

LITERATURE REVIEW: PHARMACOLOGICAL AND TOXICOLOGICAL EFFECTS OF PLANTS FROM THE SOLANACEAE FAMILY

Author:

*Dewi Damayanti Abdul Karim¹, Wina Safutri², Akmal Hammami¹
Ananda Ayu Chandra²*

¹*Institut Teknologi Sumatera; Jl. Terusan Ryacudu, Way Huwi, Kec. Jati Agung, Kabupaten Lampung Selatan, Lampung, Indonesia, Telp/Fax. 35365*

²*Universitas Aisyah Pringsewu; Jl. A. Yani, Tambahrejo, Kec. Gadingrejo, Kabupaten Pringsewu, Lampung, Telp/Fax. (0729) 7081587*

Corresponding Email: dewi.abdul@fa.itera.ac.id

About the Author

1. 1st Author : (Dewi Damayanti Abdul Karim, M.s.Farm)
Affiliation : (Institut Teknologi Sumatera).
Mailing address : (Jl. Terusan Ryacudu, Way Huwi, Kec. Jati Agung, Kabupaten Lampung Selatan, Lampung)
Email of author : (dewi.abdul@fa.itera.ac.id)
Orcid ID : <https://orcid.org/0000-0002-1624-3168>
Google Scholar URL : <https://scholar.google.com/citations?user=sEHTqi0AAAAJ&hl=id&oi=ao>
Phone number : +62 852-9994-4521
2. 2nd Author : (Wina Safutri, M.Biomed)
Affiliation : (Universitas Aisyah Pringsewu).
Mailing address : (Jl.A. Yani 1A Tambahrejo Pringsewu-Lampung 35372)
Email of author : (WinaFarmasiUAP@gmail.com)
Orcid ID : <https://orcid.org/0000-0002-4393-7077>
Google Scholar URL : <https://scholar.google.com/citations?user=7-dIDyMAAAAJ&hl=id&oi=ao>
Phone number : +62 821-7561-9881
3. 3rd Author : (Akmal Hammami)
Affiliation : (Institut Teknologi Sumatera).
Mailing address : (Jl. Terusan Ryacudu, Way Huwi, Kec. Jati Agung, Kabupaten Lampung Selatan, Lampung)
Email of author : (akmal.121260075@student.itera.ac.id)
Orcid ID : -
Google Scholar URL : -
Phone number : +62 813-6735-6550
4. 4th Author : (Ananda Ayu Chandra)
Affiliation : (Universitas Aisyah Pringsewu).
Mailing address : (Jl.A. Yani 1A Tambahrejo Pringsewu-Lampung 35372)
Email of author : (Anandaayu908@gmail.com)
Orcid ID : -
Google Scholar URL : -
Phone number : +62 895-3647-04726

ABSTRACT

Solanaceae is a family of flowering plants with 83 genera and 2,925 species spread throughout the world. People reuse natural medicines that have been passed down from generation to generation because medical medicines have a big tendency to cause many side effects. This research aims to examine the pharmacological effects and toxicity of plants in the Solanaceae family. This research used 10 plant species, including potatoes (*Solanum tuberosum* L.), golden berries (*Physalis angulata* L.), tomatoes (*Solanum lycopersicum* L.), red chilies (*Capsicum annuum* L.), cayenne peppers (*Capsicum frutescens* L.), tobacco (*Nicotiana tabacum* L.), paprika (*Capsicum annuum* var. *grossum*), amethyst (*Datura stramonium* L.), Turkey berry (*Solanum torvum* Sw.), and black nightshades (*Solanum nigrum* L.). The journal search method used in this research is the Boolean System method (AND and OR) using the Google Scholar and Sinta databases. The results obtained from this research were that among the 10 plant species of the Solanaceae family studied, there were 3 pharmacological effects with the most data modes, including antimicrobial, anti-inflammatory, and anti-oxidant effects.

Keywords: pharmacology, toxicology, solanaceae, medicine, dosage

ABSTRAK

Solanaceae termasuk salah satu suku tumbuhan berbunga yang teridentifikasi sebanyak 83 genus dan 2.925 spesies yang tersebar di seluruh dunia. Masyarakat menggunakan kembali obat-obatan alami yang telah diwariskan secara turun temurun disebabkan obat-obatan medis memiliki kecenderungan yang besar untuk menimbulkan efek samping yang banyak. Tujuan penelitian ini untuk mengkaji bagaimana efek farmakologi dan toksisitas dari tumbuhan famili Solanaceae. Penelitian ini menggunakan 10 spesies tumbuhan, antara lain kentang (*Solanum tuberosum* L.), ciplukan (*Physalis angulata* L.), tomat (*Solanum lycopersicum* L.), cabai merah (*Capsicum annuum* L.), cabai rawit (*Capsicum frutescens* L.), tembakau (*Nicotiana tabacum* L.), paprika (*Capsicum annuum* var. *grossum*), kecubung (*Datura stramonium* L.), takokak (*Solanum torvum* Sw.), dan leunca (*Solanum nigrum* L.). Metode pencarian jurnal yang digunakan dalam penelitian ini yaitu metode Sistem Boolean (AND dan OR) dengan menggunakan *database* Google Scholar, dan Sinta. Hasil yang diperoleh dari penelitian ini yaitu di antara 10 spesies tumbuhan famili Solanaceae yang diteliti, terdapat 3 efek farmakologi dengan modus data terbanyak, di antaranya efek antimikroba, antiinflamasi, dan antioksidan.

Kata Kunci: farmakologi, toksikologi, solanaceae, obat, dosis

INTRODUCTION

Indonesia is a country that has very abundant natural resources spread throughout its territory. In 2017, data from National Geographic Indonesia showed that there were around 31,750 types of plants that had been identified, including flowering plants, 15,000 plants of which had great potential to be used as medicines. However, only approximately 7,000 species were used as raw materials for making herbal medicines (Setiawan, 2022). Among the many plant species found in Indonesia, the Solanaceae family has become one of the most important plant families in terms of meeting human needs (Krisnawati 2019).

Solanaceae is a family of flowering plants with 83 genera and 2,925 species spread throughout the world (Dewi, 2015). Production of Solanaceae family plants in Indonesia is quite high. Statistical data on the production of these plants from 2014 to 2016 was recorded in the range of 500 thousand tones to 1 million tones per year; however, this has not been able to meet the needs of the Indonesian population and international market demand (Wulandari, 2019). This family is not only used as food for vegetables and fruit but is also often used as an ornamental plant, narcotic, anesthetic, and even as a raw material for medicine.

In Indonesia, ISPA and diarrhea are among the diseases that people often suffer from, especially children under five (Prasetyo, 2017). Meanwhile, information from various literature states that the majority of people suffer from hypertension, with a prevalence of 6-15% (Susanto, 2022), followed by the prevalence of cancer (1.8%), stroke (10.9%), chronic kidney disease (

3.8%), and diabetes mellitus (8.5%) in 2018 (Asmin, 2021). According to information (Azzikri, 2020), several medicinal plants from the Solanaceae family, such as cayenne peppers, golden berries, eggplant, and black nightshades, are often used by the community as natural medicinal ingredients to treat various diseases, such as stomach aches, asthma, hypertension, anemia medicine, or eye medicine. At this time, there is great hope among the public in reusing natural medicines that have been passed down from generation to generation by their ancestors due to the current price of medical medicines, which has a large tendency to cause side effects resulting from the use of chemical compounds in them (Kuntorini, 2005). Therefore, this research was carried out with the aim of examining the pharmacological effects and toxicity of plants from the Solanaceae family.

RESEARCH METHODOLOGY

Research Design

This study used a descriptive research design to determine the pharmacological effects and toxicity of plants from the Solanaceae family. The data in this research are the results of a literature review of related research primary data using the Boolean System method, which is then analyzed descriptively, namely exploring the data obtained and then providing a way to understand and interpret it.

