 minutes in a water bath. After incubation, the solution was cooled in water for 5 minutes, and the absorbance was measured at 695 nm using a spectrophotometer. The results are expressed as ascorbic acid equivalents in mg AAE/g extrac. Total vitamin C can be calculated by the formula i.e:

$$Vit\ C\ \left(mg\frac{AAE}{g}\right) = \frac{C\ x\ v\ x\ FP}{W}\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(5)$$

Notes:
C = Sample concentration from linear regression results (mg/L)
FP = Dilution factor
V = Sample volume (L)
W = Sample weight (g)

K. *Antioxidant Activity*

The antioxidant activity was determined by the DPPH method according to [16]. One milliliter of 0.1 mM DPPH solution was mixed with 2 ml of the sample in a test tube. The mixture was vortexed and incubated for 30 minutes in the dark, then measured at 517 nm using a spectrophotometer, with ethanol used as the blank. The control was prepared in the same way as the sample, but without adding the sample. The percentage of antioxidant activity was calculated using the formula:

$$AA = \frac{control\ absorbance - sampel\ absorbance}{control\ absorbance}\ldots\ldots\ldots\ldots\ldots..(6)$$

III. Result

A. *Yield*

The analysis of variance (ANOVA) showed that drying time had a significant effect (P<0.05) on the yield of Teter Leaf Herbal Tea, as shown in Figure 1.

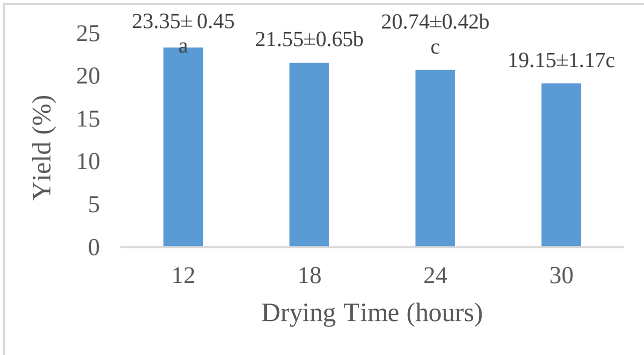

Fig. 1. Yield

The yield of the tea ranged from 19.15% to 23.35%. The highest yield was found in treatment W1 (12 hours drying time), which yielded 23.35%. Meanwhile, the lowest yield was obtained in treatment W4 (30 hours drying time), which was 19.15%, which was not significantly different from treatment W3 (24 hours drying time), which was 20.74%. Yield is one of the important parameters to consider because it involves the amount of final product produced from the research. Based on Figure 1, it can be seen that the longer the drying time, the lower the yield obtained. [17] reported that the yield decreased with increasing nutmeg peel herbal tea drying time. The same thing was also reported by [18], which states that the yield on bajakah stems herbal tea with different drying time treatments decreased with increasing drying time ranging from 8.17%-8.87%, lower than the yield produced by Teter Leaf Herbal Tea. The moisture content of the material strongly influences the yield of the material, so the longer the drying time, the lower the moisture content, which results in the yield decreasing, and the bioactive compounds produced are also reduced [19]

B. *Moisture Content*

The analysis of variance (ANOVA) showed that drying time had a significant effect (P<0.05) on the moisture content of Teter Leaf Herbal Tea, as demonstrated in Figure 2.

