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*Research Article*

# Meta-analysis on extraction methods, pharmacological activities, and cultivation techniques of *Curcuma xanthorrhiza* Roxb.

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**ABSTRACT**

*Javanese turmeric (Curcuma xanthorrhiza Roxb.) is important for study due to its increasing economic value in many aspects including marker-associated compounds for curcuminoids and xanthorrhizol. This systematic review aimed to summarize and find information about C. xanthorrhiza starting from its pharmacological activity and mechanism as an anticancer, anti-inflammatory, and antioxidant extraction process, and cultivation techniques. The data were obtained from relevant journals in national and international scientific databases PubMed, Scopus, Google Scholar, Web of Science, SINTA, ScienceDirect, and Wiley Online from 2000 to 2023. Results showed that from the perspective of anti-inflammatory pharmacological activities, xanthorrhizol inhibits pain response and inflammatory response. Its antioxidant activity showed a contribution to inhibiting oxidation which also successfully inhibits cancer cell proliferation. The extraction method of xanthorrhizol and curcuminoid compounds with Ultrasonic-Assisted Extraction (UAE) 20-2000 kHz performs better than other methods. C. xanthorrhiza cultivation techniques under shading produce better rhizomes. Based on research on cultivation techniques, extraction methods, and pharmacological activities, C. xanthorrhiza has an important role in the future.*

**Keywords:** anticancer, anti-inflammatory, antioxidant, UAE, volatile compound, yield

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## INTRODUCTION

*Curcuma xanthorrhiza* Roxb. (Zingiberaceae). syn. *Curcuma javanica* is one of 19 species native to Indonesia, which is most traditionally used as raw material for medicine in Indonesia; the rhizomes contain three derivatives of the curcuminoid compounds, i.e., curcumin, demethoxycurcumi, and bisdemethoxycurcumin (Rafi et al., 2015). Screening phytochemicals to combine extract of moringa stem bark and *Curcuma* rhizome results in maceration use of solvent methanol (Goa et al., 2021). Results test shows that the extract combination moringa bark and ginger rhizome positive contains a group of alkaloid compounds and triterpenoids/steroids and is negative to the test of flavonoids, tannins, and saponins. The difference in metabolite content and antioxidant activity of *C. xanthorrhiza* rhizome is known to be determined by the varying ages of the rhizome (Purwakusumah et al., 2016). Review several pharmacological activities of the plant *Curcuma* by arranging information compounds containing pharmacology activity (Kholilah & Bayu, 2019).

Research by Purwakusumah et al. (2016) identifies the rate of secondary rhizome turmeric and its relationship with character chemical land in Bangkalan Regency. A study on the influence of height and characteristics on secondary metabolites was carried out by Setyawati et al. (2021). Research that characterizes the difference between *C.*

*aromatica* and *C. longa* grows in Jeju-door Jin-do, South Korea island, focuses on making secondary metabolites profile from extract hexane of *Curcuma* species (Lee et al., 2014). Researched the impact of the source of the explant, medium composition, and growth regulators studied in the callus line *C. longa* (Gurav et al., 2020). Standardization and determination of qualitative and quantitative phytochemicals in *C. xanthorrhiza* were carried out by Shan and Iskandar (2018).

Rhizome *C. xanthorrhiza* contains curcuminoids, essential oil, starch, proteins, fat, cellulose, and mineral. Curcuminoids in *C. xanthorrhiza* consist on curcumin and desmethoxycurcumin. The Curcuma essential oils contains sesquiterpenes, curcumin, 1-cycloisoprenmyrcene, zingiberene, xanthorrhizol, bisabolene derivative, epolisid-bisakuron, bisakuron A, B, C, ketonesquiterpene, turmerone, a-turmerone, a-atlanton, germacrons and other compounds (Wijiyanti et al., 2019). Inside the essential oil component, there is xanthorrhizol Figure 1. Based on previous research, much research on *C. xanthorrhiza*proves that xanthorrhizol has active antioxidants and anticancer. Therefore, this overview will study the extraction method, pharmacological activity, and technique of cultivation compound curcuminoids and xanthorrhizol in *C. xanthorrhiza*.

