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Utilization of The Saga Plant *Abrus Precatorius* L. in Indonesian Folk Medicine

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Review

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A B S T R A C T

Saga or known by the Latin name *Abrus precatorius* L. belongs to the Fabaceae family and is a leguminosae plant that grows in tropical and subtropical regions and has also been widely used for traditional medicinal practices. Saga is believed to be a plant that has natural properties and is important as a source of ingredients for making medicines to treat various diseases. Many pharmacological studies have been carried out which state that saga has various biological activities that can be act as anti-diabetic, anti-fertility, anti-germ, anti-cancer, and so on. Parts of the saga plant in the form of leaves, roots and seeds can be used for natural medicine which has been carried out by many traditional people for generations. Part of the leaf blade contains triterpene compounds, alkaloids, glycosides, and glycyrrhizin. It is known that the saga plant also has an abrin compound which has a very dangerous toxic effect when consumed by humans. The review of this article aims to gather useful information regarding the saga plant so that it can be better utilized and empowered for the benefit of human beings.

1. INTRODUCTION

Indonesia is a rich in number of plants used as spice and medicinal plants. The expertise of our ancestors in concocting medicinal plants and discovering the properties of plants is a legacy that should be preserved. Knowledge of the efficacy of medicinal plants by their ancestors is known as "Jamu" or herbal medicine (Widiyanti, 2005) and has been found in many traditional community medicinal practices across generations.

The glycyrrhizin contained in saga part of the roots and leaves of this plant is used to treat thrush, cough, and sore throat (Depkes RI, 1979), also as a flavoring agent (Rosrta et al., 1991). This plant is easily propagated by seed (Heyne, 1987). According to research by Juniarti et al., (2010) saga leaves contain flavonoids and steroids in their leaves; which can be act as antioxidants. Antioxidants play an important role in counteracting the effects of free radicals associated with degenerative diseases such as coronary heart disease, cancer and diabetes or diabetes mellitus which are caused by several degenerative biochemical pathways in the human body (Juniarti et al., 2010).

Flavonoids in plants also activate as natural killer (NK) cells to stimulate production of interferon-γ (IFN-γ) production in several cells of the immune system, which is the main cytokine of Macrophage Activating Cytokine (MAC) and plays a role in cellular non-specific immunity (Eriani et al., 2018).

Saga seeds also have a potential to act as an immunomodulator. Its seeds have secondary metabolites gallic acid, trigonelline, squalene, 5-beta cholanic acid, glycyrrhizin, abrusic acid, abrine, precabrine, abraline and also hypaphorine (Akram et al., 2014). Furthermore Bhatia et al., (2013) also reports abrus agglutinin activity in native (NA) and heat denatured (HDA) states for the proliferation of secreting cytokines, murine splenocytes, activating NK cells, and for lymphocyte proliferation.

HDA-induced native agglutinins and conditioning media from adhering splenocytes can stimulate non-adherent splenocytes and vice versa. Agglutinins that are denatured by heat activate NK cells to a lower extent than the amount of NA, but at a much higher activation rate for NK cells for NA. Thymocyte proliferation by NA and HDA was also further observed. This illustrates that Abrus agglutinin is capable of being a potential immunomodulator both in the native state (NA) and in heat denatured (HDA) conditions (Bhatia et al., 2013).

The toxicity test was carried out by the Bhatia et al., (2013) to find safe dose of abrin; which was 1.25 mg/KgBW for five days in normal mice, and could stimulate a specific humoral response. Increases in numbers were observed in the distribution of total leukocyte counts, antibody-forming cells, thymus, bone marrow cellular, spleen weight, positive bone marrow cells as well as circulating antibody, alpha-esterase. Observations suggest that abrin can potentially respond to host humoral immunity (Bhatia et al., 2013). The dose of Saga leaves is safe to use is 3 × 5 g of leaves per day (Menkes, 2017).