Literature Search Strategy

The literature search in this research used the Boolean System method (AND and OR). This method is used to specify articles or literature, making it easier to determine which papers to use.

Search Database

A literature review comprehensively summarizes several specific studies based on a particular topic. The literature search was carried out in July 2023. The data used in this research is primary data obtained not from direct observation but rather from the results of studies conducted by previous researchers. The primary data source can be a nationally recognized journal article on a specified topic. This literature review search used databases, namely Google Scholar and Sinta.

Keywords

Searching for articles or literature using predetermined keywords serves to specify the search, making it easier to determine the articles or literature you want to use. The keywords used in preparing this literature review are as follows:

Data Source	Keywords
Sinta	(Potatoes) OR (<i>Toxicity</i>)
Google Scholar	(Red Chillis) AND (Effectivity)

Inclusion Criteria

The literature sources used must meet the following criteria: (1) Journals must be original articles published in the last 20 years, namely 2003 to 2023; (2) Articles in English or Indonesian; (3) Articles related to phytochemical, preclinical and clinical screening tests of Solanaceae; (4) Articles evaluating the toxicity effects of Solanaceae; (5) Scopus, WoS, Sinta accredited articles; (6) Articles can be accessed free full text.

Exclusion Criteria

The literature sources used must meet the following exclusion criteria: (1) Journals in the form of *Review Articles* or *Systematic Reviews*; (2) The related article is not from an accredited journal.

Data Extraction

The data used in this research is primary data. Primary data is data obtained from the results of the study conducted by previous researchers. Primary data sources are original articles and reports (Maharani, 2019).

Research Flow

A literature search was carried out using the Boolean system in databases, namely Sinta and Google Scholar. The results of the literature search carried out on two databases, namely Sinta, were 50 articles, and Google Scholar was 233 articles, so the results of the search for articles from the two databases were 283 articles. Furthermore, screening was carried out from the two databases; it was found that 25 articles did not meet the inclusion criteria, so 258 articles were obtained. Then, the articles that did not match the title and abstract were 0 articles or none, so we got 258 articles. Next, screening was carried out, and 13 articles were found that were not full text, resulting in complete articles deemed suitable for use, namely 245 pieces that would be used for *the literature review*.

DISCUSSION

Based on the results of literature review research, Solanaceae family plants have several pharmacological effects, including anti-inflammatory, antimicrobial, insecticidal, anthelmintic, cardioprotective, anti-influenza, anti-aging, antispasmodic, anti-oxidant, anesthetic, anti-diabetic, anti-diarrheal, antiulcerogenic, anti-cancer, oral anti mucositis, antimalarial, analgesic, antibiofilm, immunomodulatory, and neuroprotective. Meanwhile, toxicity tests on Solanaceae family plants were carried out *in vitro* and *in vivo*. Toxicity tests are carried out to determine toxic effects on plants and to determine the safety limits of compounds found in plants, especially the Solanaceae family.

Anti-inflammatory

In the potato peel extract solution, the analgesic and anti-inflammatory pharmacological effects produced are due to the presence of secondary metabolites in the form of flavonoids. The flavonoid content in potatoes can inhibit COX and LOX activity and inhibit the synthesis of prostaglandins and leukotrienes, mediators of pain and inflammation. The best pharmacological effect was obtained from potato peel extract at a dose of 100 mg/kg and 200 mg/kg using male

Wistar rats as test animals, and this was due to its ability to reduce pain for longer.

In Turkey berry plants, it is known that the ethanol extract of its seeds contains several main compounds, including palmitic acid, phytol, and 4,4,5,8-*Tetramethylchroman-2-ol*. Based on research results (Khatoun, 2015), these compounds have potential activity as anti-inflammatory agents.

Then, anti-inflammatory activity can also be known from the fruit of the black nightshades. Based on information from literature studies, research on the thick methanol extract of black nightshades shows that there is inhibition of edema formation in albino Wistar rats, which is induced by carrageenan. Based on all the different dose treatments on test animals (125, 250, 375 mg/kgBW of methanol extract), the inhibition results were respectively 17.08%, 13.09%, and 23.45%, with a dose of 375 mg/kgBW being the largest inhibition percentage. The anti-inflammatory effect produced by the thick methanol extract of black nightshades is caused by the presence of flavonoid compounds contained in it (Ravi, 2009).

Antimicrobial

Pharmacological activities for antimicrobials in Solanaceae family plants include anti-bacterial and antifungal. Potato skin extract contains several phenolic compounds, chlorogenic acid, and gallic acid. Chlorogenic acid has anti-bacterial properties by increasing the permeability of the outer membrane and plasma membrane. One causes cytoplasmic leakage of encapsulated nucleotides and participates in fatty acid synthesis by inhibiting enzymes bound to fatty acids. Gallic acid is a benzoic acid derivative with three hydroxyl groups. Phenolic compounds can interfere with the production of the extracellular saccharide (EPS) layer, which functions in maintaining the integrity of the biofilm. Therefore, phenolic compounds have an inhibitory effect on biofilm formation (Chaieb, 2011). There was antibiofilm formation activity at concentrations of 5%, 10%, and 20%; the highest activity was found at a concentration of 20% potato peel extract.

Red chilies have anti-oxidant and anti-bacterial properties (Al-Snafi, 2015). Because it has an anti-bacterial effect, red chilies are used by farmers to eradicate various diseases by using a dose of 4014-6022 mg/kg for the thick fruit extract.

In tobacco leaves, the anti-bacterial activity is due to the presence of alkaloids, tannins, terpenoids, flavonoids, and phenolic compounds, which, according to research, have been proven to have antimicrobial activity (Jaberian, 2013). Apart from that, according to various studies, the main secondary metabolite compounds, namely glycoalkaloids, in tobacco leaves also have antifungal activity (Osterikova, 2022). Based on research information from (Sastya, 2017), tobacco leaf extract made with concentrations of 0.156%, 0.312%, 0.625%, 1.25%, 2.5%, 5%, and 10% was tested on adult *Haemonchus contortus* and The highest mortality was obtained at 100% at a concentration of 0.625-10%.

Antimicrobial activity is also known to be present in liquid extracts from Angel's Trumpet bark. Based on research on antimicrobial activity on the bacteria *Salmonella typhi*, *Escherichia coli*, *Staphylococcus aureus*, *Neisseria gonorrhoea*, *Shigella sp.*, and *Klebsiella pneumonia*, Angel's Trumpet bark extract is quite effective in treating pathogenic microorganisms involved in several diseases. Ethanol extract from amethyst bark is known to have the greatest inhibitory power against *K. pneumonia*, namely 13.0 mm, followed by *S. aureus* with activity of 12.0 mm, and *S. typhi* is known to have the smallest inhibitory ability, namely 5.0 mm. Liquid extract from Angel's Trumpet bark shows anti-bacterial activity against *S. aureus*, namely 10 mm, while *N. gonorrhoea* is known to have resistance to both extracts (Shagal, 2012). It is due to the content of saponins, steroids, alkaloids, flavonoids, and glycosides found in amethyst bark. Based on information from research (Bellila, 2011), Angel's Trumpet fruit extract with a minimum bactericidal concentration (MBC) of 25 gr/ml can inhibit *E. coli* bacterial strains.

Then, in the ethanol extract of paprika, anti-bacterial activity was found, as shown by the MIC value against *Enterococcus faecalis* bacteria at a concentration of 9%; no bacterial growth was found (Syafriana, 2019). It occurs because there are various active compounds contained in the

ethanol extract of paprika, including alkaloids, flavonoids, terpenoids, and steroids, which have mechanisms as anti-bacterial agents.

