Medical Sains
Jurnal Ilmiah Kefarmasian
ISSN : 2548-2114 (e) 2541-2027 (p)

LITERATURE REVIEW : BENEFIT OF TOMATO PLANT (*Solanum lycopersicum*) IN HERBAL PRODUCT FORMULATION

Ananda Ayu Chandra[1], Muhammad Ridwan[1], Salma Gustia Putri[1], Vicko Suswidiantoro[2], Nina Salamah[1*]
[1]Faculty of Pharmacy, Universitas Ahmad Dahlan, Yogyakarta, Indonesia
[2]Faculty of Health, Aisyah Pringsewu University, Pringsewu, Indonesia
**Email Corresponding: nina.salamah@pharm.uad.ac.id*

Submitted: July 14, 2025   Revised: December 22, 2025   Accepted: December 25, 2025

ABSTRACT
Tomatoes are known to treat skin inflammation, acne, and hard to heal wounds. Tomatoes contain various chemical compounds, such as phenolic compounds (phenolic acids and flavonoids), carotenoids (alpha and beta carotene, and lycopene), vitamins (ascorbic acid and vitamin A), and glycoalkaloids (tomatin). The purpose of this study was to provide information about the potential activity of tomato plants (*Solanum lycopersicum*) as active ingredients that can be used in herbal product preparations. This study used the Boolean System method. Based on the results of the literature search, 99 original articles were obtained from two databases (Sinta and Google Scholar). The literature articles were selected based on the inclusion and exclusion criteria with the publication year 2015-2025 based on the PRISMA guidelines so that the total search results for articles that were complete and considered suitable for use were 58 articles. The results of the literature review show that tomato plants can be formulated as preparations such as sunscreen lotion, cream, liquid soap, hand and body lotion, serum, instant drink powder, cut wound gel, and sunscreen cream, showing good effectiveness and stability. Although there is potential toxicity at high doses, most research results indicate that the use of tomatoes in topical and oral preparations is relatively safe, thus supporting their use as natural active ingredients in pharmaceutical and cosmetic products.
Keywords: Pharmacology; Formulation; Herbal Product; Tomato; Toxicology

INTRODUCTION

Indonesia is the most ethnically diverse country in the world. This ethnic diversity causes variations in the utilization of plants in terms of ecology, spirituality, cultural values, health, beauty, and treatment of diseases. Indonesia is home to approximately 17% of the world's plant species, and the existence of vast tropical forests and its biodiversity make this country a very valuable natural resource. Therefore, Indonesia is often known as a natural laboratory and center for medicinal plants (Lestari & Lagiono, 2018). Knowledge of medicinal plants has been known since the time of our ancestors, and many have been scientifically proven to be efficacious for health. One of the efficacious medicinal plants is tomato (Astuti *et al*., 2021; Nuraini *et al*., 2021).

Tomatoes contain various chemical compounds, including phenolic compounds (phenolic acids and flavonoids), carotenoids (alpha and beta carotene, and lycopene), vitamins (ascorbic acid and vitamin A), and glycoalkaloids (tomatin) (Chaudhary *et al*., 2018). The abundant compound content in tomato plants can be an alternative to natural ingredients in the pharmaceutical and cosmetic fields, such as herbal products, because they are considered safer, environmentally friendly, and contain natural bioactive compounds. Formulation studies on tomato extracts have shown that lycopene, also known as ∝-carotene, can be used as a natural red colorant (Billi *et al*., 2024). In addition, lycopene, followed by vitamin content (ascorbic acid and *α-tocopherol*) in tomatoes, is known to reduce oxidative stress and minimize the risk of cancer and cardiovascular disease (Chaudhary *et al*., 2018).

The chemical content in tomatoes, such as tomatin, citric acid, malic acid, folic acid, riboflavanoids, vitamin C, vitamins A and B1, and carotenoids, function as antimicrobials, accelerate wound healing, overcome fungal infections, and reduce the risk of diseases related to inflammatory disorders, such as skin inflammation and atherosclerosis (Martí *et al*., 2016; Purwati & Pratiti, 2021). Although tomatoes contain many bioactive compounds, are widely available in Indonesia, are inexpensive, and have been used traditionally, they have not been optimally utilized in the form of modern pharmaceutical preparations.

Based on the above problems, the authors conducted this literature review to provide information to readers about the potential of tomato plants (*Solanum lycopersicum*) as active ingredients that can be formulated in herbal product preparations.

