The Potential of Medicinal Plants Cultivated from South Aceh as Anthelmintic Agents

Erlidawati a, Chessy Rima Mustika b, Rahmad Rizki Fazli b, Musri Musman b

aBiochemistry Research Division, Chemistry Education Department, Universitas Syiah Kuala, Banda Aceh, Indonesia, 23111
bDepartment of Chemistry Education Department, Universitas Syiah Kuala, Banda Aceh, Indonesia, 23111

Abstract

Studies on potential of medicinal plants used by the South Acehnese as anthelmintics for Ascaris lumbricoides have been conducted. The aim of this study was to find out the type and content of secondary metabolites of medicinal plants used by Acehnese in the South Aceh district through phytochemical screening. Data were collected through semi-structured interviews with anthelmintic medicinal plant users, herbal practitioners, and the general public. The interviews revealed that the community used 15 plant species and 19 plant parts as anthelmintics for A. Lumbricoides. Plant extracts were obtained by maceration with 96% ethanol, and secondary metabolite content was identified using phytochemical screening. According to the phytochemical screening results of 19 plant extracts, 17 extracts contained alkaloids, 18 extracts contained flavonoids, 8 extracts contained saponins, 18 extracts contained phenols, 16 extracts contained tannins, 9 extracts contained steroids, and 2 extracts contained triterpenoids.

Keywords: Plants, anthelmintics; Ascaris lumbricoides; phytochemical; secondary metabolites

INTRODUCTION

Worms cause one of the infections that harm humans. It is currently estimated that more than 1.5 billion people, or 24% of the world’s population, are infected with soil-transmitted worms [1]. Worm prevalence in Indonesia ranges from 2.5% to 62%; this figure rises to 80% when worm prevalence is calculated in school-age children [2]. Most people pay less attention to worm infections because they believe that worm infections do not cause serious illness. In fact, in the long run, worm infection can impair physical development, intelligence, and work productivity, weaken the body’s defenses, make it susceptible to other diseases, and even cause death.

Worm infections in humans are caused by Soil-Transmitted Helminths (STH) intestinal nematodes that are transmitted through the soil. Ascaris lumbricoides is the most common causative agent of soil-transmitted helminth infections and causes ascariasis [2]. A. lumbricoides enters the human body as infective eggs (eggs containing larvae). Infective eggs can be transmitted to humans through the dirt on the tips of fingernails, which may contain infective eggs that get into the body through the mouth along with food and hatch into larvae in the small intestine [3].

A. lumbricoides causes the following symptoms: 1) Worm larvae that migrate to the lungs can cause pneumonia in patients with clinical symptoms such as fever, cough, shortness of breath, and bloody sputum, 2) Adults of A. lumbricoides can secrete toxic fluids that cause clinical symptoms similar to typhoid fever, as well as allergic symptoms such as urticaria, facial swelling, and upper respiratory irritation [3]. Chronic ascariasis in children can cause digestive and protein absorption problems, resulting in growth problems and anemia due to malnutrition [2]. Worms spread from the intestine to the appendix, anus, pancreas, bile duct, liver, stomach, esophagus, and trachea, obstructing the patient’s breathing. Worms can exit the body through the nose and mouth in addition to migrating to organs.

Anthelmintic drugs are widely used against intestinal worms. Anthelmintics inhibit protein synthesis or paralyze the worm’s muscles. Although there are numerous oral drugs for ascariasis treatment available in the pharmaceutical market, most people are still using medicinal herbs as an alternative medicine due to their low cost, easy availability and effectiveness [4]. Central Kluet is one of the sub-districts in South Aceh District with enormous natural potential, as 68.7% of the area is still forest [5]. Central Kluet residents still rely on traditional medicine derived from plants for their primary health-care needs. This is due to the district’s lack of health facilities, which include only one health center unit. The nearest hospital is only in Tapaktuan City, and the distance between Tapaktuan and Central Kluet is quite long, measuring 61 kilometers [6].

Medicinal plants are enriched with essential phytochemicals, which are a variety of secondary metabolites such as alkaloids, phenolics, isoprenoids, polyketides, glycosides, peptides, and their [7]. Secondary metabolite compounds can be identified using phytochemical screening, which is a method that
uses specific reagents to detect the presence or absence of secondary metabolites in a plant extract [8]. Tannins and flavonoids are secondary metabolites with anthelmintic activity against A. lumbricoides [9]. Tannins and flavonoids work as anthelmintics by agglomerating proteins in the cuticle and intestine, causing paralysis in the worm’s muscles and eventually death [10].

