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Hepatoprotector Edible Flower in Indonesia: A Review

I Nyoman Bagus Aji Kresnapati*, Salsabila Yunita Kurniawan, Novitarini, Baiq Yulia Hasni Pratiwi

Pharmacy Study Program, Faculty of Health, Bumigora University, Mataram, Indonesia
*e-mail: ajikresnapati@gmail.com

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Abstract: Hepatotoxicity is an agent that causes damage to human liver function, and every year, cases of liver damage are increasing. Agents that cause liver damage, such as drugs (Paracetamol), chemicals, Carbon Tetrachloride (CCL4), cause liver damage, which is characterized by an increase in the liver enzymes *Serum Glutamic Oxaloacetic Transaminase* (SGOT) and *Serum Glutamic Pyruvic Transaminase* (SGPT). Giving natural ingredients such as edible flower extracts (hepatoprotectors) can reduce SGOT and SGPT levels in liver damage (Hepatoxicity). Indonesia is a country rich in biodiversity, including edible flowers. Therefore, the purpose of this study was to analyze edible flowers that grow in Indonesia and have hepatoprotective activity. This research method is based on a Google Scholar search for the last 5 years (2024-2020) with a keyword search for herbal plants that grow in Indonesia, then selected edible flowers, and a search for edible flowers, then selected edible flowers that act as hepatoprotective. From the search results, edible flowers that act as hepatoprotectors were obtained, namely, Rosella Flower (Hibiscus sabdariffa), Pagoda Flower (Clerodendrum paniculatum L.), Water Hyacinth Flower (Eichhornia crassipes), French Marigold Flower (Tagetes Patula) and Butterfly Pea Flower (Clitoria ternatea), which grow abundantly in Indonesia. Based on the content of active edible compounds, namely flavonoids, anthocyanins, tannins, alkaloids, saponins, terpenoids, phenolic acids and carotenoids, with flavonoids being the most dominant found in all edible flowers. And among the 5 edible flowers as hepatoprotective, only 2 are the most familiar in Indonesia, namely Rosella Flower (*Hibiscus sabdariffa*) and Butterfly Pea Flower (*Clitoria ternatea*), so it can be concluded that the most familiar hepatoprotective edible flowers in Indonesia are Rosella Flower (*Hibiscus sabdariffa*) and Butterfly Pea Flower (*Clitoria ternatea*).

Keywords: Edible Flower; Hepatoprotector; Hepatotoxicity; SGOT; SGPT.

Introduction

Hepatotoxicity is an agent that causes damage to human liver function, and every year, cases of liver damage are increasing. Based on the latest data from the World Health Organization (WHO), deaths caused by liver damage are 2 million worldwide [1]. Based on the Indonesian Health Survey in 2023, the percentage of deaths from diseases caused by liver damage in Indonesia is 3% of the population and will continue to increase every year (SKI, 2023). The main factors or agents that cause liver damage are the use of indiscriminate drugs [2] lead waste (PB) [3] Lifestyle factors such as poor diet, obesity, alcoholic beverages, and staying up late, which reduce human liver function [4]. Hepatotoxicity is caused by free radical agents that can damage liver cells, thereby increasing the production of Serum Glutamic Oxaloacetic Transaminase (SGOT) and Serum Glutamic Pyruvic Transaminase (SGPT) into the bloodstream. Liver function tests (SGOT and SGPT) are the gold standard parameters in assessing human liver function. Increased serum SGOT and SGPT indicate impaired liver function [2].

Liver-damaging agents, such as drugs, can cause liver damage. According to previous literature studies, the use of drugs, including paracetamol (PCT), is the most widely used drug that induces liver damage or Drug-Induced Liver Injury (DILI) [5]. Drugs that induce liver damage or Drug-Induced Liver Injury (DILI) can increase liver function, such as SGOT and SGPT [6]. Previous literature shows that long-term antituberculosis drugs such as Isoniazid can cause hepatotoxicity [7].

High-dose and long-term use of paracetamol (PCT) can produce toxic metabolites of N-acetyl-p-benzoquinoneimine (NAPQI). N-acetyl-p-benzoquinoneimine (NAPQI) irreversibly binds cysteine groups in liver molecules, causing hepatocellular centrilobular necrosis. NAPQI metabolites are produced through the biotransformation process of the highly reactive CYP 450 enzyme, causing damage to the hepatocyte cell membrane. Damage to the hepatocyte cell membrane causes the release of SGPT and SGOT enzymes into the bloodstream. As a result of the response to liver cell damage, especially in the centrilobular area where the CYP 450 enzyme is found in abundance, SGPT increases up to 5 times above normal values [8].