The dry extract of Turkey berries is known to have anti-bacterial activity, which is known from the methanol extract indicating the presence of alkaloids, flavonoids, tannins, and glycosides, which according to studies of methanol extract from its fruit is able to inhibit various bacteria, such as *Actinomyces spyogenes*, *Bacillus subtilis*, *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Salmonella Typhimurium*, *Staphylococcus aureus*, *Streptococcus pyogenes*. The minimum concentration used to inhibit bacterial and fungal activity is 0.3125 mg/ml and 1.25 mg/ml (Yousafa, 2013). The antimicrobial activity found in Turkey berries is caused by the presence of tannin compounds, which can cause toxic effects and bioactivity on *Artemia* sp shrimp larvae. Based on information from research (Alfarabi, 2018), Turkey berries extract with an LC50 value of 248 ppm and an LC50 value of 129 ppm for its stem extract caused 50% mortality in *Artemia* sp shrimp larvae.

Insecticidal

It is known that insecticidal activity can be obtained from the thick extract of angel's trumpet leaves, which is known based on phytochemical screening to contain alkaloids, saponins, flavonoids, and polyphenols. This activity is indicated by the mortality that occurs in *A. miliaris* larvae and imago, a decrease in the feeding volume of larvae and imago, a reduction in fecundity, and an increasingly long pre-reproductive period for it. The effect of insecticidal activity becomes stronger as the concentration of the thick amethyst leaf extract given increases. Based on information from research (Idris, 2015), concentrations of amethyst leaf extract (250, 500, 750, 1000, 1500, 2000, 2500, and 3500 ppm) show insecticidal activity against *A. miliaris* with the highest effectiveness at a concentration of 3500 ppm with The mortality rate for instar larvae ranges from 28.46-39.51% in contact applications, while in non-contact applications the mortality rate ranges from 26.66-37.84%.

Next, there is the acaricidal type of insecticidal activity in cayenne pepper fruit extract. In the methanol extract of cayenne pepper fruit, the treatment given to the cattle tick *Rhipicephalus (Boophilus) microplus* resulted in a death concentration of LC50 617.54 ppm and LC90 1040.41 ppm. In the cayenne pepper extract using petroleum ether, the death concentration LC50 was 2507.86 ppm and LC90 7493.0 ppm; meanwhile, in the cayenne pepper fruit extract using n-hexane the LC50 concentration was 2194.93 ppm and LC90 5972.22 ppm. One is because significant acaricidal activity was found in the fruit of the cayenne pepper plant, so extracts from the fruit can cause death in test animals, namely livestock ticks (Kishore, 2021).

Antihelminthic

Antihelminthic testing on tobacco leaves was carried out by inhibiting worm motility as a criterion for antihelminthic activity. Based on information from research (Nouri, 2014), concentrations of tobacco leaf extract (25, 50, and 75 mg/ml) showed significant antihelminthic activity at concentrations of 75 mg/ml liquid extract, 25 mg/ml ethanol extract, 50 mg/ml ethanol extract, and 75 mg/ml ethanol extract. In this case, 50 mg/ml ethanol extract showed almost the same dose effect as Levamisole 500. The mortality of *M. marshalli* worms demonstrated the antihelminthic activity of tobacco leaves after 8 hours.

Then, the thick ethanol extract from Turkey berries has antihelminthic activity, which causes mortality in adult *Ascaris suum* worms. Based on the results of research that has been carried out (Candra, 2019), 5 kg samples of Turkey berries were used, and then ethanol extract was made with five concentrations, namely 300 ppm, 600 ppm, 900 ppm, 1200 ppm, and albendazole was used as a positive control. Results at the 24th hour with a death rate of 33.4% of worms at the largest concentration, namely 1500 ppm. Based on probit analysis, a concentration of Turkey berries ethanol extract required of 1457,780 ppm within 45 hours to kill 90% of adult *Ascaris suum* worms

and a concentration of 2210,989 ppm within 45 hours to kill 99% of adult *Ascaris suum* worms at the LC90 value. Mortality of adult *Ascaris suum* worms will increase with increasing concentration of the extract given, and this is due to the presence of flavonoids, saponins, and alkaloids, which have been identified qualitatively.

Cardioprotective

The cardioprotective activity was demonstrated by the ethanol extract of paprika in male albino Wistar rats, which had previously been induced with doxorubicin. Cardioprotective effect testing was carried out on 5 treatment groups consisting of the normal group (aquades), namely 5 ml/kg B.W. orally, the group induced by doxorubicin to experience cardiotoxicity, namely with a dose of 2.5mg/kg B.W. i.p., the group generated by doxorubicin who were given ethanol extract of paprika as much as 200 mg/kg B.W. i.p., the doxorubicin-induced group was assigned ethanol extract of paprika fruit as much as 400 mg/kgBW i.p., and the doxorubicin-induced group was given ethanol extract of paprika fruit as much as 600 mg/kgBW i.p. It is characterized by an increase in systolic and diastolic B.P., a decrease in Q.T. prolongation, a reduction of p-wave duration, QRS complex duration, and a drop in ST-segment elevation (Pawar, 2023).

Anti-influenza

Anti-influenza activity can be demonstrated by the compound quinic acid, which is one of the main compounds in the seeds of the takokak plant. This compound is commonly used in the synthesis of anti-influenza or anti-swine flu agents (Zanello, 2015). Testing for anti-influenza activity was proven by data on the results of a 50% concentration of the two quinic acid derivative samples tested, which were able to fight dengue virus infection. Tests on the first sample obtained IC50, namely 6.9 ± 3.6 , 10.4 ± 3.9 , 10.3 ± 3.1 , and 9.23 ± 3.7 μM . Meanwhile, for the second derivative sample, the values obtained were 6.5 ± 0.2 , 8.7 ± 2.3 , 10.3 ± 3.8 , and 10.8 ± 1.7 μM .

Anti-aging

Apart from being used as a synthetic ingredient for anti-influenza agents, the quinic acid compound contained in Turkey berries seeds can also be used for anti-aging effects (Khatoon, 2015). Based on (Ersoy, 2019), the concentration of the quinic acid compound, which can be an anti-aging candidate in cosmeceutical preparations, is 885.50 ± 0.073 $\mu\text{g/g}$. One is due to the significant tyrosinase inhibitory effect of quinic acid, which can provide many advantages in the development of skincare products.

Antispasmodic

The antispasmodic effect of the thick extract of tobacco leaves is indicated by the ganglion stimulant effect caused by the nicotine content in the plant. In the nematode body, it is known that the muscle structure is in the form of *excitatory neuromuscular junctions containing ganglion-type nicotinic receptors* with acetylcholine (ACh) as the neurotransmitter. One tends to activate neuromuscular gaps in the nematode muscles, which will result in spastic paralysis, and the worm will die, and it will be thrown away from its host. Then, based on research that has been conducted (Nouri, 2014), it is stated that the most effective dose in producing antispasmodic activity in adult *M. marshalli* worms is 75 mg/ml for the thick alcoholic extract of tobacco leaves.

Anti-oxidant

Based on information from literary sources, consuming tomatoes can reduce the risk of developing chronic diseases and is rich in anti-oxidants; this is due to the content of lycopene,

flavonoids, and bioactive carotenoids. Tomato can prevent illness through detoxification, increase the body's immunity, and increase red blood cells and white blood cells (Junnaeni, 2019). One is proven by previous research conducted by (Junnaeni, 2019), which stated that the effect of giving tomato extract on GSH levels decreased with treatment of 1 mg/200gr BB and 1.5 mg/200grBB tomato extract on male Wistar rats, but this did not produce a significant difference in the GSH levels of test animals.