More than 166 chemical compounds have been identified from A. precatorius, which primarily cover flavonoids, phenolics, terpenoids, steroids, alkaloids, organic acids, esters, proteins, polysaccharides, etc. A wide range of in vitro and in vivo pharmacological functions of A. precatorius have been reported, such as antitumor, antimicrobial, insecticidal, antiprotozoal, antiparasitic, anti-inflammatory, antioxidant, immunomodulatory, antifertility, antidiabetic, other pharmacological activities (Qian et al. 2022).

Further studies are needed to increase the value of the saga plant by utilizing it to become a product that is known and liked by the community. This paper aims to enrich information about the saga plant which has the potential to be developed as a medicinal plant which has bright prospects in the future.

According to Backer et al, (1965) saga plants are classified as follows:

Kingdom: Plantae

Division: *Magnoliophyta*

Class: *Magnoliopsida*

Order: *Fabales*

Family: *Papilionaceae*

Genus: *Abrus*

Species: *Abrus precatorius* L.

2. SAGA PLANT MORPHOLOGY

The leaves are compound, oval in shape and small in size. Saga leaves have odd fins and have a slightly sweet taste. Saga has pods filled with red seeds having shiny and smooth black dots. The flowers are light purple in shape (resembling a butterfly), in clusters of flowers.

Shrubs, vines and twisting, branched woody stems, young stems are green and are green-brown at old age. They have compound leaves, alternate, pinnate odd, leaflets oval, green color. Inflorescence is bunch shaped. Seeds are contained in pods, which are ovoid, red with black spots.

In general, the height of old saga trees can reach 20-30 m. Saga trees are deciduous or change leaves every year (Diningrat, 1987). The leaves are even pinnate compound, grow alternately, the number of leaflets is 2-6 pairs, the leaf blade is 6-12 pairs, the stem length reaches 25 cm, the leaves are light green. Small yellowish flowers are produced with 4-5 strands of Corolla and 8-10 stamens.

Fig. 1. *Abrus precatorius* L.Plant (Source: https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.1965#image-27530)

3. DESCRIPTION OF SAGA PLANT

Saga plant shrubs, grow as vines, growing wild in forests, fields or yards in dry areas with altitudes up to 1,000 meters above sea level requiring a partial or full shade. The plant height reach 2-5 meters length and have small stems.The saga plant family fabaaceae has small green leaves oval shaped pinnate compound leaves resembling tamarind leaves, (Abrupte pinnatus) with a length of 6.025 mm and a width of 3-8 mm, occuring in pairs of 8-18 leaflets.

Saga flowers are compound in the form of bunches, small with a white and light purple butterfly-shaped crown, the lower part is androgynous, the upper part consists only of male flowers, the petals are serrated, short hairy, and the stamens are fused on the tube, the stamens are approximately 1 cm, yellow anthers pistil, winged flower crown. The fruit includes pods with a length of 2-5 cm, green when dark brown. Inside the fruit are red seeds with black dots, shiny and smooth, oval in shape, small and hard.

In Indonesia the saga plant has several regional names including: Thaga (in Aceh), Saga (in Batak Makasar and Sampit), Parusa (in Mentawai), Kundi (in Minangkabau), Kandari (in Lampung), Kendari (in Malay), Taning Bajang (in Dayak), Walipopo (in Gorontalo), Kaca (in Bugis), Ailalu Picar (in Ambon), Pikal (in Haruku), Pikolo (in Saparua), Seklawan (in Buru), Idisi Ma Lako (in Loda Halmahera), Idihi Ma Lako (in Pagu Halmahera), Idi-idi Ma Lako (in Ternate Tidore), Punoi (in Arafuru), Kalepip (in Irian/Papua) (Depkes RI, 1979).

4. CULTIVATION OF SAGA PLANTS

The plants can grow well at an altitude of 1-1.000 m above sea level, on a variety of soils, with rainfall of 1.500-4.500 mm/year in Indonesia. The anti-nutritional compounds analyzed in saga seed coat were anti-trypsin (Rosrta et al., 1991), anti-chymotrypsin (Kardianan, 2005), and saponins by spectrophotometric method (Gatler, 1991). The leaves are compound, oval in shape and small in size. Saga leaves are oddly finned. Saga has pods filled with seeds that are red and smooth. Saga seed coat which is on the outside is very hard so that the seed is resistant to environmental conditions during its period as a plant seed (regeneration).