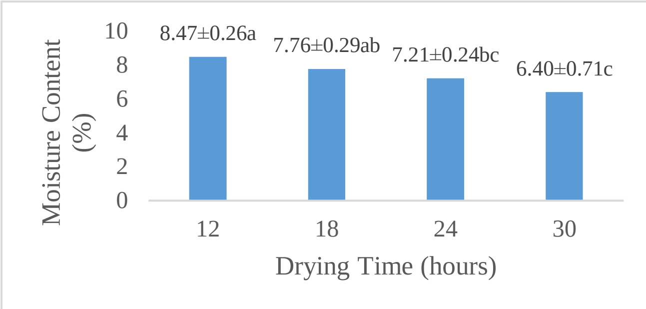

Fig. 2. Moisture Content

The moisture content at different drying times ranged from 6.40% to 8.47%. The highest moisture content was produced in treatment W1 (12 hours drying time), 8.47%, and the lowest moisture content was produced in treatment W4 (30 hours drying time), 6.40%. According to [20]The longer the drying process causes the evaporation of the moisture contained in herbal tea to be higher, the lower the moisture content contained in Teter Leaf Herbal Tea.

The same thing was also reported by [21] that the moisture content of tin leaf tea decreased with the drying time. The moisture content in the material will continue to decrease as the drying time increases until it reaches the point where the moisture content is at the minimum level [22]. The longer the drying process takes, the more heat the material absorbs. This increases the amount of water evaporated from the food, reducing the remaining water content in the material [23]. Moisture content is important in determining food's characteristics and shelf life. Low moisture content is important to maintain the quality and shelf life of herbal products, including teter leaf tea, because too high moisture content can trigger the growth of microorganisms and reduce product quality. The moisture content of Teter Leaf Herbal Tea treatments W2, W3, and W4 has met the quality requirements of dried tea in the packaging (SNI 3836:2013), which is no more than 8% except for treatment W1 (12 hours drying time), which has a moisture content of 8.47% [24].

C. Total Phenols

The analysis of variance (ANOVA) showed that drying time had a significant effect ($P<0.05$) on the total phenolic content of Teter Leaf Herbal Tea, as shown in Figure 3.

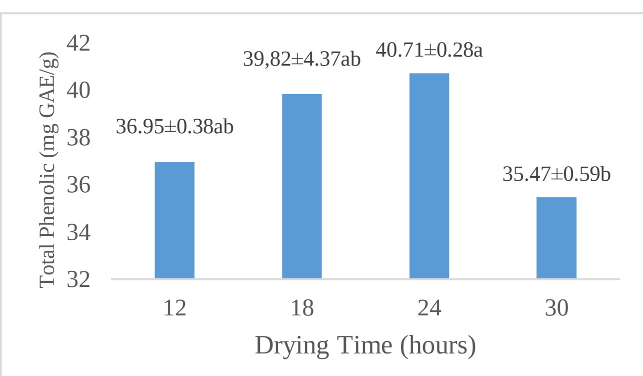

Fig. 3. Total Phenols

The total phenolics ranged from 35.47 to 40.71 mg GAE/g. The highest result was obtained in Teter Leaf Herbal Tea with treatment W3 (24 hours drying time), which amounted to 40.71 mg GAE/g, while the lowest result was obtained in Teter Leaf Herbal Tea with treatment W4 (30 hours drying time), which amounted to 35.47 mg GAE/g. The total phenol contained in Teter Leaf Herbal Tea increases as drying time increases, then will reach a stable point and decrease if the drying time gets longer.

In line with the results of research by [25] the total phenol of parijoto leaf herbal tea increased at drying times of 180, 210, and 240 minutes while drying times of 270, 300, and 330 minutes showed a decrease in total phenol. According to [26] when drying, the polyphenol oxidase enzyme is inactivated so that the damage to polyphenol compounds is less, but if the time exceeds the optimum time, the stability of polyphenol compounds in the material will be disturbed and cause a decrease in polyphenol content. The decrease in polyphenol compounds at a drying time of 30 hours indicates that the drying process has passed its optimal point, which causes polyphenol compounds to be oxidized due to prolonged exposure to hot temperatures. The statement was confirmed by [27] The drying time that exceeds the optimum limit indicates a decrease in phenol content in a natural material, so it is important to know the right drying time to maintain bioactive content.

D. Flavonoids

The analysis of variance (ANOVA) showed that drying time had a significant effect ($P<0.05$) on the total flavonoid content of Teter Leaf Herbal Tea, as presented in Figure 4.