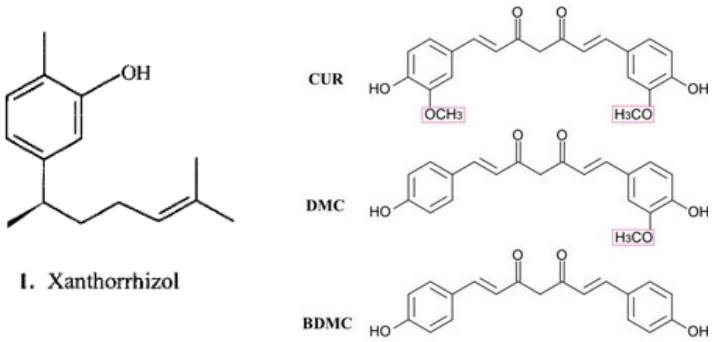


Figure 1. Chemical structure of xanthorrhizol, curcumin, demethoxycurcumi (DMC), and bisdemethoxycurcumin (BDMC) (Rukayadi & Hwang, 2006).

## MATERIALS AND METHODS

This review looks for all creations relevant to literature-related extraction methods, pharmacological activity, and cultivation techniques of curcuminoid and xanthorrhizol compounds in *Curcuma zanthorrhiza* Roxb. To collect all the published data about studies, we used international and local scientific databases like PubMed, Scopus, Google Scholar, Web of Science, SINTA, Science Direct, and Wiley Online for all articles which could in the last ten years. Some term keys used: ("*Curcuma zanthorrhiza"* OR" Temulawak "OR" Turmeric Java") AND ("Application drug "OR" Toxicity "OR" Pharmacological properties" OR "Biological properties "OR" active compound"). The data were collected from the period of 2000 to 2023.

## RESULTS AND DISCUSSION

### *Curcuminoids extraction method*

Extraction of curcuminoids is available in different methods (Table 1), including modern methods using ultrasonic-assisted extraction (UAE) as advanced tools with more cost-effective. The UEA uses ultrasonic waves ranging from 20 kHz to 2,000 kHz to generate shock waves that cause an explosion (cavitation). Cavitation produces intense heating and pressure in areas. According to the mechanism, the bubble detonation increases at a temperature of more than 5273 °K and a pressure of about 2000 atm. However, this procedure does not cause heat damage to the phytochemicals because the bubble implosion occurs quickly with a cooling rate of about 1.010 K/s. The UAE method can produce curcuminoids quite well compared to other methods (Rosarina et al., 2022).

Table 1. Comparison of various extraction methods for curcuminoid compounds in *C. xanthorrhiza.*

| Extraction solvent | Plant source | Yield extraction sample results | Extraction duration | Reference |
|---|---|---|---|---|
| 96% ethanol 250ml then liquid aqueous extract with n-hexane 1:1 (v/v) then fractionated. | *C. xanthorrhiza* rhizome | 25 g of simplicial produces 85.19 mg $g^{-1}$ of curcuminoids | 4-5 days | (Nurcholis *et al.,* 2015) |
| 76% ethanol 400 mL. | *C. xanthorrhiza* rhizome | Curcuminoids | 45 minutes and at an optimum speed of 500 rpm. | (Putri *et al.,* 2019) |
| 70% ethanol 5L | *C. xanthorrhiza* rhizome | The $LC_{50}$ value obtained was 22.35 ± 1.26 with Curcuma powder (500 g) | 2x24 hours | (Yunarto *et al.,* 2019) |
| Ethanol and fractionated with n-hexane | *C. xanthorrhiza* rhizome | 1,000 g of powder yielded 10.06% chloroform, 20.97% demethylcurcumin, | 24 hours | (Atun *et al.,* 2020) |
| Acetone 1000mL as solvent (1:5) | *C. xanthorrhiza* rhizome | 200 g sample of *C. xanthorrhiza* produces a yield of 2.86 ± 0.12% | for 8 hours | (Nurhadi *et al.,* 2020) |
| 70% ethanol | *C. xanthorrhiza* rhizome | 500 g of powder produces a yield of 30.87% | 3 x 24 hours | (Hidayanti *et al.,* 2021) |
| 20% water content in NADES (natural deep eutectic solvent) | *C. xanthorrhiza* rhizome | A total of 5 g of powder obtained a yield of 2.06 mg $g^{-1}$ | 60 min | (Rosarina *et al.,* 2022) |