Vines grow well on the fences, generally in the yard. Plant propagation is done by seeds. The seeds are soaked overnight in water and only viable seeds are selected to raise the nurseries. Thereafter, 3-4 months old plantlets are transplanted to the gardens.

Seeds can also be sown at depths of 3-5 cm directly in the garden after preparation of land and levelling for 1-2 times and leveling it using plant to plant distance of 25-60 cm. Each drill hole is filled with 3-5 grains. The need for seeds for 1 hectare of land is approximately 25-40 kg of seeds (an average of 1 kg contains 7.500 seeds).

How to plant directly in the garden is done in the rainy season or in the dry season when water is available. The plants can be hoed to improve the ground cover that serve as fertilizer and improve organic matter in the soil classified as a green manure.

This plant does not require much maintenance, which, consists of replanting, fertilizing, controlling pests and diseases. Control of plant lice using systemic insecticides, and extermination of plants attacked by Meloidogyne sp, Heterodera sp, and devil's broom disease caused by marioni virus.

Slightly weak soils are fertilized with fertilizers containing 25-50 kg of nitrogen, 45 kg of phosphorus and 50 kg of potassium per hectare. The first harvest is done after the plants are 6-8 months old. Harvest the leaves by cutting the plant 25-30 cm from the ground. Harvest the roots after the plants are 2.5-3 years old with a production of 2.500-3.500 kg of wet roots per hectare.

5. SUBSTANCE CONTENT

Saga plants have several chemical constituents in the leaves, stems, seeds and roots. The chemical content contained in the saga plant can be seen in table 1 below.

Saga seeds contain flavonol glucoside, proximate and protein which are rich in essential amino acids. Saga seeds are also rich in abrin compounds which can cause apoptosis in leukaemic cell cultures. Saga seed coat pigment dissolves in fat solvents and produces a light yellow color. The solubility properties of saga seed coat pigments in fat solvents show similarities to the solubility properties of chlorophyll and carotenoid pigments, while the solubility in water solvents show similarities to the solubility properties of anthocyanin and anthoxanthin pigments (Barrows, 1968).

Saga seeds also contain saponins in the red skin of the seeds. Saponins are a type of glycosides that are found in plants. The main source of saponins is grains, apart from saga seeds, they are also found in soybeans. Saponins have the characteristic of foaming. So if it is reacted with water and shaken, a number of foam will appear which can last longer. Saponin compounds are very easily dissolved in water and not easily soluble in ether. These saponins have a distinctive taste that is bitter, stinging and can cause sneezing and irritation of the mucous membranes. Saponin is also a poison that can destroy blood clots or hemolysis. In addition, saponin compounds are toxic to cold-blooded animals and are widely used as fish poison. Saponins that have a strong or toxic effect are known as sapotoxins (Dwijoseputro, 1989).

Saponin is a glycoside that may be present in many plants. Saponins are present throughout the plant with high concentrations in certain parts and are influenced by plant varieties and growth stages. Its function in plants is unknown, possibly as a storage form of carbohydrates or as a waste product of plant metabolism. Another possibility is as a protection against insect attacks.

Table 1. Substance Content of Saga Plants (Ministry of Health RI, 1979).

Plant Parts	Chemical Contents
Leaf	saponins and flavonoids, glycyrhizin
Stem	polyphenols, saponins and flavonoids
Seed	tannins, saponins and flavonoids
Root	glycyrizin, alkaloids, saponins, polyphenols