In research studies, paracetamol (PCT) is often used as a model for hepatotoxicity in experimental animals, targeting liver function damage. Previous studies have shown that administering PCT at a dose of 300 mg/kg has been shown to be able to show liver damage due to drug toxicity (DILI) [9]. Administration of natural ingredients (hepatoprotectors) such as edible flower extracts can reduce SGOT and SGPT levels in experimental animals. Edible flowers are flowering plants that can be consumed. Since ancient times, edible flowers have been utilized by brewing them directly. Edible flowers have a myriad of health benefits, such as anti-cholesterol, anti-hypertension, and

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lowering blood sugar. Edible flowers have active compounds such as triterpenoids, flavonoids, and phenolics that can protect hepatocytes from free radicals, NAPQI [10]. Administration of antioxidants to the liver experiencing oxidative stress can slow down the lipid peroxidation process, and increase the amount of glutathione (GSH) by increasing ROS, so that ultimately liver functions such as SGOT and SGPT return to normal levels [11].

Edible flowers are very suitable to grow well in tropical climates like Indonesia, but the problem is that people are not familiar with these plants. Rosella flowers (Hibiscus sabdariffa), butterfly pea flowers (*Clitoria ternatea*) are examples of edible flowers [12]. But people are still not familiar with the processing and benefits of these edible flowers, so it is necessary to disseminate information through articles. This article aims to summarize edible flowers that grow well in Indonesia, especially their use in liver function. Damage to liver function is related to the current human lifestyle, such as a high-fat diet, obesity, drinking alcohol, staying up late and other lifestyles that can affect liver function, such as SGOT and SGPT, so herbal plants are needed to ward off free radicals that come from this bad lifestyle. This article summarizes everything in the title, hepatoprotector edible flowers that grow well in Indonesia.

Research Methods

This research method is based on a modification of previous literature [13], which is based on Google Scholar and PubMed searches for the last 5 years (2024-2020) with keyword searches for herbal plants that grow in Indonesia, and from the search for Indonesian herbal plants, edible flowers were then selected. In the search for edible flowers, those that act as hepatoprotectives were then selected based on Table 1, namely by selecting inclusion criteria and discarding the search for edible flower literature that does not act as a hepatoprotector (exclusion) based on the PICOS Framework.

Table 1. Determination of research literature

Criteria	Inclusion	Exclusion
Population/problem intervention	Liver Function Disorders (SGOT/SGPT)	In addition to liver dysfunction
Intervention	Edible flower plants	Besides edible flower plants
Comparator	-	-
Outcomes	The effect of edible flowers as a Hepatoprotector (natural ingredients that function to protect liver function (SGOT/SGPT)	In addition to hepatoprotector
Study design	Experimental study	Review Articles are excluded
Year	2020-2024	Before 2020 and after 2024
Language	Indonesia, English	Besides Indonesian and English

Results and Discussion

From the search results, edible flowers that act as hepatoprotectors were obtained, namely, Rosella Flowers (*Hibiscus sabdariffa*), Pagoda Flowers (*Clerodendrum paniculatum* L.), Water Hyacinth Flowers (*Eichhornia crassipes*), French Marigold Flowers (*Tagetes patula*) and Butterfly Pea Flowers (*Clitoria ternatea*), which grow abundantly in Indonesia, and are reviewed in the table below.

Table 2. Research Literature Results

No	Researcher	Research Title	Hepatotoxic Agents	Medicinal plants/edible flowers	Target research samples (Humans/Experimental animals)
1	[14]	Pengaruh Ekstrak Bunga Rosella (Hibiscus Sabdariff) Sebagai Hepatoprotektor terhadap Kadar SGPT dan SGOT	Paracetamol is given at a toxic dose of 1500 mg/kg body weight (BW)	The effective dose of Rosella flowers is 500 mg/kg BB and 750 mg/kg BW.	Experimental animal: male rat (Rattus norvegicus)
2	[15]	Hibiscus sabdariffa extract improves hepatic steatosis, partially through IRS-1/Akt and Nrf2 signalling pathways in rats fed a high-fat diet	Paracetamol is given at a dose of 1000 mg/kg BW	The effective dose of Rosella flowers given is 500 mg/kg BW	Experimental animal male rat (Sprague Dawley)
3	[16]	Hepatoprotective and Antioxidant Capacity of Clerodendrum paniculatum Flower Extracts against Carbon Tetrachloride Induced Hepatotoxicity in Rats	Carbon Tetrachloride (CCl_4)	Pagoda flower (Clerodendrum paniculatum L.) with an effective dose of pagoda flower alcohol extract is 400 mg/kg	The experimental animal was a female albino Wistar rat (Rattus norvegicus)
4	[17]	In vitro hepatoprotective activity of Eichhornia Crassipes flowers	Carbon Tetrachloride	Water hyacinth flowers (Eichhornia	In vitro with buffalo mouse liver cell line (BRL3A)

