INTRODUCTION

Inflammation is an essential immune response as a strategy to protect tissue damage caused by microbes, injury and other harmful conditions. In general, inflammation is classified into acute inflammation and chronic inflammation. Acute inflammation is a very useful process in helping to immobilize the injured area and allowing the immune system to heal the wound. On the other hand, chronic inflammation becomes a problem for wounds. Inflamed tissue stimulates immune cells from the bloodstream to amplify the inflammatory response. Anti-inflammatory drugs such as Nonsteroidal Anti-Inflammatory Drugs (NSAIDs) are the most successful drugs used in the world by a large number of patients. However, NSAIDs can cause various side effects including gastrointestinal (GI), cardiovascular (CV) disturbances, high blood pressure, kidney toxicity, worsening of congestive heart failure, and hepatotoxicity.

Plants have played an important role in maintaining human health and improving the quality of human life for hundreds of years and serve as highly valuable medicines. Natural medicines have been increasingly used in recent years as alternative treatments for inflammation due to their relatively mild side effects. Previous studies have found that various plants have different pharmacological activities, including anti-inflammatory activity. One of the plants known to have many benefits, including Binahong or which has the Latin name of Anredera cordifolia (Ten).

Classification of A. cordifolia (Ten) plant is as follows: Kingdom: Plantae. Subkingdom: Tracheobionta, Division: Spermatophyta, Subdivision: Angiospermae, Class: Magnoliopsida, Order: Caryophyllales, Family: Basellaceae, Genus: Anredera and Species: Anredera cordifolia (Ten). A. cordifolia (Ten) has been shown to have activities such as antidiabetic, antibacterial, anti hematoma, antihyperlipidemic, antioxidant, analgesic, and treatment of kidney failure. However, there is no complete literature regarding its phytochemical content and its use as an anti-inflammatory. Therefore, it is important to develop knowledge related to drugs that are sourced from natural ingredients that are useful in drug discovery efforts in the future. This review aims to provide current information and obtain a comprehensive review of the anti-inflammatory activity of Anredera cordifolia (Ten).
provide up-to-date information and obtain a comprehensive review of the anti-inflammatory activity of *A. cordifolia (Ten)*.

**METHODS**

This review is based on a search of data on scientific literature databases, namely Pubmed, ScienceDirect, and Google scholar. This literature review search was conducted to find evidence in the literature on the phytochemical and anti-inflammatory activity in vitro and/or in vivo of *Anredera cordifolia (Ten)*. In this study, the search for articles was carried out using online media with the keyword being "Phytochemicals", "Anti-inflammatory", "Phytochemical", "anti-inflammatory", "Bioactive compounds", "Pharmacology" and "*Anredera cordifolia (Ten)*". Inclusion criteria include original articles or research articles published starting from August 2011-August 2021 which can be accessed online, and articles that are written in English and Indonesian. Meanwhile, the exclusion criteria are as follows: review articles, systematic reviews, meta-analytic reviews, short communications, news letters, editorials, case reports and expert opinions. All abstracts and complete articles were collected, examined, summarized, and concluded. The most relevant articles were selected for screening and included in this review. The plant taxonomy has been verified from the "Plant List" database (www.theplantlist.org).

**RESULT AND DISCUSSION**

The literature study regarding the phytochemicals and anti-inflammatory activity of *A. cordifolia (Ten)* used 10 literatures of which there are 5 studies on the phytochemical of *A. cordifolia (Ten)* and 5 literatures on its anti-inflammatory activity.

**Phytochemical**

Phytochemical activity in *A. cordifolia (Ten)* plants has been proven by research from several researchers. A total of 5 studies have been conducted and the results of these studies will be summarized in table 1 below.

| Compounds                  | Parts                        | Country   | References |
|----------------------------|------------------------------|-----------|------------|
| Saponins, triterpenoids and steroids | Leaves, stems and tubers | Malaysia  | (27)       |
| Flavonoids                 | Leaves                       | Indonesia | (28)       |
| Essential Oil              | Leaves                       | Brazil    | (29)       |
| Phenolic, sterols, alkaloids, saponins | Leaves            | Indonesia | (30)       |
| Saponins, tannins, flavonoids | Leaves                    | Indonesia | (31)       |

Phytochemical tests of binahong plants using the TLC method conducted by Astuti, M, S found the presence of saponins in the leaves, stems, and tubers of the *A. cordifolia (Ten)* plant. Saponin levels contained in the leaves of *A. cordifolia (Ten)* are (28.14±0.22), while in stems (3.65±0.11), tubers (43.15±0.10) mg/g dry sample 27.