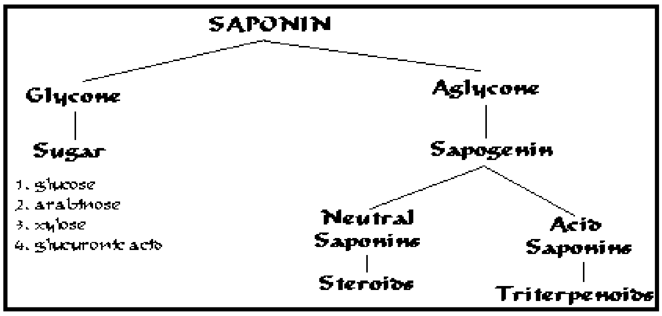

Fig. 2 Derivatives of saponin

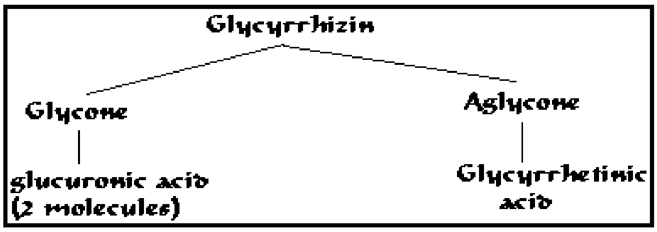

Fig. 3 Glycyrhizin

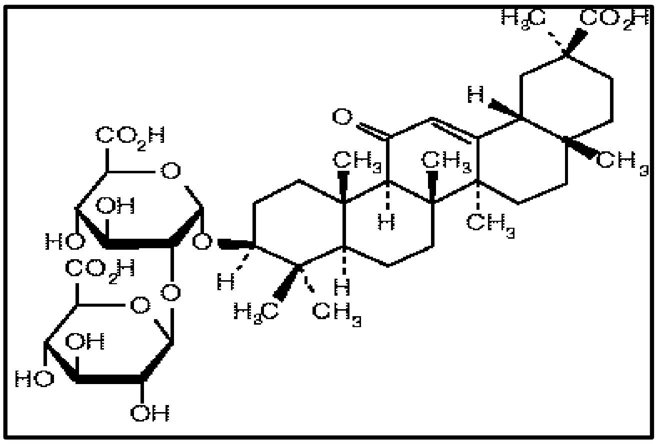

Fig. 4 Chemical structure of glycyrrhizin

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Two types of saponins are known, namely alcohol triterpenoid glycosides and structural steroid glycosides (Hadioetomo, 1985). Saponins are surface active compounds and are shaped like soap, and can be detected based on their ability to form foam and hemolyze blood cells. Saponins contained in simplicia contain terpene derivatives and a small portion of steroids. Some saponins are acidic, due to the presence of a carboxyl group on the aglycone and/or sugar group (Raddish, 1961). Hemagglutinin is mainly present in beans and peas of the Leguminose and Euphorbiaceae families. This active substance is a protein that will clot and hemolyze blood grains. Its toxic form is also in the form of inhibition of various protease enzymes (Raddish, 1961). Seeds are composed of the skin, cotyledons, and hypocotyl. The skin is the larger part, which is 52.13% with a range of 51.8-52.5%, while the cotyledons and hypocotyl are 47.87% with a range of 46.2-48.91%. The signs of old saga seeds are the pods broken and split and the cupped pod shells forming a spiral arrangement, the seeds are very hard, the seed coat is bright red, and the seeds are brownish yellow in color (Emmyzar et al., 1990).

In the structure of wood or extractives it occupies a certain morphological place. That is, fats and waxes are found in the parenchyma cells of the fingers whereas resinous acids can be found in the resin ducts. Extractive – Phenol extractives are mainly found in heartwood and in the bark. The results showed that between water, methanol, ethanol, and propanol which was able to dissolve the most dyes was methanol. The dissolving ability of each solvent sequentially is methanol > water > ethanol > propanol (Raddish, 1961).

6. BENEFITS OF SAGA PLANTS

The saga plant is used as a traditional medicine and can be used as a remedy for canker sores, tonsillitis and eye inflammation. Saga plants also contain vitamins A, B1, B6, C, protein, calcium oxalate and many other minerals needed by the body. In various tips for processing saga leaves, it is stated that it is not recommended to treat with the seeds because saga seeds contain a toxic substance called abrin.