		against CCl_4-induced toxicity in BRL3A cell line	(CCl4) dengan dosis 1% (v/v)	crassipes) with an effective dose of ethanol extract of water hyacinth flowers of 200 µg/mL	
5	[18]	Chemical Composition of Tagetes patula Flowers Essential Oil and Hepato-Therapeutic Effect against Carbon Tetrachloride Induced Toxicity (In-Vivo)	Carbon tetrachloride (CCl4) at a dose of 1.25 mL/kg Body Weight	The effective dose of French Marigold used is 10 mg/kg	Experimental animals: Rats (Wistar albino)
6	[19]	Hepatoprotective Effect of Tagetes Erecta L. Extract on Carbon Tetrachloride-Induced Hepatotoxicity in Rats	Carbon tetrachloride (CCl4) at a dose of 3 mL/kg body weight	French Marigold is used at an effective dose of 400 mg/kgBW.	Experimental animals: Rats (Wistar albino)
7	[20]	Aktivitas hepatoprotektif ekstrak etanol bunga telang *(Clitoria ternatea L.)* pada tikus putih yang diinduksi paracetamol	Paracetamol 150 mg/ 200g BW	Butterfly pea flower 274mg / 200g BB	White mouse test animal
8	[21]	Pengaruh ekstrak bunga telang (Clitoria ternatea L.) terhadap kadar SGOT	Paracetamol 27mg / 200g BB	Butterfly pea flower 500mg / 200g BB	Experimental animals: white rats, Wistar strain

Based on the description of the table above, we can discuss each of the examples of edible flowers.

Rosella Flower (*Hibiscus sabdariffa* L.)

One of the medicinal plants that is efficacious as a hepatoprotector is *Hibiscus sabdariffa* L., [22]. Rosella (Hibiscus sabdariffa L.) is a plant that is easily found in Indonesia because it is included in the category of houseplants. In Indonesia, Rosella is a plant whose flower petals can be processed as traditional medicine. Empirically, Rosella (*Hibiscus sabdariffa*) is efficacious as an antiseptic, diuretic, and sedative. The content of active compounds in rosella functions as a good antioxidant and can reduce free radicals. This is because *Hibiscus sabdariffa* has anthocyanin active substances that have a protective effect on the liver [23]. Anthocyanins have the potential to be hepatoprotective agents that have strong antioxidant effects that are directly useful for stopping the activity of free radicals formed from drug metabolism [24].

Figure 1. Rosella flower (*Hibiscus sabdariffa*)

Previous literature studies showed that Rosella flowers (*Hibiscus sabdariffa*) act as hepatoprotectors. Fifteen *Rattus norvegicus* were divided into 5 treatment groups, namely the negative control group (K-) given 1% distilled water, the positive control group (K+) given Curcumin as a comparison extract, and treatment groups I, II, and III were given Rosella flower extract for 7 days with 250 mg/kgBW, 500 mg/kgBW, and 750 mg/kgBW respectively. Furthermore, Paracetamol (PCT) was injected with a toxic dose of 500 mg/kgBW and 750 mg/kgBW for 3 days. Meanwhile, another study used 35 male Sprague-Dawley rat samples divided into five groups; negative control group (K-) was given a normal diet, positive control group (K+) was given a high-fat diet (HFD), treatment group I was given HFD and Simvastatin 40 mg/kg/day, treatments II and III were given HFD and rosella flower extract 250 mg/kg/day and 500 mg/kg/day respectively. Furthermore, paracetamol was given at a toxic dose for 8 weeks. A PCT dose of 1000 mg/kgBW was able to cause liver damage (hepatoxic) in experimental animals, which was indicated by an increase in the levels of the Serum Glutamate Oxaloacetate Transaminase (SGOT) and Serum Glutamic Pyruvic Transaminase (SGPT) enzymes in experimental animals. In addition to measuring the hepatotoxic effects of PCT, these two studies examined SGOT and SGPT levels to measure the hepatoprotective effect of Rosella flower extract [15].