The anti-oxidant activity shown by the ethanol extract of paprika is caused by the presence of flavonoids, polyphenols, carotenoids, β -carotene, capsanthin, capsorubin, cryptocapsin, and quercetin, which are compounds that are very effective in warding off free radicals. It was shown by an increase in the levels of SOD, GSH, and CAT in the group treated with ethanol extract of paprika, and this is one of the *anti-oxidant markers* for paprika (Pawar, 2023). In this study, it can be concluded that ethanol extract of paprika at doses of 200, 400, and 600 mg/kgBW of male Wistar albino rats can reduce levels of *malondialdehyde* (MDA), increase levels of *blood catalase activity* (CAT), *superoxide dismutase* (SOD), and *glutathione* (GSH) levels in the bodies of mice (Pawar, 2023). This profile level has a role as an anti-oxidant substance and anti-oxidant enzyme that defends the body against oxidative stress attacks caused by tissue damage.

In the leaves, the Turkey berries have several compounds that can act as anti-oxidant agents, including phenolic compounds, flavonoids, and saponins. Based on information from the literature, ethanol extract from Turkey berries leaves has anti-oxidant activity with an IC_{50} value of 49.824 mg/L (Julfitriyani, 2016).

Anesthesia

In this case, there are two groups of plants from the Solanaceae family that have an anesthetic effect, including thick extract of tobacco leaves and liquid extract of angel's trumpet seeds. Thick extracts of tobacco leaves have been proven to have an anesthetic effect on *M. marshalli*, which in liquid extracts and thick ethanol extracts from tobacco leaves causes spastic paralysis in *M. marshalli* worms (Nouri, 2014). Tests carried out with three different doses, namely 25, 50, and 75 mg/ml, resulted in the highest potential for causing paralysis in test animals at the highest concentration, namely 75 mg/ml.

In the liquid extract of angels' trumpet seeds, the anesthetic effect that occurs in male Kintamani dogs is caused by the main compound content of amethyst seeds, namely tropane alkaloids (hyoscyamine and scopolamine). Based on information from the literature, the effect of general anesthesia on male Kintamani dogs given a combination of ethanol extract of angel's trumpet seeds 20 mg/kgBW + 1 mg/kg xylazine produced the longest general anesthesia effect, namely 50.01 ± 0.02 minutes (Sukariada, 2016).

Anti-diabetic

The anti-diabetic activity shown by the thick ethanol extract of Turkey berry is based on research conducted on streptozocin-induced Sprague-Dawley rat test animals, characterized by a decrease in blood glucose levels, followed by a reduction in serum T.C., T.G., LDL, and VLDL, while HDL increased. (Satyanarayana, 2022). Based on the study results, this can occur due to the presence of flavonoids, steroids, terpenoids, and phenolic compounds, which are responsible for anti-diabetic activity. Treatment of test animals induced streptozotocin i.p. Given doses varying from 120, 160, and 200 mg/kgBW of thick ethanol extract of Turkey berry, the most potent dose was 200 mg/kg in reducing blood glucose levels in test animals (Satyanarayana, 2022).

Antidiarrhoeal

The thick extract of Turkey berry is known to have anti-diarrheal pharmacological effects. It is due to the presence of tannin compounds, which are responsible for the anti-diarrheal activity of

Swiss Webster mice induced by castor oil (*Oleum ricini*). The effect of the thick extract of Turkey berry is known to have an effective dose as an anti-diarrheal, namely 25 mg/kgBW calculated based on the average weight of mouse feces (Nadjamuddin, 2022).

Antiulcerogenic

Methanol extract and liquid extract from Turkey berry leaves have been proven to have antiulcerogenic activity due to the presence of phenolic compounds as the main compounds in it. One is characterized by the occurrence of ulceration inhibition induced by HCl/ethanol, indomethacin, pyloric ligation, and stress in the liquid extract, namely with percentages of 96.55%, 96.86%, 98.63%, and 98.63%. In contrast, methanol extract, at a dose of 750 mg/kg, can produce inhibition percentages of 98.12%, 99.16%, 98.70%, and 96.03%. The fraction containing flavonoids and triterpenes is the most active in inhibiting ulcer formation, with a percentage of 84.74% (Yousafa, 2013).

Anti-cancer

Turkey berries are known to contain alkaloids, saponins, and tannins in their stems. Based on the phytochemical identification of Turkey berries stem extract carried out (Alfarabi, 2018), the results of phytochemical testing on the liquid extract of Turkey berries stem showed the presence of alkaloid, saponin, and tannin compounds which have potential as phytopharmaceutical anti-cancer agents. Tests were carried out at varying concentrations of 150, 200, 300, and 400 ppm on *Artemia sp* shrimp larvae. It is known to be a source of anti-cancer phytopharmaca. One is due to the presence of quinine, quinidine, and synconine compounds, which have anti-cancer bioactivity (Alfarabi, 2018).

Oral anti-mucositis

Based on information from literature studies, research on black nightshade leaves shows the presence of alkaloids, saponins, tannins, flavonoids, steroids, phenols, and anthraquinones from the results of phytochemical analysis. Studies state that these compounds have potential in the treatment of mucositis. It is proven by the protective effect of oral mucositis against chemo-radiation and methotrexate-induced oral mucositis (Patel, 2014). The treatment of test animals given doses of 100 and 200 mg/kgBB liquid black nightshade leaf extract affected the data values for the number of leukocytes (WBC), erythrocytes (RBC), and platelets (PLT). At a dose of 100 mg/kgBW, it did not produce a significant treatment effect on OMS (Oral Mucositis Score). Meanwhile, an amount of 200 mg/kgBW showed a considerable difference compared to the first treatment dose, with a decrease in the OMS value in the test animals.

Antimalarial

In the leaves of the black nightshade plants, the results of phytochemical screening showed the presence of phenolic compounds, flavonoids, glycosides, alkaloids, saponins, steroids, tannins, and terpenoids in the hydromethanol extract. Based on literature information, research shows that there is antimalarial chemoprophylactic activity against *Plasmodium berghei* parasite infections in female Swiss albino mice with percentages for the crude extract of 30.73%, 42.91%, and 51.70%, the chloroform fraction of 42.70%, 51.84%, and 67.17%, as well as for the fraction ethyl acetate 42.70%, 53.11%, and 71.03%, at doses of 100, 200, and 400 mg/kg respectively, in which case the treatment group with a dose of 400 mg/kg of the ethyl acetate fraction showed a maximum suppression of 71.03 % against parasitemia (Birru, 2022).

Analgesic

Pain is described as the body's defense mechanism against danger, which will cause the individual to react to avoid (reflex) and stop. Pain can be felt with various stimuli, such as temperature, chemical, or mechanical. As in research conducted by (Wahyudi, 2020), the form of stimulation used is temperature, which functions to stimulate the pain receptor center (Nociceptor), which produces pain mediators through the cyclooxygenase pathway. (COX) and lipoxygenase (LOX), by inhibiting this pathway will reduce pain. The best pharmacological effect was obtained from potato peel extract at doses of 100 mg/kg and 200 mg/kg, because of its ability to reduce pain for longer.

In vitro toxicity test

In vitro toxicity tests were carried out on several parts of plants in the Solanaceae family. The toxicity test of the thick extract of angel's trumpet leaves against *A. miliaris larvae*, and imago was carried out at different doses, starting from 0, 250, 500, 750, 1000, 1500, 2000, 2500, and 3500 mg/kg. Based on research results (Idris, 2015), the percentage effect on mortality of *A. miliaris larvae* and imago continues to increase as the dose of thick extract given increases until it reaches the highest acute toxicity dose at 3500 mg/kg. At this dose, some effects show symptoms of acute toxicity of angel's trumpet leaves, such as failure to molt, preventing feeding, the skin and head of the larvae not coming off (sticky), the skin of the body cracking, the movement of the larvae is slow and tends to be paralyzed, the body color becomes brown, and the larvae die. Blackish brown. One is due to the tannin compounds found in angel's trumpet leaf extract, which can bind proteins in the digestive system and, with their bitter taste and unpleasant odor, can reduce the percentage of live *A. miliaris larvae* (Idris, 2015).