RESEARCH METHOD

Research Design

This study used a descriptive study design to determine the pharmacological effects, toxicity, and preparation formulations of tomato plants. The data in this study are in the form of literature review results from related primary research data using the Boolean System method, which is then analyzed descriptively, that is, analyzing the data obtained and then providing ways to understand and interpret it (Karim *et al*., 2023).

Literature Search Strategy

In this study, a literature search was conducted using the Boolean System method (AND and OR). This method was used to determine articles or research materials to facilitate the selection of relevant references.

Search Database

A literature review is a thorough summary of various specialized studies related to a particular topic. A literature search will be conducted in June 2025. The primary data used in this study were obtained from previous research results and not from direct observation. This data source can be a nationally recognized journal article that discusses a particular topic and was published in the last 10 years (2015-2025). Two databases were used in the search for this literature review: Google Scholar and Sinta.

Keyword

Searching for articles or literature with predetermined keywords helps to specify the search, making it easier to find the articles or literature you want to use. The keywords used in the preparation of the literature review are presented in **Table I**.

Table I. Keywords

Data Source	Keyword
Sinta	(Tomato) OR (Formulation)
Google Scholar	(Tomato) AND (Effectiveness)

Article Selection Criteria

Inclusion Criteria

The literature used as a source must meet the following criteria: (1) original articles published in the last 10 years, namely, 2015 to 2025; (2) Articles in English or Indonesian; (3) articles related to morphology, botany, chemical content, effectiveness, toxicity, and formulation; (4) articles indexed by Scopus or Sinta; and (5) articles that can be accessed as free full text.

Exclusion Criteria

The literature sources used must meet the following exclusion criteria: (1) Review Article or Systematic Review; (2) related articles not from Scopus or Sinta indexed journals.

Data Extraction

In this study, primary data were used. Primary data are obtained from the results of research conducted by previous researchers.

Research Procedure

A literature search using the Boolean System was conducted in the Sinta and Google Scholar databases. The results of literature searches conducted on two databases, Sinta (30 articles) and Google Scholar *(69 articles)*, showed that the total number of articles from the two databases was 99. Furthermore, the screening process was carried out using two databases, and 15 articles that did not match the inclusion criteria were excluded, resulting in 84 articles. Then the articles that did not match the title and abstract were 18 articles, so 66 articles were obtained. Then screened again and found as many as 8 articles that were not full text, so that the complete articles that were deemed suitable for use were 49 articles that would be used for literature review and 9 articles that discussed formulations of tomato plants (*Solanum lycopersicum*). The research flow is shown in **Figure 1**.

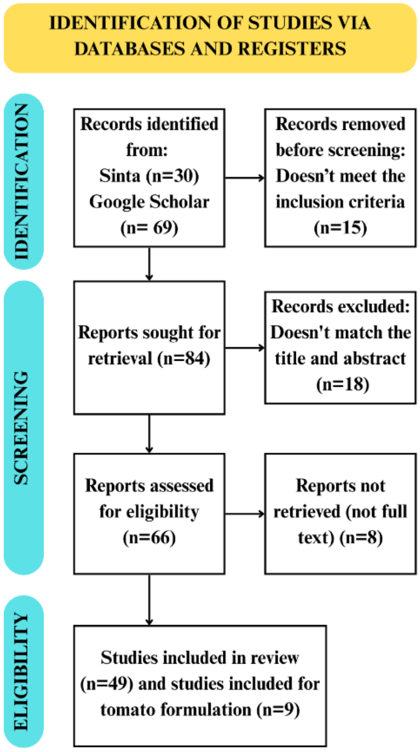

Figure 1. PRISMA Chart

RESULTS AND DISCUSSION

Tomato Classification and Morphology

Based on the classification system, tomatoes are plants that belong to the *Angiospermae* group with the following classification (Waluyo, 2020):

Regnum	: Plantae
Division	: Magnoliophyta
Class	: Magnoliopsida
Nation	: Solanales
Family	: Solanaceae
Genus	: Solanum
Species	: *Solanum lycopersicum*

The classification and characterization of plant organ shapes are important tools for determining plant characteristics. In the classification of tomato plants, one of them based on fruit shape is very important to correctly categorize different varieties (Athinodorou *et al*., 2021; Fernandes *et al*., 2018).