According to several studies, plants used as anthelmintics for A. lumbricoides include Allium fistulosum leaves [11], Butea frondose seeds, Carum copticum seeds, Eupatorium triplinerve flowers, Helleborus niger stems, Mangifera Indica seeds [12], Areca catechu seeds [13] and Cassia alata L. leaves [14]. The objective of this study is to perform a preliminary investigation of potential phytochemicals that have been utilized by people in South Aceh for A. lumbricoides anthelmintics.

**METHOD**

**Materials**

The materials used in this study were parts of the anthelmintic plant A. lumbricoides obtained in Center Kluet District, South Aceh District, filter paper, and distilled water (H₂O). The reagents and solvents used were 96% ethanol (C₂H₅OH), iron (III) chloride (FeCl₃), hydrochloric acid (HCl), sulfuric acid (H₂SO₄), acetic acid (CH₃COOH) anhydrous, gelatin, and potassium iodide (KI) (NH₃).

**Equipments**

The equipment used was cameras, rotary evaporators, blenders, test tubes, analytical balance, a freezer, and reagent bottles. This study was carried out between March and July 2019. The sampling took place in the Kluet Tengah District of South Aceh Regency. The selection of this sub-district was based on several factors, including: 1) a lack of medical workers and health facilities; 2) most people still use medicinal plants and traditional medicine practitioners to treat illnesses; and 3) very limited public transportation from Tapaktuan city to Menggatam (Central Kluet). Phytochemical screening of samples was performed at the Chemistry Education Laboratory, Faculty of Teacher Training and Education, Syiah Kuala University.

**Procedures**

**Collection of samples**

The sampling stage was conducted through semi-structured interviews with 75 people from Central Kluet District over the course of one month, including: 1) 22 users of anthelmintic plants, 2) traditional medicine practitioners (traditional healers whose treatment uses plants), and 3) 30 general public who are aware of anthelmintic plants. Following data collection via semi-structured interviews, the collected plant samples are proven by facts of plant existence in the field, namely by photographing the plants in question.

**Extraction of the sample**

The plant part used as an anthelmintic against A. lumbricoides had previously been washed with running water to remove adhering dirt. The plant parts were then dried for about 3 weeks. After drying, the plant parts were ground into a powder. Powdered anthelmintic plants were placed in a jar and macerated in 96% ethanol. The jar was tightly closed and subjected to 24 hours of dark incubation at room temperature with occasional shaking. The filtrate was filtered through filter paper before being evaporated in a rotary evaporator set to 40°C.

**Phytochemical Screening**

**Test for alkaloids**

Each extract of the sample was dissolved in 2 mL of 10% ammonia and 5 mL of chloroform and allowed to stand until two layers formed. The top layer was separated from the bottom layer and placed in a test tube, and three drops of dilute HCl were added before filtering. Three drops of Wagner’s reagent (positive reaction if a brown to red precipitate forms), Mayer’s reagent (positive reaction if a cream precipitate forms), and Dragendorff’s reagent (positive reaction if a brown precipitate forms) are added to each filtrate [8].

**Test for flavonoids**

0.1 g of each extract of the formulation was dissolved in ethanol and filtered. The filtrate was placed in the drip plate, followed by the Mg band and three drops of concentrated HCl (a positive reaction is formed if a red, yellow, or orange solution forms) [7].

**Test for saponin**

0.1 g of each sample extract was placed in a test tube and dissolved in hot water (heated for 5 minutes). For 10 seconds, the sample was shaken vertically. The presence of saponin compounds was indicated by the formation of foam that remained approximately 1 cm high after adding 1 drop of 0.1 N HCl [7].

**Test for phenol**

0.1 g of each sample extract was placed on the drip plate and dissolved with three drops of 0.1 M FeCl₃ solution. The presence of phenol was indicated by the formation of a bluish-black solution [7].

**Test for tannin**

After placing the sample extract in a test tube, a 1% gelatin solution containing NaCl was added. The presence of tannins is indicated by the formation of a white precipitate [7].

**Test for triterpenoids and steroids**

On the drip plate, 0.1 g of sample extract was added, followed by 3 drops of Libermann-Burchard reagent. A change in the color of the solution to blue or green indicates the presence of steroids, whereas a
change in the color of the solution to red or purple indicates the presence of triterpenoids [7].