In the toxicity test of the liquid extract of Turkey berry on *Artemia sp.* shrimp larvae, different concentration treatments were given, starting from 150, 200, 300, and 400 ppm. The same treatment was also given to test the toxicity of the liquid extract of its stems on *Artemia* shrimp larvae. *Sp.* This concentration treatment aims to evaluate the LC₅₀ value of fruit and stem extracts from Turkey berries because the LC₅₀ value can have a toxic effect if the value is <1000 ppm (Alfarabi, 2018). Based on research that has been carried out, Turkey berry extract is known to have a toxic effect with an LC₅₀ value of 248 ppm.

Meanwhile, for stem extract, the LC₅₀ value is known to be 129 ppm. The toxic effects produced by both parts of the Turkey berry are due to the presence of alkaloid and tannin compounds in its extract, while the stem extract contains alkaloid, saponin, and tannin compounds. According to research, this compound is known to have the ability to disrupt the life of these shrimp larvae when treated with liquid extracts of Turkey berries and stems.

Then, test the toxicity of the thick ethanol extract of Turkey berry against adult *Ascaris suum* worms, given treatment with dense fruit extract concentrations ranging from 300, 600, 900, 1200, and 1500 ppm. The results of the research show that the higher the concentration of the extract given, the higher the mortality rate that occurs in *Ascaris suum* worms. Based on the research results, the toxic effects produced had LC₉₀ and LC₉₉ values of 1457,780 ppm and 2210,989 ppm in 45 hours; meanwhile, the LC₉₀ and LC₉₉ values were 747,589 ppm and 1002,313 ppm in 48 hours (Candra, 2019). The acute toxicity experienced by the *A. suum* worm is due to the content of alkaloid and terpenoid compounds, which can have the effect of stopping nerve cell impulses from the worm's central nervous system so that the worm experiences paralysis and then dies. Furthermore, saponin has an impact on reducing the permeability of worm cell membranes so that the fruit extract will react more quickly and effectively on worms. The presence of tannin compounds, which disrupt worm metabolism, and flavonoid compounds, which can reduce the synthesis and production of nitrogen monoxide, also play a role in accelerating the mortality process of *A. suum* worms (Candra, 2019).

Next, a toxicity test of the thick ethanol extract of Turkey berry leaves was carried out on *Artemia salina* shrimp larvae. Based on research conducted (Julfitriyani, 2016), thick ethanol extract treatment was carried out with different concentrations of 1000, 100, 10, and 1 mg/L with the aim of determining the LC₅₀ value of Turkey berry leaf extract, which was able to cause 50% mortality in *A. salina* shrimp larvae. The results show that the higher the concentration, the higher the percentage of death of shrimp larvae, and the LC₅₀ value obtained is 113.762 mg/L. It is due to the presence of secondary metabolite compounds that can cause toxic effects on shrimp larvae, such as phenolic compounds, flavonoids, and alkaloids.

In vivo toxicity test

There are several doses used to test the toxicity of Solanaceae family plants *in vivo*; the parts used include a solution of potato peel extract, goldenberry leaf extract, tomato leaf extract, thick ethanol extract of red chili, cayenne pepper fruit extract, thick leaf extract tobacco, paprika fruit ethanol extract, angel's trumpet seed ethanol extract, Turkey berry fruit thick extract, Turkey berry leaf methanol extract, black nightshades thick methanol extract, and black nightshades leaf liquid extract.

In the potato peel extract solution, the glycoalkaloid content contained in potatoes has acute toxic effects if consumed in excessive amounts. Research conducted by (Mensinga, 2004) showed that giving a dose of 1.25 mg TGA/Kg showed nausea and vomiting reactions 4 hours after the dose was given. Providing a larger dose will cause more severe toxic effects.

In research conducted by (Sunday, 2023), goldenberry leaf extract was given to three groups of albino rats with two phases and different doses. In the first phase, namely, group 1 was given a dose of 10 mg, group 2 was assigned a dose of 100 mg, and group 3 was given a dose of 1000 mg. In the second phase, the dose was increased, namely group 1 at 1600 mg, group 2 at 2900 mg, and group 3 at 5000 mg. At a lethal dose of medium 50 (LD₅₀), it does not show toxicity effects such as nausea, vomiting, diarrhea, seizures, death, and changes in skin, eye, and fur color. If the dose given is <5000 mg it will cause acute toxicity effects.

Then, apart from being beneficial for the health of tomato plants, it also has dangerous effects, namely, disrupting cell membranes and inhibiting the activity of acetylcholinesterase, butyrylcholinesterase, and other glycoalkaloids. Absorption of tomato plants in the digestive tract is poor because it forms a complex that is not absorbed by the intestines. According to research (Nguenang, 2020), administering doses of tomato leaf extract of 250 mg/kg, 500 mg/kg, and 1000 mg/kg caused subacute toxicity effects because there were symptoms of poisoning in the test animals, namely gastrointestinal symptoms. At doses >5000 mg/kg, it can cause acute toxicity effects.

Red chili plants also have toxicity effects, as in research conducted by (Song, 2013). The lethal dose (LD₅₀) of red chili extract is 12043 mg/kg and 5492 mg/kg for 70% ethanol extract. Clinical signs that occurred in test animals included irritation, shortness of breath, twitching of the digestive tract, dry mouth, red lips, and convulsions.

Cayenne pepper extract can be used as an alternative to eradicate fleas. Research conducted by (Kishore, 2021) shows that the ethanol extract of cayenne pepper is effective on adults with an LC₅₀ of 617.54 ppm and an LC₉₀ of 1040.41 ppm. Research conducted by (Ernawati, 2018) shows that cayenne pepper has a nephrotoxic effect. In this study, tests were carried out on 3 groups of test animals with different doses, namely 10 mg/kg, 20 mg/kg, and 40 mg/kg. Groups 2 and 3 showed that there was an effect of giving cayenne pepper extract on the microscopic appearance of the kidneys, namely the occurrence of cell damage in the kidneys; this was due to the capsaicin content in cayenne peppers.

The toxicity test of the thick extract of tobacco leaves was carried out on test animals of female DDY strain rats at doses of 300, 2000, and 2500 mg/kgBW given orally, while the nanoinsecticide preparation for tobacco was given a dose of 2500 mg/kgBW orally. Based on research results (Handayani, 2022), rats did not show any toxic effects from the extract at a dose of

300 mg/kgBW, then continued at a dose of 2000 mg/kgBW they began to show side effects from the extract treatment, such as stress, convulsions and one mouse which died, and at a dose of 2500 mg/kgBW, similar toxic effects were shown by rats with stable body weight. Apart from that, the tobacco nanoinsecticide toxicity test was also carried out at a dose of 2500 mg/kgBW, and a similar toxic effect was produced as treatment with a thick extract of tobacco leaves. Then, hispathological testing was carried out, which showed results where there was damage (necrosis) to the rats' kidneys so that it could be concluded that the mortality of the rats occurred due to experiencing acute toxicity effects. In contrast, the kidney damage in rats caused by tobacco nanoinsecticide resulted in nephrotoxicity in the rats' kidneys.