The total flavonoid content ranged from 20.90 to 28.76 mg QE/g. The highest results were obtained in Teter Leaf Herbal Tea with treatment W3 (24 hours drying time), which amounted to 28.76 mg QE/g. In comparison, the lowest results were obtained in Teter Leaf Herbal Tea with treatment W4 (30 hours drying time), which amounted to 20.90 mg QE/g, which was not significantly different from treatment W1 (12 hours drying time), which amounted to 23.38 mg QE/g. There was an increase in total flavonoids at 12,18, and 24 hours drying time, while at 30 hours drying time, there was a decrease in total flavonoids.

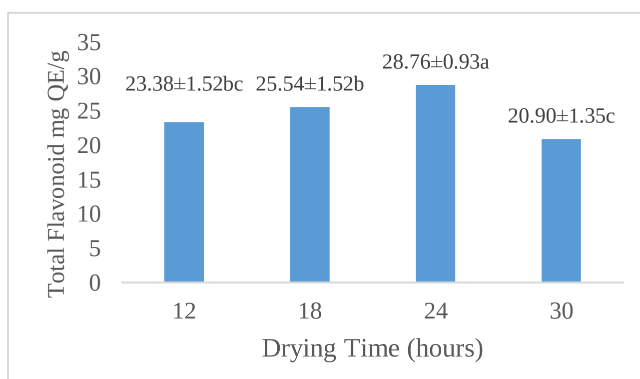

Fig. 4. Flavonoid

This indicates that a 24-hour drying time is optimal for getting the highest total flavonoids in Teter Leaf Herbal Tea. According to [28]The optimal drying temperature and time cause the moisture content in the material to decrease, making the material drier and increasing the total solids of the material. Flavonoids are a class of polyphenols with a phenol base structure that has properties that are easily oxidized and sensitive to heat treatment so that temperature treatment and drying time will affect the flavonoid content contained in the material [29]. According to [30], temperatures that are too low and drying times that are too short are not optimal for activating polyphenolase enzymes, so the resulting flavonoid levels are lower. The results of research conducted by [31] showed that a temperature of 50ºC and a drying time of 24 hours produced the highest total flavonoids in guava leaf simplisia.

E. Tannins

The analysis of variance (ANOVA) showed that drying time had a significant effect (P<0.05) on the total tannin content in Teter Leaf Herbal Tea, as presented in Figure 5.

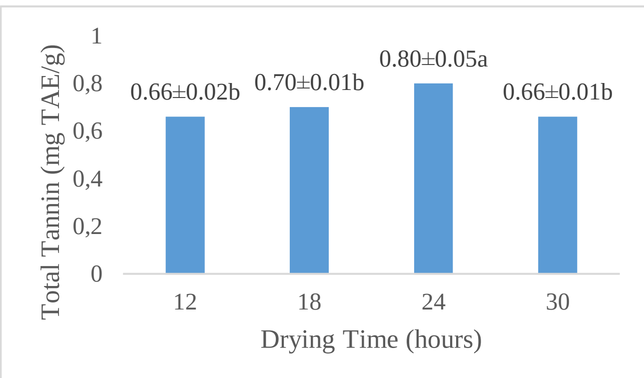

Fig. 5. Tannis

The total tannin levels ranged from 0.66 to 0.80 mg TAE/g. The Teter Leaf Herbal Tea had the highest tannin content with the W3 treatment (24 hours drying time), which had 0.80 mg TAE/g. In contrast, the lowest tannin content was found in the W4 treatment (30 hours drying time), similar to the W1 treatment (12 hours drying time), both showing 0.66 mg TAE/g. This indicates that the drying time duration affects the tannin concentration. According to [32], a temperature of 50ºC is suitable for drying tea leaves because if the temperature exceeds 50ºC, namely at 55ºC, tannin levels in tea can decrease. Drying time can affect the increase or decrease in tannin levels due to the thermal degradation of molecules so that the molecular weight becomes inconsistent [33]. This statement is reinforced by research conducted by [34] which states that the moisture content in wuluh starfruit leaf herbal tea affects tannin levels. The lower the moisture content in tea products, the more tannin levels increase because the moisture content can inhibit the mass of tannins if herbal tea is brewed. Hence, the degradation of tannin content occurs.