Several methods are commonly used to extract curcuminoids from the dry powder of *C. xanthorrhiza*, namely maceration with ethanol for 24 hours at room temperature. As much as 1 kg of *C. xanthorrhiza* powder produces a chloroform yield of 10.06% with demethylcurcumin content of 20.97%. The total phenolic content of the chloroform fraction was 745.5 ± 18.5 mg (Atun et al., 2020). Another maceration method uses a dry sample of *C. xanthorrhiza*, which is put into a percolator. Then the solvent is flowed from top to bottom with the solvent composition (ethanol 96%) then as much as 500 g of dry *C. xanthorrhiza* powder is tested for antioxidants and produces an $IC_{50}$ value of 22.35 ± 1.26 (Yunarto et al., 2019). The maceration method utilizing ethanol as the solvent for a total extraction duration of 2 days yielded extracts with a curcuminoids concentration ranging from 35.57 to 85.19 mg $g^{-1}$, as reported by Nurcholis et al. (2015). An extract with a curcuminoids content of 30.87 mg $g^{-1}$ was obtained through maceration using the same procedure and duration but with 70% ethanol as the solvent (Hidayanti et al., 2021). Putri et al. (2019) reported producing curcumin nanoparticles using the solvent-antisolvent method from *C. xanthorrhiza* rhizome. They were extracting curcumin nanoparticles using the solvent-antisolvent method. Different stirring speeds (500, 750, and 1,000 rpm) and stirring times (15, 30, 45, 60, and 120 minutes) were then centrifuged for separation. The optimum stirring time for the curcumin extraction process to become nanoparticles was obtained at 45 minutes, while the optimum stirring speed was obtained at 500 rpm (Putri et al., 2019).

*Xanthorrhizol extraction method*

There are many xanthorrhizol extraction methods with different yields (Table 2). Supercritical fluids, in general, can be defined as any fluid at conditions above its critical point, where there is no difference between the liquid and gas phases. Under these conditions, the liquid has a density like a liquid with transport properties like a gas and moderate solubility. These features can be adjusted by changing the ambient temperature and pressure. Because of this, supercritical fluids have been used in various applications, namely separation (extraction), particle generation, and chromatography. The success of $SCCO_2$ as an antisolvent to form particles in the nano and micro scales is influenced by the

solubility of the feed solvent in the $SCCO_2$ medium and the solubility of the feed solute in the $SCCO_2$ medium (Machmudah et al., 2022).

Extraction experiments with supercritical fluid carbon dioxide (SCFE-$CO_2$) were carried out using custom-built SCFE-$CO_2$ equipment. The extractor vessel was filled with 100 g of earthed material for each experimental condition. Extraction pressure varies from 10 to 25 MPa, and temperature varies from 35 to 60 °C. Carbon dioxide ($CO_2$) flow rates varied from 10 to 25 g $min^{-1}$, and static extraction times were set to 60 min, followed by dynamic extraction times (60-240 min). Experiment with the Taguchi method with an orthogonal L-16 design. A total of 50 g and 150 g of dry matter produced xanthorrhizol yields of 90 mg and 128 mg (Salea et al., 2014).

