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Methanolic Extract of Gletang Flower as Natural Antioxidant for Crude Palm Oil

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ABSTRACT

Crude palm oil (CPO) is a primary raw material used in the production of cooking oil, margarine, and cosmetics. The quality of CPO deteriorates due to an increase in free fatty acid levels caused by oxidation reactions; therefore, antioxidants are required to inhibit this process. Natural antioxidants can be obtained from plants, one of which is the gletang flower. This study aimed to evaluate the potential of gletang flower methanolic extract as a natural antioxidant by determining its ability to reduce free fatty acid (FFA) levels and peroxide value in CPO. In this study, gletang flower was utilized as a natural source of antioxidants. The method employed was maceration extraction, followed by analysis of free fatty acid (FFA) levels and peroxide value in CPO samples. The study was conducted by comparing the FFA levels and peroxide value before and after the addition of natural antioxidants. The results showed that the addition of the natural antioxidant reduced the average free fatty acid (FFA) content by 20.3% and decreased the peroxide value by an average of 7.33%. These findings indicate that gletang flower extract has potential as a natural antioxidant to improve the quality and stability of CPO.

Keywords: extraction, maceration, CPO, antioxidant, *tridax procumbens*

INTRODUCTION

Indonesia is one of the world's largest palm oil producers. According to Statistics Indonesia (BPS), the country's palm oil production reached approximately 47.08 million tonnes in 2023[1][2]. This abundant resource is expected to enhance competitiveness at the international industrial level in palm oil production[2]. One type of vegetable oil extracted from oil palm is crude palm oil (CPO) [3]. CPO is widely used as a raw material for cooking oil, margarine, and cosmetics [4]. The processing of CPO requires careful control to obtain high-quality vegetable oil [5]. A decline in CPO quality is generally caused by an increase in free fatty acid (FFA) content [6].

Free fatty acids are fatty acids that have been released from their triglyceride structures [7]. Oils with high free fatty acid content are known to oxidize more rapidly [8]. This process leads to rancid odors as well as changes in taste and color. Therefore, it is necessary to inhibit oxidation reactions in CPO by using antioxidants [9].

Antioxidants are oxidation inhibitors that can prevent the formation of free radicals [10]. Natural antioxidants are commonly derived from plants. Plants exhibiting antioxidant activity typically contain flavonoid compounds [11]. One plant with potential as a natural antioxidant is the gletang flower. Gletang (*Tridax procumbens*), a weed species that grows abundantly in the environment, represents a readily available potential source of bioactive compounds.

In recent years, the chemical composition and biological activities of gletang have been investigated, revealing that its major chemical constituents are flavonoids, which exhibit notable antioxidant activity [12]. Previous studies reported that the total flavonoid content of the methanolic extract of gletang flower was 5.07 mg QE/g, with antioxidant activity in DPPH and ABTS showing an IC_{50} value of 6.8478 ± 1.335 and 12.8608 ± 0.579 ppm [13]. This study aimed to evaluate the potential of gletang flower methanolic extract as a natural antioxidant by determining its ability to reduce free fatty acid (FFA) levels and peroxide value in CPO. However, studies on the use of natural antioxidants derived from gletang flower extract to inhibit oxidation reactions in CPO have not yet been reported. Therefore, further research is needed to explore the potential of gletang as an inhibitor of oxidation reactions in CPO.

RESEARCH METHODS

The study was conducted using a maceration extraction method. The sample was dried and then ground using a blender until a fine powder was obtained. The powder was sieved through an 80-mesh sieve and subsequently extracted by maceration. A total of 100 g of gletang flower powder was weighed and macerated by adding approximately 1500 mL of

methanol. The mixture was kept for 3 × 24 hours in a tightly closed container with periodic stirring. The extract was then filtered using filter paper. The filtrate was concentrated using a rotary evaporator at 50 °C for 60 minutes to obtain a viscous gletang flower extract [14]

The determination of free fatty acid content was carried out as follows: 5 g of CPO sample was weighed and placed into a 250 mL Erlenmeyer flask. Then, 50 mL of methanol was added, and the mixture was heated in a water bath at 40 °C until the oil was completely dissolved. Subsequently, 1–2 drops of phenolphthalein (PP) indicator were added. The solution was then titrated with 0.1 N NaOH until a pale pink endpoint was reached [15]. Repeat the procedure in duplicate. One control sample and one treated sample were used. The control consisted of CPO without the addition of Gletang flower extract, while the treated sample consisted of CPO with the addition of Gletang flower extract. Both were stored and analyzed under the same conditions.