RESULTS AND DISCUSSION
South Aceh medicinal plants used as anthelmints
The results of interviews with users of anthelmintic plants, herbal practitioners, and the general public showed that there were 15 plant species used by communities in Kluet Tengah District, South Aceh Regency as anthelmints for A. lumbricoides. The plant species reported were lamtoro leaves (Leucaena leucocephala (Lamk.) de Wit), nilam mencit leaves (Pogostemon sp.), ke kucing leaves (Pogostemon auriculatus (L.) Hassk.), selaih air leaves (Ocimum sp.), sembung leaves (Blumea balsamifera (L.) DC), all part of the rumpun mutiara (Hedyotis corymbosa (L.) Lamk), ciplukan fruits (Physalis angulata L.), tanjung leaves (Mimusops elengi L.), tikusan leaves (Clausesa excavate Burm.), melati susun leaves (Clerodendrum chinense Blume) Mabb., coconut pistil fruits (Cocos nucifera L.), kumis kucing leaves (Orthosiphon aristatus (Blume) Miq.), pegagan leaves (Centella asiatica (L.) Urb.), and waru leaves (Hibiscus tiliaceus L.). The total number of plant parts cited during the interviews was 19 plant parts.

Extraction
Parts of medicinal plant anthelmintic used in this study were the roots, stems, leaves, fruits, and seeds. Samples are air-dried to remove moisture and prevent chemical changes in the sample, such as rapid decay [8]. The dried samples were then stored in watertight plastic containers. It was aimed to keep the sample intact until the analysis was executed [7]. The sample was mashed with a blender to increase the surface area of contact and helped in the breakdown of cell walls and membranes, maximizing the extraction process [15].

The maceration method was used to extract simplicia because it was simple, produced high yields, and avoided possibility of damage to the chemical compounds contained in the sample. The solvent used in this study was 96% ethanol because it was non-toxic, cheap, and had good extractability, allowing almost all secondary metabolites to dissolve completely [16]. The solvent was then evaporated using an evaporator to obtain a thick extract as a result of the maceration.

Phytochemical Screening Results
The phytochemical profile from the preliminary investigation showed that the various extracts of medicinal anthelmintic plants for A. lumbricoides are enriched with a variety of secondary metabolites including alkaloids, flavonoids, saponins, phenols, tannins, steroids, and triterpenoids, as depicted in Table 1.

Table 1
<table>
<thead>
<tr>
<th>Phytochemical Screening Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>The phytochemical profile from the preliminary investigation showed that the various extracts of medicinal anthelmintic plants for A. lumbricoides are enriched with a variety of secondary metabolites including alkaloids, flavonoids, saponins, phenols, tannins, steroids, and triterpenoids, as depicted in Table 1.</td>
</tr>
</tbody>
</table>

Alkaloids
Phytochemical screening results revealed that all of the plant part samples contained alkaloids except for H. corymbosa flower extract and Ocimum sp. leaf extract. The alkaloid test was carried out using three reagents, namely Mayer, Wagner, and Dragendroff reagents. The formation of a white precipitate indicates positive alkaloid results in the Mayer test. A solution of mercury (II) chloride and potassium iodide reacts to form mercury (II) iodide during the preparation of Mayer’s reagent. Excess potassium iodide results in the formation of potassium tetraiodomercurate (II) (K₂[HgI₄]) [17].

Because alkaloids contain nitrogen atoms with lone pairs of electrons, they can form coordinate covalent bonds with metal ions [18]. The nitrogen in the alkaloids reacts with Hg metal ions from potassium tetraiodomercurate (II) to form a mercury-alkaloid complex that precipitates white in the alkaloid test with Mayer’s reagent, as shown in Figure 1 [19].

Figure 1. Reaction of the Mayer test
Wagner’s reagent was made by reacting potassium iodide with iodine, as follows:

\[
\text{K}^+ + \text{I}^- + \text{I}^- \rightarrow \text{K}^+ + \text{I}^+ + 2\text{I}^{-}
\]

The alkaloids will react with the Wagner reagent to form a brown precipitate. This precipitate was formed because I⁻ ions in the Wagner reagent will form coordinate covalent bonds with nitrogen in the alkaloids to produce brown iodine-alkaloid complexes [19]. The alkaloid test reaction with Wagner’s reagent is shown in Figure 2.