On the ethanol extract of paprika, toxicity tests were carried out on male albino Wistar rats with varying doses of 5 ml/kgBW (normal), 2.5 mg/kgBW (control), 200, 400, and 600 mg/kgBW for the extract treatment dose. Based on the research results, the group of rats that received a dose of 5 ml/kgBW of distilled water orally did not show any toxicological effects, and at a dose of 2.5 mg/kgBW a doxorubicin solution was used, which was given i.p., as induced cardiotoxicity in mice. Doxorubicin treatment showed symptoms of toxic effects in rats, such as fur loss, red eyes and nose, watery feces, alopecia, and necrosis of body parts. The cardiotoxic condition experienced by rats can then be *counter-acted* by treatment with paprika fruit ethanol extract because this extract has cardioprotective activity. It can occur due to the presence of polyphenol, flavonoid, and carotenoid compounds, which have anti-oxidant activity in fruit extracts so that they can ward off the free radical movement, thereby causing a cardioprotective effect (Pawar, 2023).

Then the ethanol extract of angel's trumpet seeds was carried out at doses of 10, 15, 20, and finally, 15 mg/kgBW of liquid extract, each of which had 1 mg/kgBW of xylazine added as an inducer and also done for a dose of 15 mg/kgBW of ketamine added 1 mg /kgBB xylazine. Research shows that there is no significant effect on the treatment dose of 10 mg/kgBW and 15 mg/kgBW liquid extract of angel's trumpet seeds on the consciousness of test animals; however, at 20 mg/kgBW there is a toxicological effect on test animals, characterized by a drastic increase in R.R. and hyperthermia. So, it can be said that the toxic dose for liquid extract of angel's trumpet seeds is at a dose of ≥ 20 mg/kgBW. Meanwhile, for treatment with ketamine, it was found that the test animals experienced hypothermia due to low body temperature for a long time, followed by the effect of xylazine, which affected relaxing bronchial muscles, reducing the activity of the parasympathetic nervous system, thereby making the thermoregulatory function of the test animals' bodies unable to work normally (Sukariada, 2016).

On the thick extract of Turkey berry, a toxicity test was carried out on Sprague-Dawley rat test animals with several doses, namely 120, 160, and 200 mg/kgBW given orally. Based on research, there were no symptoms indicating toxic effects in mice for each of these treatments; meanwhile, Turkey berry extract was known to affect reducing blood glucose levels at a dose of 200 mg/kgBB due to decreased expression of the *PCK1* gene. However, acute toxicity studies show the LD₅₀ value of thick fruit ethanol extract at doses ≥ 1600 mg/kgBW (Satyanarayana, 2022).

Based on the results of studies from various literature, not much research has been carried out regarding toxicity tests of Turkey berry leaves on test animals. The dose of the methanol extract of Turkey berry leaves has been determined as an anti-ulcerogenic agent at a dose of 250, 500, 750 mg/kgBW, and the same dose was also tested on the liquid extract of the leaves on rat test animals (Yousafa, 2013). In this case, it is still necessary to carry out further research regarding the dose range that causes toxic effects in test animals.

The toxicity test of the thick methanol extract of black nightshade was carried out using Wistar albino rat test animals with treatment doses of 125, 250, and 375 mg/kgBW. Based on research (Ravi, 2009), giving methanol extract of black nightshades to test animals that had been induced by carrageenan was proven to have effective activity in inhibiting inflammation with the highest percentage of inhibition at a dose of 375 mg/kgBW. However, in this research, it is not yet known with certainty regarding the toxic dose range of the thick extract of black nightshades.

In the toxicity test for the liquid extract of black nightshade leaves, female Wistar rats were used as test animals at doses of 100 mg/kgBW and 200 mg/kgBW. Currently, this dose is known to

be able to treat oral mucositis due to chemo-radiation and methotrexate-induced mucositis. However, the results of the study show that the toxic dose tolerance limit for liquid black nightshade leaf extract is at a dose of 2000 mg/kgBW orally, so it can be concluded that a dose of >2000 mg/kgBW can cause toxic effects in test animals (Patel, 2014).

Furthermore, research on the toxicity test of black nightshade leaf extract carried out (Birru, 2022) was used with 3 test groups on the same animals, namely female Swiss albino rats. The first group used doses of 100, 200, and 400 mg/kgBW for hydromethanol extract orally and did not show any signs of test animals experiencing toxic effects. The second group also used doses of 100, 200, and 400 mg/kgBW for black nightshade leaf extract in the chloroform fraction given orally, and it was found that the results obtained did not show any toxic effects in the test animals. Likewise, the ethyl acetate fraction at doses of 100, 200, and 400 mg/kgBW did not cause any harmful effects in test animals. Based on these results, it can be concluded that the possible LD₅₀ value of black nightshade leaf extract is above 2000 mg/kg, so based on the WHO hazard classification, black nightshade leaves are included in the "not dangerous substance" category (Birru, 2022).

CONCLUSION

Based on the literature review research that has been carried out, it can be concluded that among the 10 species of the Solanaceae family studied, there are 3 pharmacological effects with the most data modes, including antimicrobial, anti-inflammatory, and anti-oxidant. Antimicrobial effects can be found in the species *Physalis angulata* L., *Solanum lycopersicum* L., *Capsicum annuum* L., *Nicotiana tabacum* L., *Capsicum annuum* var. *grossum*, *Datura stramonium* L., and in *Solanum torvum* Sw. Anti-inflammatory effects can be found in the species *Solanum tuberosum* L., *Physalis angulata* L., *Solanum lycopersicum* L., *Capsicum frutescens* L., *Solanum torvum* Sw., and *Solanum nigrum* L. Meanwhile, anti-oxidant effects can be found in the species *Physalis angulata* L., *Capsicum annuum* L., *Capsicum frutescens* L., *Capsicum annuum* var. *grossum*, and *Solanum torvum* Sw.

Based on the results of toxicity tests that have been carried out both *in vitro* and *in vivo*, there are several species whose safety has been tested. Mashed potatoes applied in clinical trials on humans were toxic at doses ≥ 1.25 mg TGA/kgBB with side effects of nausea and vomiting 4 hours after dosing. The ethanol extract of goldenberry leaves applied orally to albino rats is toxic at doses ≥ 5000 mg/kgBW. Methanol extract of tomato leaves applied orally to female Wistar rats is toxic at doses >5000 mg/kgBW. The thick ethanol extract from red chilies will be toxic at a dose of 12043 mg/kg in the distilled water extract, and 5429 mg/kg in the 70% ethanol extract. Then, the thick leaf extract and tobacco nano insecticide applied orally to female DDY rats will both be toxic at a dose of ≥ 2500 mg/kg. The thick extract of angel's trumpet leaves has a toxic effect at a dose of ≥ 3500 mg/kg applied to *A. miliaris* larvae and imago. Meanwhile the liquid extract from angel's trumpet seeds is known to produce a toxic effect at a dose of ≥ 20 mg/kgBW in male Kintamani dog tests intramuscularly. The thick ethanol extract from Turkey berry has a toxic dose of ≥ 1600 mg/kgBW which is applied to Sprague-Dawley rats orally, for the liquid extract has an LC₅₀ of 129 ppm as an anti-cancer test and 248 ppm as an antimicrobial test on *Artemia* sp., then on worms, *Ascaris suum* had an LC₉₀ and LC₉₉ of 747,589 ppm and 1002,313 ppm in 48 hours. Meanwhile, the thick ethanol extract of Turkey berry leaves had a cytotoxic effect at a dose of $< 113,762$ mg/L applied to *Artemia salina* shrimp larvae. Then, for the black nightshade, it was discovered that the toxicity test on the liquid extract of black nightshade leaves was estimated to be toxic at a dose of >2000 mg/kgBW, which was tested on female Wistar rats.

The results of this research show that the majority of plants in the Solanaceae family have a very high range of toxic effects, so the use of plants in low doses can still be declared effective and safe.