$$\% \text{ FFA} = \frac{\text{V NaOH (ml) X N NaOH X Mw}}{\text{massa (g)}}$$

The peroxide value was determined as follows: 5 g of CPO sample was weighed into a 250 mL glass-stoppered Erlenmeyer flask, and 30 mL of an acetic acid:chloroform mixture (3:2) was added, then the flask was closed. The mixture was shaken until the sample was completely dissolved. Subsequently, 0.5 mL of saturated KI solution was added, and the flask was closed again. The solution was allowed to stand for 1 minute and shaken at least three times during this period. Then, 30 mL of distilled water was immediately added. Next, 1–2 drops of starch indicator were added, producing a brownish-blue color, and the solution was titrated with 0.01 N $Na_2S_2O_3$ until the blue color disappeared [16]. Repeat the procedure in duplicate.

$$\text{Peroxide value} = \frac{\text{V } Na_2S_2O_3 \text{ (ml) X N } Na_2S_2O_3 \text{ X 1000}}{\text{massa (g)}}$$

The determination of free fatty acid (FFA) content and peroxide value with the addition of extract was carried out as follows: 250 mg of the extract was weighed and dissolved in 50 mL of methanol to obtain a solution with a concentration of 5000 ppm. Then, 50 mL of CPO was placed into a 250 mL Erlenmeyer flask, and 50 mL of gletang flower extract was added. The mixture was homogenized for 5 minutes and transferred into a separatory funnel for phase separation. The lower layer was collected and analyzed for CPO parameters (FFA and peroxide value) as day 0 (H-0). The extract-treated solution was then allowed to stand for 24 hours. After this period, the determination of free fatty acid content and peroxide value was repeated on days 2, 4, 6, 8, and 10 [17]. The research methodology flowchart is presented in Figure 1.

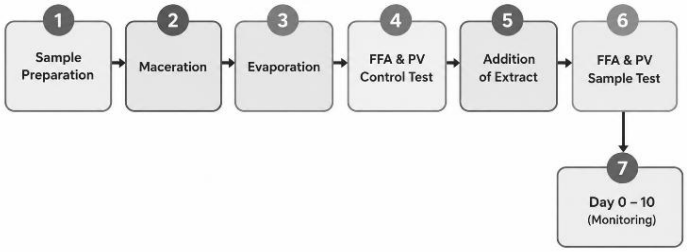


Figure 1. The research methodology flowchart

RESULT AND DISCUSSION

In this study, the sample used was gletang flower, with a total fresh weight of 350 g. After drying for 14 days, the sample weight decreased from 350 g to 100 g. The dried gletang flower samples were ground to increase the surface area, thereby enhancing the efficiency and rate of extraction [18]. The extract was concentrated using a rotary evaporator at approximately 50 °C, yielding 9.91% (9.91 g) of concentrated extract. [20].

The results of the CPO quality analysis, in terms of free fatty acid (FFA) content and peroxide value before the addition of antioxidants, are presented in Table 1 and Figure 2.

Table 1. Results of CPO Quality Testing Before the Addition of Extract

Day	FFA content (Max. 5%)	Peroxide Velue (Max. 10 meq O_2/Kg)
Day 0	6.69	1.75
Day 2	6.99	1.79
Day 4	7.25	1.83
Day 6	7.57	1.89
Day 8	7.91	1.95
Day 10	8.42	2.02

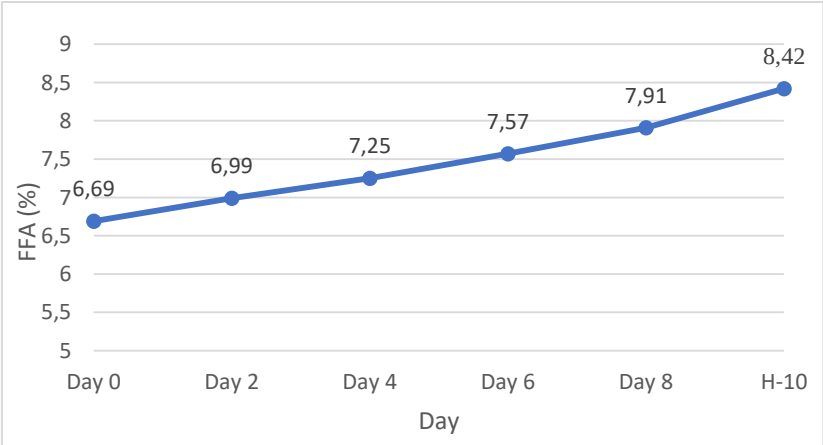


Figure 2. Results of Free Fatty Acid Analysis of CPO Samples

Based on the research results and calculations of the free fatty acid (FFA) test shown in the graph above, the CPO does not meet the standard specified by SNI 01–2901–2006, which sets a maximum limit of 5%. The FFA values obtained for CPO were 6.69% on day 0, 6.99% on day 2, 7.25% on day 4, 7.57% on day 6, 7.91% on day 8, and 8.42% on day 10. These results indicate that the CPO samples exceeded the maximum allowable limit established by SNI 01–2901–2006. The increase in FFA during storage is attributed to the hydrolysis of triglycerides by water and residual lipase enzymes, as well as exposure to air and moisture. These processes progressively increase FFA levels over the storage period.