F. Vitamin C

The analysis of variance showed that drying time had a significant effect (P<0.05) on the vitamin C content in Teter Leaf Herbal Tea. Based on Figure 6.

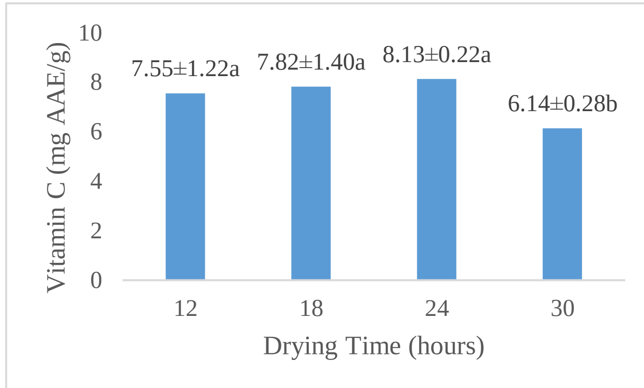

Fig. 6. Vitamin C

Vitamin C levels in Teter Leaf Herbal Tea ranged from 6.14-8.13 mg AAE/g minutes. The highest results were obtained in Teter Leaf Herbal Tea with treatment W3 (24 hours drying time), which amounted to 8.13 mg AAE/g, which was not significantly different from treatment W1 (12 hours drying time) and W2 (18 hours drying time). The lowest results were obtained in Teter Leaf Herbal Tea with treatment W4 (30 hours drying time), which amounted to 6.14 mg AAE/g. Based on these results, the vitamin C of Teter Leaf Herbal Tea, until the drying time of up to 24 hours, still shows statistically similar results. However, after reaching the optimum time of 24 hours vitamin C will decrease. This happens because vitamin C is one of the compounds that is unstable to heat, so after reaching the optimum time and exposure to excessive heat for too long, the vitamin C content in tea decreases. This statement is supported by research conducted by [35], which reports that the duration of drying can affect the decrease in vitamin C content of Moringa leaf herbal tea. Based on research conducted by [9], kenikir leaf herbal tea that goes through a drying process for 3.5 hours has a vitamin C content of 3.35 mg AAE/g. [10], Also reported was that takokak leaf herbal tea, with a drying time of 24 hours, produced vitamin C levels of 7.89 mg AAE/g. This shows that Teter Leaf Herbal Tea contains higher vitamin C.

G. Antioxidant Activity

The analysis of variance (ANOVA) showed that drying time had a significant effect (P<0.05) on the antioxidant activity of the Teter Leaf Herbal Tea, as indicated in Figure 7.

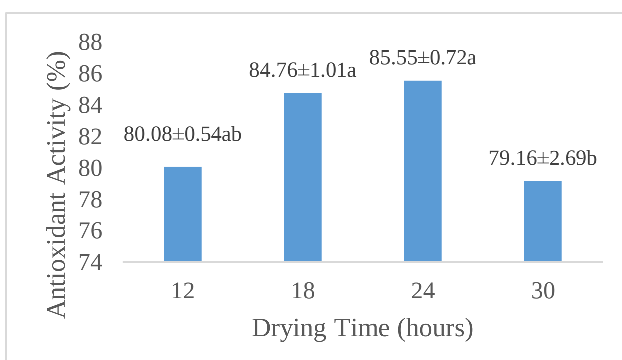

Fig. 7. Antioxidant Activity

The antioxidant activity for each treatment ranged from 79.16% to 85.55%. The highest antioxidant activity was produced in treatment W3 (24 hours drying time), 85.55%, while the lowest antioxidant activity was produced in treatment W4 (30 hours drying time), 79.16%. This showed that the antioxidant activity of Teter Leaf Herbal Tea increased up to 24 hours drying time and decreased at 30 hours drying time. The increase in antioxidant activity of Teter Leaf Herbal Tea is in line with the increase in total phenolics, flavonoids, and tannin content in this study. Non-optimal drying time can cause a decrease in antioxidant activity in teter leaf tea.