Tomato (*Solanum lycopersicum*) is one of the plants included in the fruit category with the most commonly found morphological forms (Astuti *et al*. 2021). Tomatoes have a root system that spreads at an average depth of 30-40 cm and taproots, which support the uprightness of plants and absorb water and nutrients from the soil (Wahyuni *et al*., 2018). This plant has a round stem with green bark and hair. The leaves are green, ranging from 15 to 30 cm long and 10 to 25 cm wide, and the petiole is round with a length of 3 to 6 cm. Tomatoes have a compound flower type consisting of 4–14 florets arranged on a flower stalk (*pedicellus*) (Sutapa & Kasmawan, 2016). In the tomato fruit, it has ovules with a range of 250 to 1000 ovules, and of these about 20-50% can develop into seeds (Sutapa & Kasmawan, 2016).

In a study of 123 tomato genotypes, researchers identified six main categories of fruit shapes based on morphological measurements, such as polar and equatorial diameters, as well as stem tip and flower tip shapes. These shapes included round, oval, elongated, heart-shaped, flat, and bell pepper-like. These variations are important in terms of aesthetics and market preferences and are closely related to the number of fruit chambers (*locules*), fruit weight, and pulp thickness, all of which are important parameters in tomato breeding programs (Sacco *et al*., 2015).

Tomato plants have highly variable genes in their germplasm. Therefore, the characterization of locally adapted and acclimatized germplasm is an effective way to identify promising gene sources and utilize them to produce improved varieties (Odinita *et al*., 2017). Based on information from the literature, there is rich diversity across the evaluated tomato collections and a large variation in fruit shape, size, productivity, yield components, and fruit quality. Multivariate analysis of morphological and quality traits showed that 35 principal components contributed to the total variation, and the first two and 12 principal components explained 47.2% and 90% of the variation, respectively. The evaluated tomato collection seems to have breeding potential, and approximately 20% of the accessions in the collection (LYC-6, LYC-17, LYC-18, LYC-26 to LYC-31, and LYC 33) are very promising genetic resources for the cultivation of tomato plant variety development enriched with improved fruit quality (Grozeva *et al*., 2021).

Research (Herison *et al*., 2018) explains that the CFrim descriptor is classified as monomorphic because all genotypes (100%) show a greenish white color. Chlorophyll in tomatoes causes immature fruits to appear green. For CFrim characteristics, there were five groups based on color variations in fruit ripening. Group one (51.31%) of the genotype was yellow, the second genotype (32.43%) was green, the third genotype (8.11%) was orange, the fourth genotype (5.41%) was pink, and the fifth genotype (2.7%) was red (Herison *et al*., 2018).

Tomato Content

Tomato plants are rich in vitamins A and C, lutein, folate, protein, and fiber. In addition, tomatoes contain phenolic compounds such as flavonoids and phenolic acids, β-carotene, lectins, and lycopene. The calorie and fat content is low, it is cholesterol-free, and it is high in potassium, which is beneficial for the body (Tarigan *et al*., 2016). Tomatoes contain many vitamins and minerals that are very helpful for the growth and health of the human body. Tomatoes also contain calories, carbohydrates, fats, and proteins. Carotene in orange tomato skin functions as provitamin A, and vitamin C functions as an antioxidant and antisclerotic agent (Andriani & Hintono, 2018). Table 2 shows information related to the nutritional content of tomatoes.

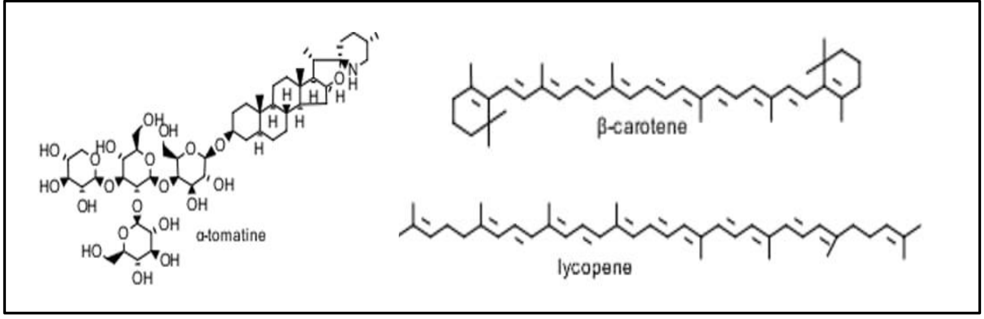

Figure 2. Molecular Structure of α-tomatine, β-carotene, and Lycopene

Table II. Compositions of Nutrient in Tomatoes
(Yuniastri *et al*., 2020)

Type of substance	Amount
Calories	19 cal
Protein	0.9 gr
Fat	0.2 gr
Carbohydrates	4.0 gr
Vitamin A	1.496 SI
Vitamin B	0.05 mg
Vitamin C	38 mg
Calcium	3 mg
Phosphorus	24 mg
Iron	0.4 mg
Water	95 gr