REFERENCES

- Abdel-Moneim, A.A., dkk "Ameliorative Effects of Quercetin and Naringenin on Diethylnitrosamine/2-acetylaminofluorene-Induced Nephrotoxicity in Male Wistar Rats", *American Journal of Biochemistry*, Vol.6, pp 113-121, Oktober 2016.
- Alfarabi, M., dan Widyadhari, Gupita, "Uji Toksisitas Dan Identifikasi Fitokimia Ekstrak Buah Dan Batang Rimbang (*Solanum torvum* Swartz)", *Al-Kaunyah: Journal of Biology*, Vol.11, pp 109-115, Maret 2018.
- Al-Snafi, A.E. "The Pharmacological Importance Of Capsicum Species (*Capsicum Annuum* And *Capsicum Frutescens*) Grown In Iraq", *Journal of Pharmaceutical Biology*, Vol.5, pp 124-142, Januari 2015.
- Ananta, I.G. Bagus Teguh, dan Anjasmara, D.G. Anom, "Potensi Ekstrak Buah Cabai Merah Keriting (*Capsicum annum* var. Longum) sebagai Antioksidan dan Antibakteri", *Jurnal Ilmiah Medicamento*, Vol.8, pp 48-55, Maret 2022.
- Asmin, E., dkk, "Penyuluhan Penyakit Tidak Menular Pada Masyarakat", *Communnity Development Journal*, Vol.2, pp 940-944, November 2021.
- Azzikri, A., Wardana, S. Tri, dan Harmida, H., "Etnobotani Tumbuhan Obat Solanaceae Pada Masyarakat Suku Kerinci di Wilayah Lempur Kabupaten Kerinci Provinsi Jambi", *SRIBIOS: Sriwijaya Bioscientia*, Vol.1, pp 10-13, Desember 2020.
- Barus, N. Sari Br., dkk, "Uji Toksisitas Subakut Ekstrak Daun Tembakau (*Nicotiana tabacum* L.) Yang Difermentasi Terhadap Gambaran Histologi Organ Vital Mencit (*Mus musculus*)", *Jurnal Sains, Teknologi, Farmasi & Kesehatan*, Vol.02, pp 33-40, November 2018.
- Birru, E. Melese, dkk., "Antimalarial Activity of Crude Extract and Solvent Fractions of Leaves of *Solanum nigrum* L. (*Solanaceae*) against *Plasmodium berghei* in Mice", *Evidence-Based Complementary and Alternative Medicine*, Vol.2022, pp 1-10, Juli 2022.
- Candra, M. Vinda, dkk, "Aktivitas Ekstrak Buah Takokak (*Solanum torvum*) terhadap Kematian Cacing Gelang Dewasa", *Hang Tuah Medical Journal*, Vol.16, pp 204-216, Mei 2019.
- Chaieb, K., dkk, "Antibacterial Activity of Thymoquinone, An Active Principle of *Nigella sativa* And Its Potency To Prevent Bacterial Biofilm Formation", *BMC Complement Altern Med*, Vol.11, pp 1-6, April 2011.
- Dewi, V. Puspita, Hindun, I., dan Wahyuni, Sri, "Studi Trikoma Daun Pada Famili Solanaceae Sebagai Sumber Belajar Biologi", *Jurnal Pendidikan Biologi Indonesia*, Vol.1, pp 209-218, Juli 2015.
- El-Mesallamy, Amani M.D., dkk "Toxicity and Latent Effect of Pepper Plant Essential Oil (*Capsicum Annuum* L.) on Some Cotton Pests", *Middle East Journal of Applied Sciences*, Vol.5, pp 1184-1191, Desember 2015.
- Ernawati, L., Witjahyi, R.B.Bambang, Ismail, Akhmad "Pengaruh Pemberian Ekstrak Cabai Rawit (*Capsicum frutescens* L.) Terhadap Gambaran Mikroskopis Ginjal Mencit Balb/C", *Jurnal Kedokteran Diponegoro*, Vol.7, pp 1647-1660, Oktober 2018.
- Ersoy, E., dkk, "Anti-Aging Potential and Anti-Tyrosinase Activity of Three *Hypericum* Species With Focus on Phytochemical Composition by L.C.–MS/MS", *Industrial Crops & Products*, Vol.141, pp 1-9, Agustus 2019.
- Gogoi, P. dan Islam, M., "Phytochemical Screening of *Solanum nigrum* L and *S.myriacanthus*

- Dunal from Districts of Upper Assam, India.", *IOSR Journal of Pharmacy*, Vol.2, pp 455-459, Juni 2012.
- Handayani, S. Wahyuni, dkk, "Uji Toksisitas Akut Nano insektisida Tembakau (*Nicotiana tabacum* L.) terhadap Mencit", *Jurnal Kesehatan*, Vol.13, pp 554-561, November 2022.
- Idris, H., "Tanaman Kecubung (*Datura metel* L.) Sebagai Bahan Baku Insektisida Botanis Untuk Mengendalikan Hama *Aspidomorpha milliaris* F.", *Jurnal Penelitian Tanaman Industri*, Vol.21, pp 41-46, Maret 2015.
- Jain, R., dkk, "*Solanum nigrum: Current Perspectives on Therapeutics Properties*", *Alternative Medicine Review: a Journal of Clinical Therapeutic*, Vol.16, pp 78-85, Maret 2011.
- Julfitriyani, J. Runtuwene, M. Revolta, dan Wewengkang, Defny, "Uji Aktivitas Antioksidan Dan Toksisitas Ekstrak Etanol Daun Foki Sabarati (*Solanum torvum*)", *PHARMACON: Jurnal Ilmiah Farmasi*, Vol.5, pp 94-101, Agustus 2016.
- Julianti, W.P., Ikrawan, Yusep, dan Iwansyah, A.Chandra "Pengaruh Jenis Pelarut Terhadap Kandungan Total Fenolik, Aktivitas Antioksidan Dan Toksisitas Ekstrak Buah Ciplukan (*Physalis angulata* L.)", *Jurnal Riset Teknologi Industri*, Vol.13, pp 70-79, Juni 2019.
- Junnaeni, J., Mahati, E., dan Maharani, N., " Ekstrak Tomat (*Lycopersicon esculentum* Mill.) Menurunkan Kadar Glutation Darah Tikus Wistar Hiperurisemia", *Jurnal Kedokteran Diponegoro*, Vol.8, pp 758-767, April 2019.
- Khatoon, N., Jain, Paras, dan Choudhary, A.K., "*Phytochemical Studies On Seed And Leaf Extracts Of Solanum torvum* Sw.", *Indo American Journal of Pharmaceutical Research*, Vol.5, pp 1649-1656, Mei 2015.
- Khaerunnisa, N., Saraswati, Indah, dan Sasikirana, Widyandani, "Kandungan Total Fenolik Ekstrak Metanol Buah Leunca (*Solanum nigrum* L.) Dan Fraksi-Fraksinya", *Generics: Journal of Research in Pharmacy*, Vol.2, pp 86-92, September 2022.
- Kishore, V. dkk "*Toxicity evaluation and chemical composition of Capsicum frutescens for natural control of Asian blue tick, Rhipicephalus (Boophilus) microplus (Acari: Ixodidae)*", *The Journal of Basic and Applied Zoology*, Vol.82, pp 1-10, Oktober 2021.
- Krisnawati, Y., Febrianti, Yuli, "Identifikasi Tumbuhan Famili Solanaceae Yang Terdapat Di Kecamatan Tugumulyo", *Biosfer: Jurnal Biologi dan Pendidikan Biologi*, Vol.4, pp 73-84, Desember 2019.
- Kuntorini, E. Mintowati, "Botani Ekonomi Suku Zingiberaceae Sebagai Obat Tradisional Oleh Masyarakat di Kotamadya Banjarbaru", *BIOSCIENTIAE*, Vol.2, pp 25-36, Januari 2005.
- Lagu, C. dan Kayanja, Frederick I.B. *Acute Toxicity Profiles of Aqueous and Ethanolic Extracts of Capsicum annum L. Seeds from South Western Uganda. InTech*, 2013.
- Mensinga, T.T., dkk "Potato Glycoalkaloids and Adverse Effects in Human: An Ascending Dose Study", *Regulatory Toxicology and Pharmacology*, Vol.41, pp 66-72, Desember 2004.
- Nadjamuddin, M. dkk, "Efektivitas Antidiare Ekstrak Buah Terong Takokak (*Solanum torvum*) Terhadap Hewan Uji Mencit (*Mus musculus*) Diinduksi Dengan Minyak Jarak (*Oleum ricini*)", *Jurnal Novem Medika Farmasi*, Vol.1, pp 50-56, Desember 2022.
- Naimon, N., Pongchairerk, Urai, dan Suebkhampet, Araya, "*Phytochemical Analysis and Antibacterial Activity of Ethanolic Leaf Extract of Solanum torvum Sw. Against Pathogenic*

Bacteria", *Kasetsart Journal (Natural Science)*, Vol.49, pp 516-523, Januari 2015.