Figure 2. Reaction Wagner test
Dragendroff reagent was prepared by dissolving bismuth (III) nitrate in HCl and potassium iodide to form potassium tetraiodobismutat (K[BiI₄]) [17]. The formation of an orange precipitate indicates a positive Dragendroff test result. This precipitate was formed because the metal ion Bi in potassium tetraiodobismutat forms coordinate covalent bonds
with nitrogen in the alkaloids to produce an orange bismuth-alkaloid complex [19]. The alkaloid test reaction with Dragendorff reagent is shown in Figure 3.

![Alkaloid Test Reaction]

**Figure 3.** Reaction alkaloid with Dragendorff reagent

### Table 1. Preliminary investigation of phytochemical constituents in various extracts of the medicinal anthelmintic plants for *A. lumbricoides.*

<table>
<thead>
<tr>
<th>No</th>
<th>Botanical name of plant</th>
<th>Part of plant</th>
<th>Alkaloid</th>
<th>Flavonoid</th>
<th>Saponin</th>
<th>Phenolic</th>
<th>Tannin</th>
<th>Steroid</th>
<th>Triterpenoid</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Leucaena leucocephala</em> (Lamk.) de Wit</td>
<td>Leaves</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
<td>(-)</td>
</tr>
<tr>
<td>2</td>
<td><em>Pogostemon sp.</em></td>
<td>Leaves</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
<td>(-)</td>
</tr>
<tr>
<td>3</td>
<td><em>Pogostemon auricularius</em> (L.) Hassk.</td>
<td>Leaves</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
</tr>
<tr>
<td>4</td>
<td><em>Ocimum sp.</em></td>
<td>Leaves</td>
<td>(-)</td>
<td>(+)</td>
<td>(-)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
</tr>
<tr>
<td>5</td>
<td><em>Blumea balsamifera</em> (L.) DC</td>
<td>Leaves</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Root</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
<td>(-)</td>
<td>(+)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stem</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
<td>(-)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leaves</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
<td>(-)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Flower</td>
<td>(-)</td>
<td>(+)</td>
<td>(-)</td>
<td>(+)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fruits</td>
<td>(+)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(+)</td>
<td>(-)</td>
</tr>
<tr>
<td>6</td>
<td><em>Hedyotis corymbosa</em> (L.) Lamk</td>
<td>Fruits</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
</tr>
<tr>
<td>7</td>
<td><em>Physalis angulata</em> L.</td>
<td>Fruits</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
</tr>
<tr>
<td>8</td>
<td><em>Callicarpa longifolia</em> Lam.</td>
<td>Leaves</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
<td>(-)</td>
</tr>
<tr>
<td>9</td>
<td><em>Mimusops elengi</em> L.</td>
<td>Leaves</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
</tr>
<tr>
<td>10</td>
<td><em>Clausena excavata</em> Burm. f.</td>
<td>Leaves</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
<td>(-)</td>
</tr>
<tr>
<td>11</td>
<td><em>Clerodendrum chinense</em> (Osbeck) Mabb.</td>
<td>Leaves</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
</tr>
<tr>
<td>12</td>
<td><em>Cocos nucifera</em> L.</td>
<td>Fruits</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
<td>(+)</td>
</tr>
<tr>
<td>13</td>
<td><em>Orthosiphon aristatus</em> (Blume) Miq.</td>
<td>Leaves</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
</tr>
<tr>
<td>14</td>
<td><em>Centella asiatica</em> (L.) Urb.</td>
<td>Leaves</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
</tr>
<tr>
<td>15</td>
<td><em>Hibiscus tiliae</em> L.</td>
<td>Leaves</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
<td>(-)</td>
</tr>
</tbody>
</table>

Key: (+) Present, (-) Absent
Flavonoids

The identification of secondary metabolites of the flavonoid group was carried out by the Shinoda test. In the Shinoda test, concentrated HCl and Mg were added to plant extracts, resulting in the formation of H2 gas bubbles. By hydrolyzing O-glucose, concentrated HCl attempts to hydrolyze flavonoids into their aglycones. Because the acid is electrophilic, the glucose group was replaced by H+ from the acid. A colored complex is formed after reduction with concentrated Mg and HCl [20, 21]. The colors that appear indicate the flavonoid group, with orange to red indicating flavones, red to dark red indicating flavonoids, and dark red to purple red indicating flavonones [7].

Figure 4. Flavonoid reaction with HCl and Mg

Based on the results of the phytochemical screening, all parts of the anthelmintic medicinal plant formed an orange solution except for H. corymbosa (L.) Lamk fruit extract. Flavonoid compounds of the flavonol group such as galocatechin and epigalocatechin have been reported to play a major role in anthelmintic activity [9]. Flavonoid can bind to proline-rich proteins in the cuticle of worm eggs, causing the motility of the worm eggs to decrease. Moreover, flavonoids that come into contact with the bodies of adult worms are rapidly absorbed, resulting in protein denaturation in the worm’s tissues and neurodegeneration in the worm’s body. This process paralyzes the worms and causes them to die slowly [10].