Previous studies have shown that giving Rosella flower extract at a dose of 500 mg/kg BW and 750 mg/kg BW was significantly effective in reducing SGOT and SGPT levels compared to the untreated group. Meanwhile, the study gave Rosella extract at a dose of 500 mg/kg BW, which can significantly reduce SGOT and SGPT levels. This decrease shows the protective effect of Rosella flowers against liver damage. Rosella flowers can also inhibit the increase in SGPT and SGOT in experimental animals in both studies that have been injected with toxic doses of paracetamol (PCT). The flavonoid, polyphenol, and anthocyanin content in Rosella flowers can increase the activity of antioxidant enzymes (SOD, GPx, and catalase), thereby reducing oxidative stress in liver cells. Rosella extract at a dose of 500 mg/kg BW also showed the best results in reducing SGOT and SGPT, which were comparable to or better than simvastatin as a positive control.

Rosella flower extract is effective as a hepatoprotector by reducing SGOT and SGPT levels, both in models of liver damage due to high-fat diet and paracetamol toxicity [25].

Based on the two studies that have been conducted, it can be concluded that the extract of Rosella flowers (*Hibiscus sabdariffa*) has the potential as a significant hepatoprotector in maintaining liver function, especially by reducing the levels of Serum Glutamic Oxaloacetic Transaminase (SGOT) and Serum Glutamic Pyruvic Transaminase (SGPT) enzymes. This flower extract is also used as an alternative or complementary therapy in preventing and treating liver dysfunction, especially those caused by oxidative stress and inflammation. By paying attention to the doses given, namely 500 mg/kgBW and 750 mg/kgBW, it provides optimal results in reducing liver enzyme levels and increasing antioxidant function [11].

Among other types of edible flowers, the study of rosella flowers (Hibiscus sabdariffa) has been the most widely studied. In addition to research on experimental animals, rosella flowers have been studied in humans. The implications of rosella flowers in the form of tea infusions can significantly lower cholesterol levels in humans [26]. And empirically, rosella flowers are quite well known by the public as medicinal plants compared to other edible flowers

Pagoda Flower (*Clerodendrum paniculatum* L.)

Pagoda flower (*Clerodendrum paniculatum* L.) is usually planted as an ornamental plant in the yard of a house in Indonesia, and grows wild in several areas. Globally, this plant is used as a traditional medicine by the people of India, China, Japan, Korea and Thailand [27].

Figure 2. Pagoda Flower (C. Paniculatum)

Clerodendrum species are known to be able to overcome several diseases, such as antidiabetic, anti-inflammatory, antimalarial and so on. This plant contains flavonoids, phenolics, terpenes, steroids, volatile constituents and so on. Leaves, roots, stems and so on from the *Cleodendrum Paniculatum* L. plant are identified as having several compound activities as anti-inflammatory, antidiabetic, antioxidant and hepatoprotective, but the flowers of this plant have not been studied so that a study was conducted on hepatoprotective activity in Pagoda flowers (*Clerodendrum paniculatum* L.) using experimental animals with CCl_4 induction [28].

Previous literature studies have shown that pagoda flowers (*Clerodendrum paniculatum* L.) act as hepatoprotectors. The results of phytochemical screening of Pagoda flower extracts show that the plant contains protein, carbohydrates, flavonoids, tannins, phenolics and steroids, with the presence of flavonoids and phenolics considered the main indicators of antioxidant activity in the herb [29]. Pagoda flowers (*Clerodendrum paniculatum* L.) act as hepatoprotective agents. The experimental animals in the form of female albino Wistar rats were divided into 5 treatment groups consisting of a negative control group (K-) injected with hepatotoxic carbon tetrachloride (CCL4) and Carboxymethyl Cellulose (CMC) 5 ml/kgBW, a positive control group (K+) injected with carbon tetrachloride (CCl4), treatment group I/standard group was given standard hepatoprotective drugs, namely silymarin 50 mg/kgBW, and treatment groups II and III were given orally ethanol extract of pagoda flowers (*Clerodendrum paniculatum* L.) at a low dose of 200 mg/kgBW and a high dose of 400 mg/kgBW, respectively. The purpose of administering CCL4 is to see liver damage before administering treatment. After being tested for 14 days, all experimental animals were examined by centrifugation at 3000 rpm for analysis of the enzymes SGOT, SGPT, Alkaline Phosphatase (ALP), total and direct bilirubin and total protein content [30].