According to [37], there was an increase in antioxidant activity in matoa leaf herbal tea as the temperature and drying time increased. In contrast, matoa leaf herbal tea dried at 50ºC with a drying time of 3 hours produced an antioxidant activity of 69.89%. Drying at the right time can reduce moisture content without damaging bioactive components such as polyphenols, a source of antioxidants [21]. The same thing was also reported by [38], who stated that drying temperatures that are too high and drying times that exceed the optimum time can cause a decrease in antioxidant activity. On the other hand, if the drying temperature is too low and the drying time is too short, not all active compounds are extracted from the material, so the active compounds obtained are low. [39] also stated that prolonged heating can reduce antioxidant activity because antioxidants will be damaged by heat and cooking. The longer drying time can cause secondary metabolic compounds that act as antioxidants to be damaged.

H. Abbreviations and Acronyms

A product can be considered functional if it contains bioactive components that positively impact health, such as antioxidant compounds. One of the bioactive components that function as antioxidants is phenol.

Phenols are the most abundant compounds in plants and serve as natural antioxidants. These compounds contain hydroxy groups that function as antioxidants by donating hydrogen atoms during reactions with free radicals, preventing the oxidation process through electron transfer. The total phenol content in an ingredient correlates with its antioxidant activity [36], [37].

The utilization of food ingredients to make functional beverage products has been widely done. One of the plants that can be processed into functional beverage products is teter leaf, which is processed into herbal tea. According to [3], also reported that teter leaf decoction is often used as a diuretic drug to treat malaria, leprosy, and venereal diseases and stimulate liver function.

The study showed that Teter Leaf Herbal Tea with a drying process at 24 hours had a yield of 20.74%, moisture content of 7.21%, total phenols 40.71 mg GAE/g, total flavonoids 28.76 mg QE/g, total tannins 0.80 mg TAE/g, vitamin C mg AAE/g, and antioxidant activity of 85.55%. When compared to the report of [38], where the drying process of tin leaves at 50°C for 3 hours produced herbal tea with an antioxidant activity of 69.89%, the antioxidant content of Teter Leaf Herbal Tea is higher. The high antioxidant activity is influenced by the natural bioactive components of teter leaves, such as alkaloids, flavonoids, phenolics, tannins, saponins, steroids, terpenoids, and vitamin C, which function as antioxidants [4]. Teter plants contain flavonoids with high antioxidant potential because they contain hydroxyl groups and can protect more efficiently against radical diseases such as cardiovascular disease, kidney disease, etc. Therefore, Teter Leaf Herbal Tea has great potential to be developed as a functional beverage product.

CONCLUSION

Teter Leaf Herbal Tea is one of the solutions for utilizing the potential of teter plants found in Taro Village. Based on the research, the drying time of teter leaf has a significant effect on the yield, moisture content, total phenols, total flavonoids, total tannins, vitamin C, and antioxidant activity in Teter Leaf Herbal Tea. Drying for 24 hours showed the best results with a yield of 20.74%, moisture content of 7.21%, total phenols 40.71 mg GAE/g, total flavonoids 28.76 mg QE/g, total tannins 0.80 mg TAE/g, vitamin C mg AAE/g, and antioxidant activity of 85.55%.

Furthermore, this research is expected to be developed into an innovative product for the people of Taro Village. Further research is needed on adding flavor to improve the product's sensory characteristics.

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