Saponins

According to the results of the tests, saponin-containing plant extracts included B. balsamifera (L.) DC leaves, the root and leaves of H. corymbosa (L.) Lamk., M. elengi L. leaves, C. excavate Burm. f. leaves, the pistil fruit of C. nucifera L., O. aristatus (Blume) Miq. leaves, and C. asiatica (L.) Urb. leaves. Saponin was identified by adding hot water to plant extracts because saponin dissolves in polar compounds, one of which is water. The formation of stable foam was a positive outcome of this test. The presence of foam indicated the presence of glycosides, which can form foam in water after being hydrolyzed into glucose and other compounds, as seen in Figure 5 [21,22].

Figure 5. Hydrolysis reaction of saponins in water

Phenols

Plant extracts were used to identify phenols by adding FeCl3 reagents. The formation of a green-black solution was a positive result of this test because the phenolic compounds in the sample react with the Fe3+ ions in the FeCl3 reagent to form a blue-black complex compound, as shown in Figure 6 [23]. A preliminary investigation of phytochemical screening for phenol indicates that all parts of the anthelmintic medicinal plant contain phenol except H. corymbosa (L.) Lamk flower.

Figure 6. Phenol reaction with FeCl3

Tannins

Tannins were detected by adding 1% gelatin containing NaCl to medicinal plant extracts. The formation of a white precipitate was a positive result of this test because of the presence of hydrogen bonds between tannins and gelatin, as shown in Figure 7 [24,25] In the gelatin structure, hydrogen atoms from tannin hydroxyl groups form hydrogen bonds with O and N atoms. Furthermore, the addition of NaCl was intended to improve tannin and gelatin salting [8]. The results of the phytochemical screening investigation revealed that all extracts of medicinal plants were positive for tannins except for the stem, flower, and fruit of H. corymbosa (L.) Lamk.
A previous study reported that tannin acted as an anthelmintic by entering the digestive tract and inhibiting the action of the phosphatase enzyme found in the microvilli [26]. The phosphatase enzyme is required for food absorption. Furthermore, this enzyme binds to tannins, disrupting the process of food absorption in the microvilli and causing the microvilli to be damaged, causing them to fall off and break [9]. As a result, the worms will starve to death due to a lack of nutrition. Tannins also have ovicidal activity by binding to proteins in the worm egg cuticle [13].

According to Williams et al. (2014), the worm egg cuticle contains a lot of proline, which can be damaged by tannins by precipitating proteins. When proline is damaged, worm eggs lose motility and eventually die slowly.

**CONCLUSION**

Medicinal plants used as anthelmintic for *A. lumbricoides* by the community in South Aceh District include *lamtoro* leaves (*L. leucocephala* (Lamk.) de Wit), *nilam mencit* leaves (*Pogostemon sp.*), *ke kucing* leaves (*P. auricularius* (L.) Hassk.), *selasih air* leaves (*Ocimum sp.*), *sembung* leaves (*B. balsamifera* (L.) DC), all part of the *rumput mutiara* (*H. corymbosa* (Lamk) Lamk), *ciplukan* fruits (*P. angulate* L.), *tampah besi* leaves (*C. longifolia* Lam.), *tanjung* leaves (*M. elengi* L.), *tikusan* leaves (*C. excavate Burm. f.*), *melati susun* leaves (*C. chinense* (Osbeck) Maub.), *kumis kucing* leaves (*O. aristatus* (Blume) Miq.), and *waru* leaves (*H. tiliaceus* L.) with a total of 19 plant parts. The phytochemical screening revealed that 17 extracts had alkaloids, 18 extracts had flavonoids, 8 extracts had saponins, 18 extracts had phenols, 16 extracts had tannins, 9 extracts had steroids, and 2 extracts had triterpenoids.

**SUGGESTION**

The authors suggest further research on the isolation of active compounds from plant extracts that have anthelmintic activity against *A. lumbricoides*.

**ACKNOWLEDGEMENT**

The authors acknowledge Dr. Hasanuddin, M. Si, from the Department of Biology Education, Universitas Syiah Kuala, Banda Aceh, Indonesia for identifying medicinal plants.

**REFERENCES**