*C. xanthorrhiza* rhizome powder 1 g is weighed into a conical flask containing various liquid-solid ratios. The conical flask is put into the ultrasonic bath. The ultrasonic cleaning bath is equipped with a power of 750 W and a frequency of 60 kHz, equipped with a timer and temperature used. *C. xanthorrhiza* extraction was performed 17 times with medium frequency at 30 to 50 $^oC$. The highest yield percentage (72.20%) and xanthorrhizol concentration (85.68%) were obtained at 20 min of extraction time (Azemi *et al.*, 2020).

The following method *C. xanthorrhiza*, which has been cleaned and dried as much as 100 g of dry powder and is macerated using 300 mL of 96% ethanol for 24 hours. The xanthorrhizol content in the sample is 27% (Irfan *et al*., 2021). *C. xanthorrhiza* was macerated with 95% ethanol for two days at room temperature. The filtrate of *C. xanthorrhiza* was concentrated with a rotary evaporator (Heidolph Instruments GmbH & Co. KG., Schwabach, Germany) and then performed multilevel fractionation. It reversed phase column chromatography (LiChroprep, RP-18, 25–40 m, Merck & Co., Inc.). Initially, 100 g of dried *C. xanthorrhiza* yielded 11% (Kim et al., 2014). The sample is put into the distillation vessel, and water is added in a ratio of 1:5 (sample: water) and then heated at 100-105 $^oC$ for 4 hours. A total of 3,000 g yields a 6% yield in 2 mL volume (Fitria et al., 2019) for other xanthorrhizol extraction methods can be seen in Table 2.

Table 2. Comparison of various extraction methods for *C. xanthorrhiza*

| Extraction solvent | Plant sources | Extraction sample result | Duration of extraction | Reference |
|---|---|---|---|---|
| 95% ethanol | *C. xanthorrhiza* rhizome | For 100 g of dry matter from C. xanthorrhiza, the yield obtained is 11% | 2 days | (Kim *et al*., 2014b) |
| Maceration of 95% ethanol | *C. xanthorrhiza* rhizome | 100 g of dry matter, a yield of 11% xanthorrhizol | 2 days | (Kim *et al*., 2014b) |
| *Supercritical fluid carbon dioxide (*$SCFECO_2$) | *C. xanthorrhiza* rhizome | 50 g obtained 90 mg and 150 g obtained 128 g xanthorrhizol | flow rate 15 g $min^{-1}$ and duration 60 min | (Salea *et al.,* 2014) |
| 95% ethanol solvent and 800 mL distilled water | *C. xanthorrhiza* rhizome | 50 g sample obtained 22.89% in ethanol and 3.41% in water. For 300 g sample gives 6% in 2 mL volume | 30 minutes and 1:5 steam distillation for 4 hours | (Fitria *et al.,* 2019) |
| Methanol solvent | *C. xanthorrhiza* rhizome | Xanthorrhizol concentration 85.68% | 5 min-20 min | (Azemi *et al.*, 2020) |
| Maceration of 96% ethanol 300 mL | *C. xanthorrhiza* rhizome | 23 g concentrated extract with HPLC, xanthorrhizol 27% | 24 hours | (Irfan *et al.,* 2021) |

*Pharmacological activity*

Anti-inflammatory in vitro first from XNT has shown on cell macrophage monocytes leukemic monocytes which activated lipopolysaccharide RAW 264.7. This result shows that XNT probably is a strong COX-2 and iNOS inhibitor. Further in vivo anti-inflammatory studies of XNT have been performed in a 12-O-tetradecanoylphorbol-13-acetate (TPA)-induced acute inflammation model in mice (Chung et al., 2007). Other studies report that XNT can exert anti-activity inflammation by obstructing painful neurogenic and inflammation in painful test formalin-induced rats (Oon et al., 2015).