Antioxidants play a major role in reducing the effects of free radicals which can trigger degenerative diseases such as coronary heart disease, cancer, high blood pressure and diabetes which are based on the biochemical processes that occur in the body. Free radicals that are produced continuously during normal metabolic processes are believed to be one of the causes of damage to the function of body cells which results in degenerative diseases (Helliwel, 1999). Generally, the effects of free radicals can be minimized by certain antioxidants, namely natural antioxidants or synthetic antioxidants. Most natural antioxidants come from plants, including tocopherols, carotenoids, ascorbic acid, phenols, and flavonoids (Wang. et al, 1989).

At high doses of compounds, bioactive compounds can have toxic effects, so that the in vivo killing power of these compounds against certain organisms such as animals can be used for bioactivity and also for observing bioactive fractions during fractionation and purification. Brine shrimp is an example of an organism suitable for animal testing (Meyer et al., 1982).

7. PHYTOCHEMICAL COMPOUNDS OF SAGA PLANT

Parts of the Leaves: the leaves contain glycyrrhizin compounds up to 10%, triterpenes, glycosides, pinitol and also alkaloids namely abrine, hepaphotine, choline then precatorine (Garaniya and Bapodra 2014). Tree glycoside compounds based on aglycones as well as abrutigenins, while for the cycloartane type, namely triterpene glycoside compounds include abusosides A, B, and C (Bahrami and Franco 2016). There are other active compounds that can be found in saga leaves, namely methyl abrusgenate, tritepenes abrusgenic acid, abruslactone A, liquirtiginin-7-diglycoside, toxifolin-3-glucoside, flavonoid vitexin and liquirtiginin-7-monoglycoside.

Part of the seed: the seeds of the saga plant contain ash (5.38%), fat (3.92%), carbohydrates (42.42%), crude protein (39.20%), crude fiber (9.08%) and high water (5.06%) (Das et al., 2016). Other active compounds can be found in saga seeds, namely alkaloids, flavonoids, anthocyanins, steroids, fixed oils and lectins (Pal et al., 2009). Alkaloid compounds found in saga seeds contain precatorine, choline, abrine and hepaphotine (Garaniya and Bapodra 2014). Meanwhile, the oil contained in sage seeds is oleic acid and linoleic acid

Steroids were found in saga seeds containing cholesterol, abricin, stigmasterol, linoleic, 5β-cholanic acid and also-sitosterol (Yonemoto et al., 2014). The red color seen in saga seeds is the presence of delphinidin, pelargonidin, cyanide, abranin and glycosides (Bhakta and Das 2020). Other compounds that can be found are hederagenin methyl ether, sapogenol, kaikasaponin III methyl ester, abrisapogenol J, sophoradiol, flavones including abrectorin and saknone which are other main supports of saga seeds (Verma, 2016). The main supports of saga seeds are abrin and lectin. The toxic (abrin) and non-toxic lectin constituents are (abrus agglutinin). Abrin is known as abrin a, b, c, and d which are short polypeptide chains and also large β-polypeptide chains which are then connected by disulfide bonds (Herrmann and Behnke, 1981). Root components: the root part of the saga plant contains alkaloid compounds and also glycyrrhizin such as abrasives and precasine in addition to related bases and also abrine (Verma et al., 2011).

8. CHEMICAL COMPOUND CONTENTS OF SAGA LEAF EXTRACT

Juniarti et al., (2009) mentions chemical content of saga leaf extracts as shown in Table 3. It can be seen that after the phytochemical tests were carried out on the three extracts, it was found that the n-hexane extract of saga leaves contained steroid compounds, and the ethyl acetate extracts contained flavonoids and steroids, while the methanol extract contained steroid compounds. Phenolic compounds and saponins were not found in the three extracts of the saga (*Abrus precatorius*, L) leaves. This can be seen from the absence of foam in the saponin test and the absence of green, blue, or purple colors in the phenolic compound tests.