These results are consistent with previous studies, which reported that delayed processing of oil palm fresh fruit bunches increased FFA content and peroxide value, while decreasing the deterioration of bleachability index (DOBI) and oil content [21]. Consistent with previous studies that demonstrated that fruit maturity, pest attacks, handling practices, and delayed delivery to the palm oil mill significantly affected FFA levels in CPO. These findings suggest that appropriate postharvest handling and timely processing are essential for maintaining palm oil quality [22].

Mechanical damage to oil palm fruits is another factor associated with FFA formation. Research on FFA formation during palm oil processing showed that bruising can accelerate the increase in FFA, emphasizing the importance of minimizing mechanical damage during fruit handling and transportation [23]. Previous research has demonstrated that delaying the processing of oil palm fruits for up to 24 hours increased FFA content, particularly in the inner fruit samples. The increase in FFA observed in the present study may therefore be associated with changes in oil quality during storage. However, because the present experiment monitored CPO samples rather than freshly harvested fruit bunches, the specific contribution of enzymatic hydrolysis, moisture, and storage conditions requires further investigation [24].

The FFA content exceeding 5% indicates that the samples did not satisfy the specified quality limit. In addition to FFA analysis, parameters such as moisture content, impurities, color, and odor may provide supplementary information regarding CPO quality.

Peroxide Value Test

The peroxide value is defined as the amount of peroxide (meq) present in every 1000 g of oil or fat. The procedure was carried out by weighing 2–5 g of CPO sample into a 250 mL glass-stoppered Erlenmeyer flask, followed by the addition of 30 mL of an acetic acid:chloroform mixture (3:2), and then the flask was closed. The purpose of adding chloroform was as a solvent, since oil is insoluble in water but soluble in non-polar organic solvents such as chloroform. Acetic acid (CH_3COOH) was used to provide an acidic medium, allowing potassium iodide to react completely.

The mixture was shaken until the sample was completely dissolved. Then, 0.5 mL of saturated KI solution was added and the flask was closed again. The addition of KI serves to liberate iodine, indicated by the formation of a yellow color in the sample. The solution was allowed to stand for 1 minute and shaken at least three times during this period. Subsequently, 30 mL of distilled water was added to ensure proper mixing. Next, 1–2 drops of starch indicator were added, resulting in a dark bluish-brown color. The starch functions as an indicator for the presence of iodine (I_2). The solution was then titrated with 0.01 N $Na_2S_2O_3$ until the blue color disappeared.

The results of the peroxide value analysis of pure CPO samples on days 0, 2, 4, 6, 8, and 10 are presented in Figure 3.