Role XNT as antioxidant contributed oxidation inhibitory effect neuroprotective and LDL. In the neuronal HT22 cell line murine hippocampal hip, XNT reduces oxidative damage, which mediates free radicals. XNT hinders the peroxidation of LDL in humans with a method dependent on dose. The presence of group hydroxyl phenolic (Sesprettyrpene phenol) on the XNT bisabolene framework greatly contributes to its powerful antioxidant by chelating $Cu^{2+}$. Matter, in turn, could push the initiation oxidation of LDL and the formation of radical free lipoprotein (Oon et al., 2015).

As an anticancer, antioxidant-strong XNT and character repellent radical-free could exert a chemopreventive on carcinogenesis. XNT first time reported hindering system enzyme cytochrome p450 heart. Cytochrome p450 plays a role in the oxidation and detoxification of toxic compounds. When caught toxin, oxidation occurs and produces carcinogenic metabolites that form additional DNA, which could start carcinogenesis (Choi et al., 2005).

*C. xanthorrhiza cultivation techniques*

Various cultivation techniques have been carried out on *C. xanthorrhiza* to produce metabolite compounds and the quality of the resulting rhizomes. For example, spacing techniques, pre-, and post-planting fertilizers, shading, combinations of fertilizers, seedling techniques, and planting media can affect the quality of *C.* x*anthorrhiza* produced, such as plant height, number of tillers, quality of rhizomes, and metabolites.

Basri and Ekawati (2019) conducted research regarding the spacing, the position of the shoots upwards, pre-planting fertilization, and the application of urea fertilizer had a good effect on the yield of *C. xanthorrhiza* production in shaded home garden. The shade is one alternative for resolving intensity light that is too high. Giving shade could also reduce the airflow around the canopy, make the maintenance air humidity in the area header more stable by 60-70%, reduce evapotranspiration, and guard the balance between water supply and plant photosynthesis and transpiration (Handoko, 2002).

The productivity of *C. xanthorrhiza* rhizomes and the rate of photosynthesis are also affected by the planting location (Sasongko et al., 2020). The effects of plant stress and harvesting age also affect the xanthorrhizol content of *C. xanthorrhiza* (Khaerana et al., 2008). Based on the results of Ratri et al. (2015), the treatment of shade levels significantly affects plant height. In the treatment of no shade, 25% shade, and 50% shade, the plant height increased by 163.70 cm, 180.95 cm, and 196.50 cm, then decreased again at 75% shade of 170.60 cm. The research results state that the highest plant height is in 50% shade, as high as 128.25 cm, and significantly different from no shade, 25, and 75%. This is due to the little light intensity received, and etiolation will occur. Signs of etiolation are reduced leaf growth, elongated stem growth, and reduced chlorophyll content so that the color of the leaves becomes yellowish or pale white (Ratri et al., 2015). Plants will grow taller under shade. Salisbury and Ross (1995) state that plants exposed to shade will experience cell elongation, especially in the stem. This happens because the production of auxin in the shoots increases to stimulate the elongation of plant cells.

The results of the study by Ratri et al. (2015) showed that the treatment condition without shade had the highest number of leaves, which amounted to 22.70. The treatment differed significantly from the 25, 50, and 75% shade treatments. Increasing the level of shading resulted in a decrease in the number of leaves. This is because low light intensity will reduce the function of stomata in plants (Ratri et al., 2015), and inhibit

photosynthesis. Little photosynthate is formed so that it greatly affects leaf formation (Ratri et al., 2015).