Phytochemical activity was evaluated by Selawa et al., this study showed the identification of flavonoids using [Thin Layer Chromatography] TLC and color reaction. The types of secondary metabolites obtained from the isolation and identification of fresh powder and dry powder of ethanolic leaf extract from *A. cordifolia (Ten)* are flavonoids. Flavonoids contained in the leaf extract of *A. cordifolia (Ten)* from fresh samples (7.81 mg/kg) and dry samples (11.23 mg/kg) 28.

Phytochemical tests conducted by Souza et al., qualitatively using GC & GC-MS identified essential oil in *A. cordifolia (Ten)*. The results were 19 compounds, namely 1-Tetradecene, n-Tetradecane, 2,6,10-Trimethyl-dodecan, 2- Dodecanol, n-Pentadecane, trans-Cyclohexane, 6-Methyl-a-ionone, 2-Hexyl-1-decanol, 1,10-Decadienol, n-Hexadecane, Tetradecan, n-Heptadecane, n-Pentadecanol, 1-Octadecene, n-Octadecane, n-Hexadecanol, n-Nonadecane, n-Eicosene and n-Eicosane 29.

In addition, the phytochemical analysis conducted by Basyuni *et al.*, qualitatively using a color reaction, showed that the leaf extract of *A. cordifolia (Ten)* contains phenolic secondary metabolites, which was proven positive when reacted with 1% FeCl3 marked by a change in color to blackish, positive for steroids/terpenoids when reacted with 1% FeCl3. libermann-bouchard that was indicated by a turquoise color, positive for alkaloids when reacted with drangendorff that was indicated by the formation of a precipitate, and positive for saponins when tested with distilled water-HCl 30.

Another study by Hanafiah et al., phytochemical conducted a test on *A. cordifolia (Ten)* leaves using the TLC method for saponin testing, and spectrophotometers method for tannins and flavonoids testing, the result showed that *A. cordifolia (Ten)* leaves contain saponins, tannins and flavonoids 31.

**Anti-inflammatory Activity**

Anti-inflammatory activity in *A. cordifolia (Ten)* has been proven by experimental studies both in vitro and in vivo. A total of 5 studies have been conducted and the results of these studies will be summarized in table 2 below.
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red blood cells in a hypotonic solution. The optimum
properties of each dose were 25.2 mg/200 g BW, 12.6mg/200 g BW, and 100.8 mg/200 g BW respectively by 5.17%, 10.12%
and 400 mg/kg BW. The
f
induction of carrageenan on rat
edema of rats. The anti
32

Table 2. Anti-inflammatory activity of Anredra cordifolia (Ten) plants (in vitro and in vivo)

| Type of Extract/ Formulation | Plant part used | Dose/ Concentration | Experimental model | Animal/ test cell | Reported activity | Region | Ref |
|-------------------------------|-----------------|---------------------|-------------------|------------------|-----------------|--------|-----|
| Binahong leaves extract      | Leaves          | 25.2, 50.4, 100.0 mg/200 g BW | Carrageenan induced paw edema (in vivo) | Sprague Dawley Male Rats | Binahong leaves extract provides an anti-inflammatory effect. Characterized by a decrease in the volume of hind paw edema | Indonesia | (32) |
| Ethyl Alcohol Extract        | Leaves          | 100, 200, 400, and 800-ppm | Hypotonicity induced human red blood cell (HRBC) | Human Red Blood Cell (HRBC) (in vitro) | Ethyl alcohol extract of binahong leaves showed anti-inflammatory activity through inhibition of hemolysis | Indonesia | (33) |
| Ethanol Extract              | Leaves          | 100, 200 and 400 mg/kg BW | Carrageenan induced paw edema (in vivo) | Wistar rat | Ethanol extract provides an anti-inflammatory effect. Characterized by a decrease in the volume of hind paw edema | Indonesia | (34) |
| Ethanol extract              | Leaves          | 10, 50, 75 μg/mL | LPS-stimulated RAW264.7 macrophage cells | RAW 264.7 macrophage cells | Binahong ethanol extract showed anti-inflammatory activity through the inhibition of inflammatory mediators TNF-α, IL-1β, IL-6, and NO | Bangladesh | (35) |
| Ethanol extract              | Leaves          | 10%, 20%, 40% | Injection of ketamine (in vivo) | Sprague dawley white male rat strain | Binahong leaf extract showed an anti-inflammatory effect by reducing the number of PMN neutrophils | Indonesia | (36) |