Based on the results of the study, it was found that the normal control group or group I showed that the enzyme levels of SGOT, SGPT and ALP were within the normal range, indicating healthy liver function. Then for group II, namely the control given CCl4, there was a significant increase in SGOT levels to 145.83 IU / L, then in SGPT to 112.17 IU / L, and in ALP to 324.17 IU / L. The increase indicates liver damage due to CCl4 toxicity. Carbon tetrachloride (CCl4) is a hepatotoxic agent that functions to damage the liver through the mechanism of oxidative stress. In addition, it can induce the accumulation of reactive oxygen radicals (ROS), which worsen and disrupt the balance of redox in the liver [31]. Then, for group III, namely the standard group (Silymarin, 50 mg/kg), there was a significant decrease in liver enzyme levels when compared to the toxic control group, namely SGOT decreased to 66.33 IU/L, SGPT to 109.67 IU/L, and ALP to 109.83 IU/L, indicating the hepatoprotective effect of silymarin. Then group IV CPFA (200 mg/kg) at a low dose using Pagoda flower alcohol extract, there was a significant decrease in liver enzyme levels when compared to the toxic control, namely SGPT decreased to 64.67 IU/L, SGPT to 62.83 IU/L and ALP to 128.50 IU/L, these results indicate fairly good liver function when using this dose. And finally, in Group V CPFA (400 mg/kg) at a high dose of Pagoda flower alcohol extract, SGOT decreased to 59.83 IU/L, SGPT to 58.67 IU/L and ALP to 120.33 IU/L. These results have an optimal hepatoprotective effect.

Water hyacinth flower (*Eichhornia crassipes*)

Water hyacinth (*Eichhornia crassipes*) is a weed in water because of its rapid growth. Because of its rapid growth, eventually, water hyacinth can cover the surface of the water and cause environmental problems. Besides being detrimental, water hyacinth has several benefits, especially as a hepatoprotector. Water hyacinth flowers are light purple (lily) [32]. Water hyacinth (*Eichhornia crassipes*) is a plant that lives floating in water, sometimes rooted in the soil. The height of water hyacinth is around 0.4-0.8 meters. Water hyacinth has no stem, single leaves and oval in shape, the tips and bases are tapered, the base of the leaf stalk is swollen and like cork, the leaf surface is smooth and green. The flowers

are compound flowers with a grain shape, the petals are tube-shaped, and the roots are fibrous roots [33].

Figure 3. Water hyacinth (*Eichhornia crassipes*)

In Bangladesh, the roots and stems are used as a treatment for liver disorders and Pandu or abdominal swelling on the one hand, previous studies have conducted experiments on the hepatoprotective effect of Water hyacinth (*Eichhornia crassipes*) leaves. The hepatoprotective activity of Water hyacinth flowers is not yet known. So, previous studies have revealed that ethanolic extracts of Water hyacinth flowers have quite high antioxidant activity when compared to other extracts tested [17].

Water hyacinth flowers (Eichhornia crassipes) contain compounds such as flavonoids, tannins, alkaloids, saponins, phenolic acids and terpenoids, where one of these compounds plays a role in hepatoprotective activity which is caused by its ability to inhibit lipid peroxidation and can maintain glutathione (GSH) levels in a reduced state, this shows the strong antioxidant properties of ethanol extract of water hyacinth flowers [34].

Three concentrations of EEEC (Ethanol Extract of Water Hyacinth Flowers) were selected in the test, namely 50, 100 and 200 µg/mL based on the previous MTT test, BRL3A liver cells were used which have characteristics similar to normal human liver cells and in vitro testing, the hepatotoxicity induction used was CCl_4 or potassium tetrachloride Where in the experiment CCl4 was added at a concentration of 1% (v/v) to the cell culture medium as a toxicity inducer. In the experiment, several treatments were carried out, such as group I Normal control as cells without treatment, then group II DMSO (0.25%) with the addition of dimethyl sulfoxide media, then group III CCl_4 (1% v/v) namely cells induced with CCl_4 as an induction of liver damage, then group IV CCl_4 + Silymarin (200 µg/mL) Where cells are induced with CCl_4 but treated with Silymarin as a standard hepatoprotector, then group V CCl_4 + EEEC (concentrations of 50,100,200 µg/mL) cells induced by CCl_4 and treated with ethanol extract of water hyacinth flowers. Based on the research results, it was found that the CCl_4 + Ethanol Extract of Water Hyacinth Flowers (EEEC) group (50 µg/mL) was given CCl4 and treated with ethanol extract of water hyacinth flowers (EEEC) where the results of AST, ALT and LDH were found to have an insignificant decrease in enzymes so that the dose provided minimal protection from CCl4 induction [17].