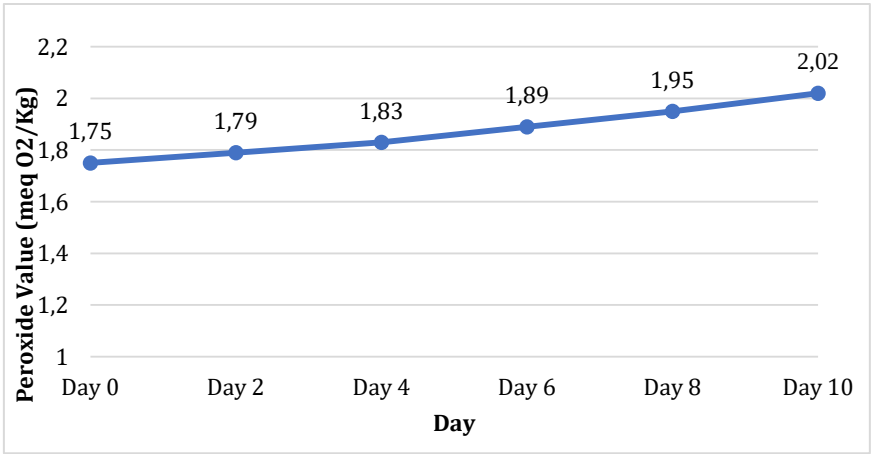


Figure 3. The results of the peroxide value analysis of pure CPO samples

Based on the research results and calculations of the peroxide value test shown in the graph above, the CPO oil met the standards established by SNI 01–2901–2006, which specifies a maximum peroxide value of 10 meq O_2/kg. The analysis results showed that the peroxide value of CPO oil was 1.75 meq O_2/kg on day 0, 1.79 meq O_2/kg on day 2, 1.83 meq O_2/kg on day 4, 1.89 meq O_2/kg on day 6, 1.95 meq O_2/kg on day 8, and 2.02 meq O_2/kg on day 10. These results indicate that the CPO sample complied with the SNI 01–2901–2006 standard, which sets the maximum peroxide value at 10 meq O_2/kg. When oxidation reactions occur, they produce free radicals as by-products. In the absence of antioxidants, these free radicals can attack surrounding molecules, leading to the formation of additional free radicals and triggering harmful chain reactions. In contrast, when antioxidants are present, free radicals react with the antioxidants to form stable and harmless molecules [24].

Test of Gletang Flower Extract Addition as a Natural Antioxidant

The antioxidant compound was prepared at a concentration of 5000 ppm. The use of 5000 ppm has been recommended in several studies [8] because it provided the best results at that concentration. A total of 50 mL of CPO was mixed with 50 mL of methanolic extract of gletang flower (as an antioxidant), resulting in a 1:1 ratio between CPO and the antioxidant. The mixture was then homogenized for 5 minutes and transferred into a separatory funnel for phase separation.

The lower layer was collected and analyzed for free fatty acid content and peroxide value as the day-0 sample. The mixture was then allowed to stand for 24 hours. Afterward, the lower CPO layer was collected again and tested for free fatty acid content and peroxide value. The experiment was repeated on days 2, 4, 6, 8, and 10. The following are the results of the analysis of free fatty acid content and peroxide value after the addition of antioxidants. From the experiment above, several analytical test results were obtained in Table 2.

Table 2. The result of CPO after addition extract

Day	*Free Fatty Acid* (*FFA*)		Peroxide Value	
	Control	Sample	Control	Sample
Day 0	6,69	5,32	1,75	1,65
Day 2	6,99	5,58	1,79	1,67
Day 4	7,25	5,81	1,83	1,71
Day 6	7,57	6,02	1,89	1,75
Day 8	7,91	6,29	1,95	1,79
Day 10	8,42	6,73	2,02	1,83

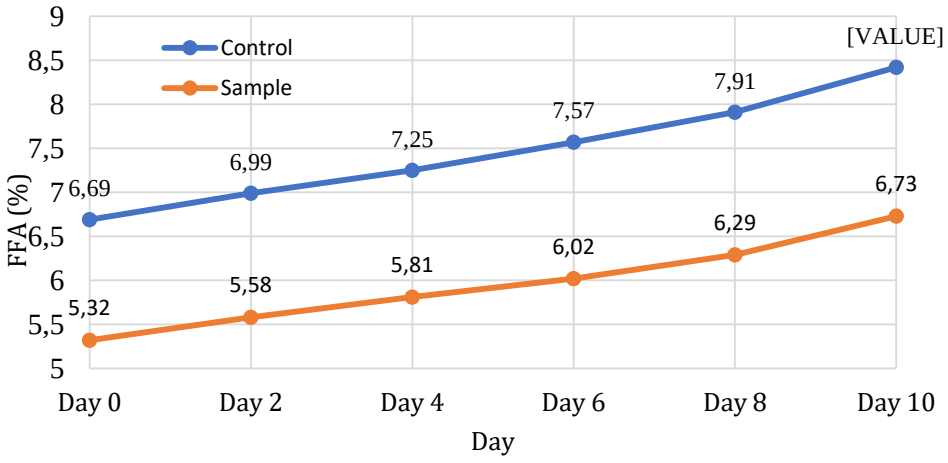


Figure 4. Comparison of FFA Content in CPO with and without Addition of Gletang Flower Extract