Kurniawan et al. tested the anti-inflammatory activity of binahong leaves extract by dividing the male rats into five groups, each group was given a different dose as follows: group 1 (5ml aquadest), group 2 (mefenamic acid 12.6mg/200g BW), group 3 (A. cordifolia (Ten) extract 25.2mg/200g BW), group 4 (A. cordifolia (Ten) extract 50.4mg/200g BW) , group 5 ( A. cordifolia (Ten) extract 100.8mg/200g BW). The leaf extract of A. cordifolia (Ten) has anti-inflammatory properties as indicated by a decrease in the volume of hind paw edema of rats. The anti-inflammatory properties of each dose were 25.2 mg/200 g BW, 50.4 mg/200 g BW, and 100.8 mg/200 g BW respectively by 5.17%, 10.12%, and 1.92%. In line with previous studies using the method of induction of carrageenan on rat paws, the research of Yuziani et al. examined the anti-inflammatory effect of the ethanolic extract of the leaves of A. cordifolia (EEDB) orally was carried out on 5 treatment groups, group 1 was given 1% CMC suspension (SCMC), group 2 was DSS (dicholen sodium suspension) at a dose of 2.25 mg/kg BW as for comparison, groups 3, 4, and 5 were given EEDB doses of 100 mg/kg BW, 200 mg/kg BW, and 400 mg/kg BW. The ethanol extract of binahong leaves showed effectiveness against anti-inflammatory by decreasing the volume of hind paw edema. The results of this study prove that the leaf extract of A. cordifolia (Ten) has anti-inflammatory activity.

Laksmiawati et al. proved that the anti-inflammatory potential of A. cordifolia (Ten) leaf extract in a pure macrophage cell line was induced by lipopolysaccharide (RAW 264.7). Cell viability test was carried out by MTS test. Parameters that have been measured to determine anti-inflammatory activity are interleukin-1β (IL-1β), tumor necrosis factor (TNF)-α, nitric oxide (NO and IL-6). A. cordifolia (Ten) plants with a concentration of 50g/ml can significantly reduce levels of TNF-α (250.3 pg/ml), IL-1β (50 g/ml), IL-6 (10 g/ml), and NO (50 g/ml). This study proves that A. cordifolia (Ten) has anti-inflammatory potential by inhibiting inflammatory mediator activity, including TNF-α, IL-1β, IL-6, and NO.

In another study, the anti-inflammatory activity was also tested by Susanti, G. By conducting experiments on the number of (Polymorphonuclear) PMN neutrophils in male sprague dawley rats, which were divided into 5 experimental groups, each group was given an extract of A. cordifolia (Ten) with different levels, where in group 1 was given ointment base, group 2 was given povidone iodine ointment, group 3 was given ointment extract (10%), group 4 was given ointment (20%), and group 5 was given ointment extract (40%). Ointment is reported after 4 hours of incision. In testing the effectiveness between groups with independent t-test, it has shown a significant difference (p<0.05) except in the positive control group and 40% extract, Post Hoc test showed that there was a difference in effectiveness between the administration of leaf extract ointment of A. cordifolia.
(Ten) and povidone iodine ointment. From this test, it was concluded that the leaf ointment of A. cordifolia (Ten) at 40% level has an anti-inflammatory effect with a decrease in neutrophil PMN by 81.25% in incision but lower than povidone iodine ointment which decreases the number of neutrophil PMN by 94.64% 36.

CONCLUSIONS

The A. cordifolia (Ten) plant has an important role in society for medicine, including inflammation. The A. cordifolia (Ten) plant also contains phytochemicals that we can use in everyday life. This review describes the importance of A. cordifolia (Ten) as an anti-inflammatory agent and has a variety of chemical. Several pharmacological studies reported the potential of A. cordifolia (Ten) for the treatment of diseases associated with inflammatory stimuli. This study also confirmed the anti-inflammatory effect in vitro and in vivo. A. cordifolia (Ten) showed anti-inflammatory activity by several mechanisms including by decreasing the volume of paw edema, inhibition of hemolysis, inhibition of inflammatory mediators TNF-, IL-1β, IL-6, and NO, , and a decrease in the number of PMN neutrophils.

The chemical content of A. cordifolia (Ten) has high value and benefits because it has natural phytochemical compounds that have potential, especially in plant parts, namely the leaves. Phytochemical components that have been found include essential oils, saponins, phenolics, triterpenoids, steroids, flavonoids, tannins and alkaloids.

However, further research needs to be done to understand the metabolic processes and the role of metabolites as anti-inflammatory in the body as a prelude to the development of new anti-inflammatory drugs in the future.

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CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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