French Marigold Flower (*Tagetes Patula*)

French Marigold (*Tagetes patula*) is a member of the Asteraceae family, widely known for its therapeutic properties. It is often referred to as marigold, and is a garden plant rich in various bioactive compounds, including flavonoids, alkaloids, and essential oils. It is also useful in the medical health world, including dermatology, cosmetics, and phytotherapy, due to its antioxidant, anti-inflammatory, analgesic, and hepatoprotective properties [35].

Geographically, French Marigold (*Tagetes patula*) flowers originate from Central America, especially Mexico, but are now cultivated globally. The distribution and cultivation of this plant is carried out in several countries such as India and Southeast Asia, Africa, Europe and North America and Indonesia [36].

Figure 4. French Marigold (*Tagetes patula*) flower

French Marigold (*Tagetes patula*) has bioactive content that provides benefits for liver protection (hepatoprotective), especially related to the function of liver enzymes such as Serum Glutamic-Oxaloacetic Transaminase (SGOT) and Serum Glutamic-Pyruvic Transaminase (SGPT). Various parts of the French Marigold (Tagetes patula) plant contain phytochemical compounds, including carotenoids, flavonoids, triterpenoids, essential oils (which contain various volatile components, with (E)-β-caryophyllene as the dominant sesquiterpene (24.1%), and thiophene, which is responsible for its antimicrobial, antioxidant, and antiseptic activities [37].

Research conducted used an animal model as an experimental sample, namely 40 albino Wistar rats weighing 180-200 grams, induced hepatotoxicity with Carbon Tetrachloride (CCl_4). These experimental animals were grouped into five groups to receive different treatments. Research conducted used a dose of Carbon Tetrachloride (CCl_4) to induce hepatotoxicity in albino Wistar rats of 1.25 mL/kg body weight. This dose was given intraperitoneally for 15 days to trigger significant liver damage, as indicated by increased liver enzyme levels (SGOT and SGPT) and histopathological changes in the tissue. Next, essential oil from French Marigold flowers (*Tagetes patula*) was given orally at a dose of 5 mg/kg BW and 10 mg/kg BW. The final stage was an evaluation of both groups, through liver enzyme measurements (SGOT, SGPT) and histopathological analysis of liver tissue in mice [38]. Meanwhile, research used a dose of carbon tetrachloride (CCl_4), which was used to induce hepatotoxicity in albino Wistar mice of 3 mL/kg body weight. The next stage, essential oil from French Marigold flowers (*Tagetes patula*) was given orally at an oral dose for 5 days at a dose of 100 mg/kg BW (body weight), 200 mg/kg BW, and 400 mg/kg BW [19].

Based on the results of the experiment, at a dose of 5 mg/kg BW, French Marigold (*Tagetes patula*) essential oil provided a moderate protective effect on the liver. While at a dose of 10 mg/kg BW, the hepatoprotective effect became more significant, with greater recovery in liver function and

histopathological signs. So it can be concluded that the therapeutic effect is seen more significantly at a dose of 10 mg/kg compared to 5 mg/kg. So it is more suitable to give a dose of 10 mg/kg for the restoration of liver function and reduction of histopathological damage in experimental animals. In a study conducted by, a dose of 400 mg/kg BW showed the most significant hepatoprotective effect, equivalent to silymarin at a dose of 25 mg/kg BW. The histopathological results of the two studies showed significant improvements in liver structure and showed good ability to reduce liver damage and decrease SGOT and SGPT by paying attention to the doses given, namely 10 mg/kg and 400 mg/kg BW [38].

This essential oil also shows significant antioxidant ability by reducing Malondialdehyde (MDA) levels, a major indicator of oxidative stress in the liver. This helps protect liver cells from damage that can increase SGOT and SGPT levels [39]. Essential oil from French Marigold (*Tagetes patula*) flowers at a dose of 10 mg/kg and a dose of 400 mg/kg BW can help in the restoration of liver cell structure through anti-inflammatory and regenerative activities. High SGOT and SGPT enzymes due to liver damage can return to normal with the repair of hepatocyte cells. The dominant content in essential oils, such as (E)-β-caryophyllene and limonene, has anti-inflammatory properties. It also helps reduce inflammatory cell infiltration in the liver and prevents the worsening of tissue damage that causes increased SGOT/SGPT [19]. By decreasing the levels of SGOT and SGPT in rats induced by Carbon Tetrachloride (CCl4) 1.25 mL/kg and 3 mL/kg, it causes an increase in liver enzyme activity in response to liver cell damage. So that French Marigold flowers (*Tagetes patula*) at a dose of 10 mg/kg can be an alternative therapy to significantly reduce SGOT and SGPT levels. In the Wistar rat model, the increase in enzymes due to CCl4 was overcome by administering the extract, thereby helping to restore liver function [40].