- Nguenang, G.S., Ntyam, Arse'ne S.M., dan Kuete, Victor "Acute and Subacute Toxicity Profiles of the Methanol Extract of *Lycopersicon esculentum* L. Leaves (Tomato), a Botanical with Promising In Vitro Anti-cancer Potential", *Evidence-Based Complementary and Alternative Medicine*, Vol.2020, pp 1-10, Maret 2020.
- Nouri, F. dan Nourollahi-Fard, Saeid R., "In vitro anthelmintic effect of Tobacco (*Nicotiana tabacum*) extract on parasitic nematode, *Marshallagia marshalli*", *Journal of Parasitic Diseases*, Vol.40, pp 643-647, September 2014.
- Ostreikova, T.O., dkk, "Glycoalkaloids Of Plants In The Family Solanaceae (Nightshade) As Potential Drugs", *Pharmaceutical Chemistry Journal*, Vol.56, pp 948-957, Oktober 2022.
- Patel, A., dkk., "Protective Effects of Aqueous Extract of *Solanum nigrum* Linn. Leaves in Rat Models of Oral Mucositis", *The Scientific World Journal*, Vol.2014, pp 1-10, November 2014.
- Pawar, Dhiraj J., Naikwade, Dr.N., dan Shikalgar, Dr.T.S., "Cardioprotective Effect of *Capsicum annum* L.VAR. *Grossum* SENDT. on Doxorubicin-Induced Cardiac Oxidative Stress in Rats", *International Journal of Pharmaceutical Sciences Review and Research*, Vol.78, pp 1-11, Februari 2023.
- Prasetyo R., dan Siagian, T. Hadumaon, "Determinan Penyakit Berbasis Lingkungan Pada Anak Balita di Indonesia", *Jurnal Kependudukan Indonesia*, Vol.12, pp 93-104, Desember 2017.
- Ravi, V., dkk, "Anti-Inflammatory Effect of Methanolic Extract of *Solanum nigrum* Linn Berries", *International Journal of Applied Research in Natural Products*, Vol.2, pp 33-36, Juli 2009.
- Rumape, O., dkk, "Isolasi dan Karakterisasi Senyawa Metabolit Sekunder Dari Ekstrak Metanol Biji Kecubung (*Datura metel* L.)", *Jambura Journal of Chemistry*, Vol.3, pp 105-112, Oktober 2021.
- Rybak, K. dkk "The Effect of Traditional and Non-Thermal Treatments on the Bioactive Compounds and Sugars Content of Red Bell Pepper", *Molecules*, Vol.25, pp 1-17, September 2020.
- Sastya, S., Kumar, R. Ranajan, Vatsya, Stuti, "Evaluation of Anthelmintic Efficacy of *Nicotiana tabacum* against Gastrointestinal Nematodes of Goats", *International Journal of Current Microbiology and Applied Sciences*, Vol.6, pp 780-789, Oktober 2017.
- Satyanarayana, N., et al., "Antidiabetic Activity Of *Solanum torvum* Fruit Extract In Streptozotocin-Induced Diabetic Rats", *Frontiers in Nutrition*, Vol.9, pp 1-11, Januari 2022.
- Setiawan, A., "Keanekaragaman Hayati Indonesia: Masalah dan Upaya Konservasinya", *Indonesian Journal of Conservation*, Vol.11, pp 13-21, Juni 2022.
- Shagal, M.H., Modibbo, U.U., Liman, A.B., "Pharmacological justification for the ethnomedical use of *Datura stramonium* stem-bark extract in treatment of diseases caused by some pathogenic bacteria", *International Research of Pharmacy and Pharmacology*, Vol.2, pp 16-19, Januari 2012.
- Siddique, Md A.B., dan Brunton, Nigel. *Food Glycoalkaloids: Distribution, Structure, Cytotoxicity, Extraction, and Biological Activity*. IntechOpen, 2019.
- Srinivasan, P., Smolke, C.D., "Biosynthesis Of Medicinal Tropane Alkaloids In Yeast", *Nature*, Vol.585, pp 614-619, September 2020.

- Sukariada, IP. Juli, Sudira, I Wayan, dan Sudisma, I Gusti Ngurah, "*The Effectivity of Ethanol Extract of Datura Metel L. Seeds as a General Anaesthesia on Kintamani Dogs*", *Veterinary Science and Medicine Journal*, Vol.4, pp 27-31, Februari 2016.
- Sunday, R.T., dan Ilesanmi, Olapade R. "*Toxicity Studies of Physalis angulata L. Leaves Extract on Biochemical and Haematological Parameters in Albino Rats*", *Journal of Pharmacology and Toxicology*, Vol.18, pp 83-88, Februari 2023.
- Susanto, S. Edi, dan Wibowo, T. Heri, "*Effectiveness Of Giving Deep Relaxation To Reduce Pain In Hypertension Patients In Edelweis Room Down, Kardinah Tegal Hospital*", *Jurnal Inovasi Penelitian*, Vol.3, pp 5841-5846, September 2022.
- Syafriana, V., Natasha, Nurul, dan Wahidin, W., "Uji Aktivitas Antibakteri Ekstrak Etanol Buah Paprika Merah (*Capsicum annum L.*) Terhadap Bakteri *Enterococcus faecalis*", *Sainstech: Jurnal Penelitian Dan Pengkajian Sains dan Teknologi*, Vol.12, pp 44-47, Januari 2019.
- Wahyudi, I.A., dkk "Analgesic, Anti-Inflammatory and Anti-Biofilm-Forming Activity of Potato (*Solanum tuberosum L.*) Peel Extract", *Indones. J. Cancer Chemoprevent*, Vol.11, pp 30-35, Januari 2020.
- Wahyuningsih, Mae S.H., dkk "Bioassay Guided Fractionation of Ciplukan (*Physalis angulata L.*) Monitored by Glucose Consumption Assay and Thin Layer Chromatography on Myoblast Cells", *Trad. Med. Journal*, Vol.28, pp 22-30, Januari 2023.
- Wulandari, D. Rizkya, Sudana, I M., dan Singarsa, I D. Putu, "Tingkat Fekunditas Nematoda (*Meloidogyne spp.*) pada Beberapa Tanaman yang Tergolong Familia Solanaceae", *Jurnal Agroekoteknologi Tropika*, Vol.8, pp 468-477, Oktober 2019.
- Yousafa, Z., Wang, Ying, dan Baydoun, Elias, "*Phytochemistry and Pharmacological Studies on Solanum torvum Swartz*", *Journal of Applied Pharmaceutical Science*, Vol.3, pp 152-160, April 2013.
- Zanello, P.R., dkk, "*Quinic Acid Derivatives Inhibit Dengue Virus Replication In Vitro*", *Virology Journal*, Vol.12, pp 1-13, Desember 2015.