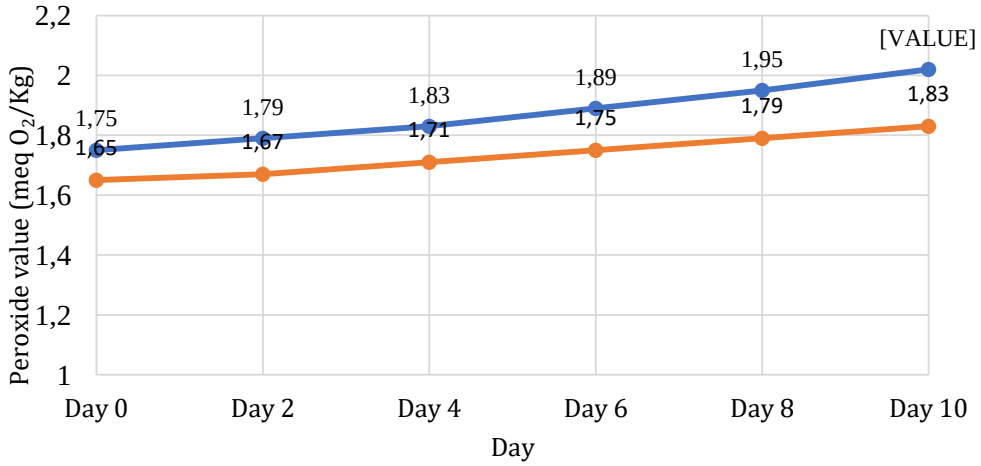


Figure 5. Comparison of Peroxide Value Content in CPO with and without Addition of Gletang Flower Extract

Free Fatty Acid Content Test of CPO After the Addition of Antioxidants

Based on the research results and calculations of the free fatty acid (FFA) test presented in the table above, after the addition of 5000 ppm antioxidant and analysis on days 0, 2, 4, 6, 8, and 10, the CPO oil still did not meet the standard established by SNI 01–2901–2006, which specifies a maximum FFA content of 5%. However, the results of the study and calculations showed a decrease in free fatty acid levels after the addition of antioxidants.

The free fatty acid content of the CPO sample before the addition of antioxidants on day 0 was 6.69%. After the addition of 5000 ppm antioxidant on day 0, the FFA content decreased to 5.32%, indicating a reduction of 1.37%. Furthermore, after antioxidant addition, the FFA values on days 2, 4, 6, 8, and 10 were 5.58%, 5.81%, 6.02%, 6.29%, and 6.73%, respectively. These results indicate reductions in free fatty acid levels of 1.40% on day 2, 1.44% on day 4, 1.55% on day 6, 1.62% on day 8, and 1.69% on day 10. These findings demonstrate that the addition of antioxidants resulted in an average reduction of free fatty acid levels by approximately 20.3%.

Peroxide Value Test of CPO After the Addition of Antioxidants

Based on the research results and calculations of the peroxide value test presented in the table above, after the addition of 5000 ppm antioxidant and analysis on days 0, 2, 4, 6, 8, and 10, the CPO oil still met the standard established by SNI 01–2901–2006, which specifies a maximum peroxide value of 10 meq O_2/kg. The results of the study and calculations showed a decrease in peroxide value after the addition of antioxidants.

The peroxide value of the CPO sample before the addition of antioxidants on day 0 was 1.75 meq O_2/kg. After the addition of 5000 ppm antioxidant on day 0, the peroxide value decreased to 1.65 meq O_2/kg, indicating a reduction of 0.10 meq O_2/kg. Furthermore, after antioxidant addition, the peroxide value on days 2, 4, 6, 8, and 10 were 1.67 meq O_2/kg, 1.71 meq O_2/kg, 1.75 meq O_2/kg, 1.79 meq O_2/kg, and 1.83 meq O_2/kg, respectively. These results indicate reductions in peroxide value of 0.12 meq O_2/kg on day 2, 0.12 meq O_2/kg on day 4, 0.14 meq O_2/kg on day 6, 0.16 meq O_2/kg on day 8, and 0.19 meq O_2/kg on day 10.

These findings demonstrate that the addition of antioxidants resulted in an average reduction in oxidation value of approximately 7.33%.

CONCLUSION

This study aimed to evaluate the potential of methanolic extract of gletang flower (*Tridax procumbens*) as a natural antioxidant to inhibit oxidation in crude palm oil (CPO), as indicated by changes in free fatty acid (FFA) levels and peroxide value (PV). The results showed that the addition of gletang flower extract reduced FFA levels and PV compared with untreated CPO during the 10-day observation period. The average reduction in FFA levels was approximately 20.3%, indicating that the extract may help inhibit the increase in free fatty acids during CPO storage. Meanwhile, the average reduction in PV was approximately 7.33% based on the reported data, suggesting that the extract may also inhibit primary lipid oxidation. These findings support the hypothesis that methanolic extract of gletang flower has the potential to act as a natural antioxidant in CPO. However, further studies with appropriate controls, replication, and validated analytical procedures are needed to confirm its antioxidant effectiveness and determine the optimal concentration for maintaining CPO quality.

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