Applying nitrogen fertilizers increased rhizome production. Using N and P fertilizers alone or in combination affects rhizome weight and curcumin content (Nihayati et al., 2013). The use of organic fertilizer generally increased rhizome production in Java turmeric. Using large rhizome seeds for propagation and organic fertilizer increased the number, weight, and diameter of secondary rhizomes. High levels of starch in the primary rhizome are important for plant growth. Therefore, using large rhizomes for propagation is important in Java turmeric cultivation. Treatment with organic fertilizer produces rhizomes with larger diameters when harvested ten months after planting. The interaction between rhizome size at planting and fertilizer treatment showed that larger rhizome size at planting followed by organic fertilizer application stimulates the largest secondary rhizome diameter. The largest secondary rhizome weight was seen using big rhizome seeds and organic and inorganic fertilizers. The highest number of secondary rhizomes was yielded when using organic fertilizer on any seed size (large: 4.3±0.1 g, medium: 3.1±1.3 g, small: 3.2±1.2 g).

Adi and Mulyaningsih (2019) noted that turmeric plants produce more secondary rhizomes (16.2 on average) when using cow manure compared to not using any fertilizer. The availability of micronutrients such as B, Fe, and Zn is also required for curcumin production. Based on Hossain et al. (2009), the application of N, P, and K fertilizers as separated applications or their combination has been studied to affect growth, rhizome yield, and curcumin levels in turmeric (*C. longa*). Similar research was conducted by Nihayati et al. (2013) which shows that N, P, and K fertilization at different levels, as well as single N and K fertilization or the combination, affects the growth and quantity of rhizomes Curcuma.

The availability of nutrients is very important for the growth and development of plants because the content of nutrients will help expedite plant metabolic processes, including the process of photosynthesis so that the resulting photosynthate is high, which can then be translocated to all parts of the plant; as a result, it will affect plant growth. Applying manure and planting media can produce better rhizomes on *C. xanthorrhiza* plants. The nutrient content of manure, namely P and K elements, is given to support the formation of rhizome length and N, which play a very important role in plant vegetative growth, including plant height, number of leaves, and number of shoots (Sarira et al., 2020).

In the research of Pribadi and Raharjo (2008) *C. xanthorrhiza* treated with a planting technique with a combination of NPK fertilizers, proved to be higher in producing xanthorrhizol and curcuminoids. The results of the combination of fertilizers gave a higher yield of curcuminoid compounds by 1.46% compared to curcuminoid levels with the expectation of Balittro. The NPK fertilizers produced xanthorrhizol of 2.00-3.50% while the number of expectations of Balittro was 1.20-3.00%. Research conducted by Sarira et al. (2020) regarding the planting medium with the application of fertilizers applied to *C. xanthorrhiza*, there were significant differences in the yield of plant height, number of shoots produced, fresh weight, and dry weight of *C. xanthorrhiza* for various cultivation techniques for planting *C. xanthorrhiza* can be seen in Table 3.

The content of the volatile compound was impacted by prior in vitro treatments and the amount of fertilizer applied during growth in the greenhouse. The fertilizer treatments during growth in the greenhouse increased the content of the volatile compounds of the rhizomes. A high mineral concentration of growing media supplemented with low ammonium concentration (5 mM) is developed to increase the phytochemical production in turmeric rhizomes. The interaction of $KNO_3$ and the divalent cation, $Ca^{2+}$ plays an important role in the accumulation of sesquiterpenes in turmeric rhizomes. $Ca^{2+}$ and $KNO_3$ interaction in vitro is similar to both fertilizer treatments in the greenhouse. In vitro, at the highest $KNO_3$ concentration, increasing $Ca^{2+}$ concentration increases the total content of germacrene, isocurcumenol, and β-elemenone in turmeric rhizome. On the other side, the lowest concentration of $Ca^{2+}$ increases curcumin isomers I and II, and curcuminoid.

However, the biochemical role of $Ca^{2+}$ in the volatile compounds' biosynthesis is still unclear, thus further investigations are needed. The increase in volatile content extracted from turmeric rhizome can be done without diminishing curcuminoid production. The total volatile compound content correlates to the primary metabolism and growth, dissimilar to curcuminoid accumulation in rhizomes (El-Hawaz et al., 2018).