French Marigold (*Tagetes patula*) flower extract can accelerate the regeneration of damaged liver cells, with several contents, namely: flavonoids, polyphenols, and antioxidant compounds that can fight free radicals that cause liver damage, bioactives such as tannins and alkaloids work as anti-inflammatory agents that reduce inflammation in liver tissue [41]. Based on the results of the study that have been carried out, it can be concluded that the essential oil content of French Marigold (Tagetes patula) has significant hepatoprotective potential, proven to be able to reduce liver enzyme levels SGOT and SGPT, repair liver tissue damage, and reduce oxidative stress. The main content, such as (E)-β-caryophyllene and other antioxidant compounds, supports the recovery of liver function impaired by carbon tetrachloride (CCl4) [41]. This oil also shows safety at certain doses, making it a candidate for natural therapy for liver disorders. French Marigold (*Tagetes patula*) flowers support the potential as a source of natural hepatotherapeutic agents, while opening up opportunities for further research, including its application in humans. However, further research is needed on the formulation of essential oils from French Marigold (*Tagetes patula*) into therapeutic products such as supplements and ensuring their safety and effectiveness in humans [42].

Butterfly pea flower (*Clitoria ternatea*)

Butterfly Pea (*Clitoria ternatea* L.), or Butterfly Pea, is known for its purple, blue, pink, and white petals [43]. This plant belongs to the legume family and can produce green beans. This butterfly pea flower originates from Ternate Island, Maluku, and is now widely found in tropical and subtropical countries, including its distribution to the United States and Africa [44]. Butterfly pea flowers have long been used in traditional medicine to cure various diseases. This plant is suitable for processing into health drinks because it does not have a disturbing odor [45]. Its properties come from chemical content such as terpenoids, flavonoids, tannins, anthocyanins, alcohol and saponins, which have antioxidant, anti-inflammatory, and antimicrobial properties [46].

Figure 5. Butterfly Pea Flower (*Clitoria ternatea*)

Previous literature studies concluded that butterfly pea flowers have shown promising potential as natural hepatoprotective agents through studies examining the effects on SGOT and SGPT levels in rats induced by paracetamol 150mg/200g BW. This plant has high antioxidant activity, especially flavonoid and anthocyanin compounds, which play an important role in protecting liver cells from oxidative damage. Butterfly pea flower extract was tested on rats grouped into 6 groups, each consisting of 5 rats, for 7 days with various doses as hepatoprotective. This study concluded that the most optimal dose of 247 mg/200 g BW effectively reduced SGPT and SGOT enzyme levels, respectively, to 54.00 ± 3.46 U/L and 121.40 ± 10.31 U/L, lower than the negative control. Another literature study explains [47] with the same inducer, namely paracetamol, using 28 male Wistar rats divided into 4 groups: negative control, positive control paracetamol induction, control treatment 1 consisting of paracetamol + pea flower 250mg / 200g BB and control treatment 2 consisting of paracetamol + pea flower 500mg / 200g BB, which were given oral treatment. The results of the study showed that the administration of paracetamol succeeded in significantly increasing SGOT levels (77.82 ± 0.96 U/L) compared to the normal group (36.76 ± 0.86 U/L). Administration of pea flower extract has been shown to be able to reduce SGOT levels, with the best results at a dose of 500 mg / 200g BB, which reached levels of 400.16 ± 0.87 U/L approaching normal [47]. This effect is associated with the flavonoid content in butterfly pea flowers, which acts as an antioxidant [48]. So it can be concluded that the ethanol extract of butterfly pea flowers can prevent liver damage because it contains secondary flavonoids and anthocyanin metabolites that can provide electrons to stabilise free radicals that cause liver damage. In addition, secondary flavonoid metabolites can interfere with oxidation reactions in cells and protect

cells against oxidative stress and increase the body's endogenous antioxidants, so that it can reduce the possibility of liver damage [49].

There are 5 edible flowers reviewed, namely Rosella Flower (Hibiscus sabdariffa L), Pagoda Flower (*Clerodendrum paniculatum* L.), Water hyacinth flower (Eichhornia crassipes), French Marigold Flower (Tagetes Patula) and Butterfly pea flower (Clitoria ternatea), and they contain various phytochemical compounds that act as antihepatoprotectors, namely flavonoids, anthocyanins, tannins, alkaloids, saponins, terpenoids, phenolic acids and carotenoids. Among the various phytochemical compounds, flavonoids are found in all edible flowers. Flavonoids are often found in phytochemical tests of natural materials before the natural materials are tested in vivo or in vitro. Flavonoids are among the most frequently found in natural materials, both in the roots, leaves, and flower petals, including in this edible flower. Flavonoid compounds act as phytomedicines, including as antihypercholesterolemic agents [50], antibacterial [51], anti-inflammatory [52], anti-diabetic and hepatoprotector [53].