Table 2. Phytochemical Test of Saga Leaf Extract

No	Chemical Compounds	Extract results			Notes
		n-hexane	ethyl acetate	methanol	
1	Flavonoids	Yellow (-)	Orange (+)	Green (-)	(+) If red, yellow or orange is formed
2	Phenolic	Yellow (-)	Brown (-)	Brown (-)	(+) If a green, blue or purple color is formed
3	Saponins	No foam (-)	No foam (-)	No foam (-)	(+) if permanent foam is formed ± 15 minutes
4	Steroids/terpenoids	Dark green (+)	Green (+)	Green (+)	Steroids (+) if a blue or green color is formed, triterpenoids (+) if a red/violet color is formed

9. TOXIC EFFECT

An unfortunate incident has been discovered after ingesting the chewed saga seeds. Because the seed coat is hard, it can then pass through the digestive tract without being properly processed and then shows a harmless state. Raw seeds have a soft skin and break easily so it is more dangerous. Symptoms of poisoning have been found through finger pricks while stringing seeds. These symptoms then develop after a few hours to several days after consumption.

Toxicity can be identified including severe nausea and vomiting or gastroenteritis. Mydriasis may occur, followed by cold sweats, muscle weakness, tremors and tachycardia. There is no physiological drug that can be found (Ross, 2003). However, even though the saga plant has many therapeutic benefits, it should be a concern if an inappropriate or excessive dose or intake will result in poisoning which is very dangerous and can cause death (Nenov et al., 2003). Saga seeds can cause toxic effects in the dose range of 90 to 120 mg Tam et al., 2017. Apart from that, saga seeds contain the compound abrin, if consumed in the dose range of 0.0001 to 0.0002 mg/kg it will become a natural poison Wooten et al., (2014). The effects of accidentally ingesting saga seed poisoning can affect the performance of the digestive tract, kidneys, lymphatics, liver and spleen systems (Patil et al., 2016). When exposed to saga seed extract, it can cause eye damage, blindness and conjunctivitis (Karpurashetti, 2014). Acute gastroenteritis with vomiting is another symptom of poisoning from saga seeds.

10. USE OF SAGA PLANTS IN ETHNOMEDICINAL SYSTEM OF INDONESIA

Saga plants as medicine can treat several diseases, namely:

10.1. Thrush

The patients take enough saga leaves and dry them until they wilt. These leaves are chewed until smooth while using them to rinse mouth.

10.2. Tonsils

The patients take enough saga root, one piece of cinnamon, and rock sugar to taste after washing the roots with cinnamon and boiling in 5 cups of water. There after, the patients strain the water and drink twice a day in the morning and evening.

10.3. Eye Inflammation

The patients take enough sage leaves, crush them until they are smooth. Next, the paste is boiled in 2 cups of water to take hot steam. The patients also use water vapors of saga leaves as eye drops.

10.4. Relieves heart pounding and cold sweat

The patients take 8 grams of sweet saga leaves and 10 grams of sembung (Blumea balsamifera; DC). They add 5 grams of aromatic ginger and boil it with 2 cups of water followed by drinking the the boiled water.

10.5. Treat high blood pressure

The patients take sweet saga leaves, horse-foot leaves, duringgi leaves, white pumpkin leaves, and kejibeling leaves (Strobilanthes crispa). They boil them in 4 cups of water and reduce it to 2 cups. The mixture is strain before drinking the compound.

10.6. Treat dry cough

The patients take sweet saga leaves, ripe pace fruit, and po'o leaves (Mentha × piperita L). These are ground finely before boiling with 4 cups of water. It is strained before drinking.

11. CONCLUSION

From the discussion about the saga plant, it turns out that it is used to maintain health, and treat several diseases. These can be used by pounding, boiling, chewing as per prescription. Saga plants also contain vitamins A, B1, B6, C, protein, calcium oxalate and many other minerals needed by the body. It is not recommended to use seeds because they contain toxins the saga plant seeds has an abrin compound which has a very dangerous toxic effect when consumed by humans that can injurious to intestines.

COMPLIANCE WITH ETHICAL STANDARDS

Author Contributions

All authors contributed to the study conception and design. The first draft of the manuscript was written by J.K and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Conflict of Interest

The authors do not have any conflicts of interest to declare.

Ethical Approval

For this type of study, formal consent is not required.

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