Table 3. Comparison of various cultivation techniques for *C. zanthorrhiza* Roxb.

| Cultivation techniques | Curcuminoids results | Reference |
|---|---|---|
| Application of N, P fertilizers singly or in combination | The weight of the rhizome and curcumin compounds produced was better | (Nihayati *et al.,* 2013) |
| Plant spacing, the position of shoots upwards, pre-planting fertilization, provision of urea fertilizer, and shading | The results of sheltered and fenced rhizomes were more than the control group | (Basri and Ekawati, 2019) |
| Application of nitrogen fertilizers | Production of rhizomes was higher than the control | (Hidayah *et al.*, 2019) |
| Fertilization of fertilizers urea (N), SP 36 (P), and KCl (K) respectively with doses of 100 kg $ha^{-1}$, 200 kg $ha^{-1}$, and 300 kg $ha^{-1}$. The plot size experiment was 3.75 mx 4 m per treatment/replication | Rhizome and xanthorrhizol were higher than inorganic | (Pribadi and Raharjo, 2008) |
| Media soil, rice husk charcoal, coconut fiber powder, and manure | The planting medium of soil + rice husk charcoal + coconut husk powder with fertilizer 30 tons $ha^{-1}$ gave better growth than other treatments. In the planting medium soil + coconut coir powder, a fertilizer of 20 tons $ha^{-1}$ gives good results of rhizome dry weight. | (Sarira *et al.,* 2020) |

The cultivation method of *C. xanthorrhiza* is well-studied. Research conducted by Adzkiya (2006) to evaluate curcuminoid content has shown that the content is associated with many factors including the seedling nursery. *C. xanthorrhiza* cultivation is divided into four types according to fertilizer treatment: BPTO, Biopharmaca Research Center (PSB), BALITTRO, and LOCAL methods. Rhizomes could be planted after nursery for about 3 weeks before planting or planting directly in the field. Best direct planting is done by planting one cutting (2-3 shoots) in each planting hole and supplemented with straw mulch. Embroidery was carried out at two months of planting (MAP). Fertilizer application is commonly divided into two times, namely basic and maintenance. Basic fertilizer is applied at the time before planting. For one hectare of land, BPTO type applies 15 tons of manure and 180 kg of SP -36. PSB applies 15 tons of manure, while BALITRO applies 15 tons of manure, 250 kg of SP-36, and 70 kg of urea in the first application and 200 kg of SP-36, and 200 kg of KCl for one hectare. For LOCAL, the fertilizer applications are only 7 tons of manure.

Fertilizer for plant maintenance was applied according to the cultivation method. For BPTO, fertilizers were split at 2 and 4 MAP using 250 kg of urea and 150 kg of KCl for a hectare. For PSB, maintenance fertilizer is applied at 4 MAP using 70 kg urea. BALITRO treatment was given at the age of 1, 2, and 3 MAP includes 70 kg of urea, and LOCAL does not apply maintenance fertilizer. Other agronomic activities including weeding, hilling, rolling, and controlling plant disease are conducted regularly. Weeding is done every month, starting one month after planting. Hilling is done every month for three months after planting. Rolling is carried out specifically for the PSB treatment every month starting two months after planting.

Harvesting was done at 6, 7, 8, 9, and 10 months after planting. Harvesting is done by digging the rhizome and trying not to injure the rhizome. Before total harvest, sampling harvest is recommended. The composition and time of fertilizer application did not

significantly affect curcuminoid levels. While the planting period will have a significant effect on the curcuminoid content. A good cultivation treatment to obtain the greatest productivity is the BALLITRO cultivation treatment, while a good harvest age is 9 months after planting (Adzkiya, 2006).

## CONCLUSIONS

Various methods are available for extracting *C. xanthorrhiza* as a pharmacological agent with different cultivation techniques. Curcuminoid and xanthorrhizol content in *C. xanthorrhiza* has antibacterial, antioxidant, and anticancer activities. The weight and height of the rhizome produced are different according to the cultivation techniques carried out such as applying fertilizer and providing shading.

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