In its role as an antihepatoprotector, flavonoids act as exogenous antioxidants that indirectly play a role in changing the toxic metabolic compound N-acetyl-p-benzoquinoneimine (NAPQI) produced by high doses of paracetamol. Paracetamol in standard doses can be analgesic, but if in high doses, it will form the compound N-acetyl-p-benzoquinoneimine (NAPQI), which is very toxic and reactive to hepatocyte damage. Flavonoids work by inducing an increase in the endogenous antioxidant glutathione, which then glutathione will converts N-acetyl-p-benzoquinoneimine (NAPQI) into Cysteine and mercapturic acid, which are non-toxic and immediately excreted from the liver to the kidneys to be secreted in the urine [54].

The results table shows that of the 8 journals of toxic agents used to increase liver damage, 4 journals used paracetamol and 4 other journals used Carbon Tetrachloride (CCl_4). Both CCL4 and high doses of paracetamol can induce cytochrome P450 (CYP 450) in producing toxic compounds such as *N-acetyl-p-benzoquinoneimine* (NAPQI) in paracetamol and *Trichloromethyl* (CCL3 •) in CCL4, both of which are reactive to hepatocyte cell damage characterized by increased transaminase enzymes such as *Serum Glutamic Oxaloacetic Transaminase* (SGOT) and *Serum Glutamic Pyruvic Transaminase* (SGPT) [55]. This is in accordance with all journals using SGOT and SGPT parameters in measuring liver function parameters, both after induction of toxic agents (CCL4 and high doses of paracetamol), as well as measuring levels after administration of edible flowers. This is because the SGOT and SGPT enzymes are enzymes produced by hepatocytes, so their presence and levels in the blood can be used as biomarkers in assessing liver function [56].

The results table also shows that out of 8 journals, there are 2 edible flower journals originating from Rosella Flower (*Hibiscus sabdariffa* L) and 2 journals originating from Butterfly pea flower (*Clitoria ternatea*). Both rosella flowers and butterfly pea flowers are edible flowers that are quite familiar to the Indonesian people. These two flowers are the most frequently studied edible flowers besides hepatoprotective research, such as the ability of butterfly pea flowers to lower cholesterol levels in experimental animals [57], or an antihyperglycemic from rosella tea flowers [58]. In addition to animal studies, these two edible flowers have even been studied in humans, such as lowering blood pressure in people with hypertension using either a butterfly pea flower tea infusion [59], or a rosella flower tea [60]. So it can be concluded that these two flowers are one step ahead, both in pre-clinical trials on experimental animals and clinical trials on humans, compared to other edible flowers. This is also supported by the commercialization of rosella and telang flower tea packaging products compared to other edible flowers. However, this review does not deny that other edible flowers such as pagoda Flower (*Clerodendrum paniculatum* L.), marigold flower (*Tagetes patula*) and Water hyacinth flower (*Eichhornia crassipes*) have the same potential or even as good as rosella and telang flowers. However, for now, these two flowers are not as familiar as studies on rosella and telang flowers, thus opening up opportunities for researchers to explore as many studies as possible related to edible flowers such as pagoda, Water hyacinth flowers and marigold flowers.

Conclusion

The conclusion of this article is that edible flowers that grow well in Indonesia and act as hepatoprotectors are: Rosella flowers (*Hibiscus Sabdariffa*), Pagoda flowers (*Clerodendrum paniculatum* L.), Water hyacinth flowers (*Eichhornia crassipes*), French marigold flowers (*Tagetes Patula*) and Butterfly pea flowers (*Clitoria ternatea*) and the most familiar are rosella flowers and butterfly pea flowers. The purpose of this literature is to serve as a reference for safe edible flowers based on hepatotoxicity tests, so that they are safe for consumption. Suggestions for further literature review are literature reviews on edible flowers related to other phytomedicines such as antihypercholesterolemic, antihypertensive, antibacterial, antihyperglycemic, analgesic and others.

Author's Contribution

I Nyoman Bagus Aji Kresnapati: wrote the paper; Salsabila Yunita Kurniawan: collected the data; Novitarini: conceived and designed the analysis; Baiq Yulia Hasni Pratiwi: contributed data or analysis tools

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