Lycopene

Lycopene is a carotenoid with a molecular formula of $C_{40}H_{56}$ and a molecular weight of 536.85 grams/mol (Tarigan *et al*., 2016). Lycopene levels in tomato fruits are influenced by the genetic potential of the variety and environmental factors, especially temperature and lighting. During ripening, lycopene levels increase significantly. The conjugated structure of lycopene makes it a powerful antioxidant and is thought to play an important role in the prevention of certain types of cancer (Arifulloh, 2016). Increasing the feed-to-solvent ratio increases the lycopene extraction levels (Tarigan et al., 2016). At a ratio of 1:4.5 with hexane, the highest lycopene levels obtained were 2.7 mg/150 ml and 2.2 mg/150 ml. Meanwhile, with the same ratio, ethyl acetate produced the highest lycopene levels of 3.2 mg/150 ml and 2.8 mg/150 ml. In addition, the use of methanol as an antisolvent in this study can produce higher lycopene levels. Thus, ethyl acetate is a solvent that can provide greater and better lycopene yields compared to other solvents (Tarigan *et al*., 2016).

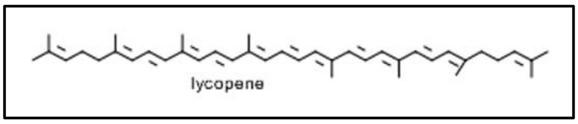

Figure 3. Lycopene

Vitamin C

Vitamin C, also known as ascorbic acid, is a white crystalline vitamin that is water soluble and easily oxidized in air. Its functions are important as an antioxidant, anticancer, and to maintain healthy teeth, gums, and the immune system (Tareen *et al*., 2015). Vitamin C has a molecular weight of 176.13 and a molecular formula of $C_6H_8O_6$. It is a white crystal-like compound that can dissolve in water and is odorless (Safnowandi, 2022).

Plant conditions before and after harvest, temperature, storage methods, length of storage, and fruit maturity are some of the things that can affect the amount of vitamin C content in plants (Ernest *et al*., 2017). Fruit maturity and other variables during fruit growth, including climate and environmental conditions, contribute to variations in the vitamin C content of fresh tomatoes. Vitamin C content increases between 45-63 days after planting but decreased by day 72. Tomatoes harvested on day 63 showed the highest vitamin C content of 21.29 mg per 100 grams (Sari *et al*., 2021). The daily requirement of vitamin C varies, with the average for adults/productive age (16-64 years) being 75-90 mg and higher for pregnant (70 mg) or lactating women (95 mg). This shows that vitamin C is important for maintaining health (Rosmaniar *et al*., 2018).

Metabolite Compounds

Plant compounds such as flavonoids, alkaloids, terpenoids, saponins, tannins, and essential oils are known to inhibit or damage the membrane layer in eggs (Raveen *et al*., 2017). This is in line with the results of a previous study (Madona *et al*., 2020), which showed that a concentration of 1% tomato fruit extract can provide an ovicidal effect against *Aedes aegypti* mosquito eggs.

Flavonoids

Flavonoids are low-molecular-mass compounds produced through biosynthesis from acetic acid derivatives or phenylalanine through the shikimic acid pathway and have a core in the form of 2-phenyl-chromones. Several subclasses of flavonoids, including flavonols, flavanones, flavones, isoflavones, and anthocyanidins, are divided based on their structural properties (Wang *et al*., 2018).

Alkaloids

The heterocyclic ring system consists of nitrogen as the heteroatom of alkaloids. Alkaloids are compounds that are generally composed of carbon, hydrogen, nitrogen, and oxygen, although some types do not contain oxygen. The alkaline nature of alkaloids is due to the presence of nitrogen atoms in their chemical ring structure (Maisarah *et al*., 2023).

Saponins

Saponins are glycoside compounds with steroid or triterpenoid aglycones. Generally, saponins have a glycosyl group attached at the C3 position, although some types have two sugar chains attached at the C3 and C17 positions. This chemical structure gives saponins properties resembling soap or detergent; therefore, they are known as natural surfactants (Putri *et al*., 2023). The chemical structure of Saponins are glycosides consisting of glycons and aglycons. The glycone part consists of sapogenins, such as glucose, fructose, and other sugars. The amphiphilic nature of saponins allows natural materials containing them to act as surfactants (Nurzaman *et al*. 2018).

Tannins

Tannins are secondary metabolites that are naturally synthesized by plants. This compound is classified as a polyphenol with varied structures and a high molecular weight, ranging from 500 to 20,000 Daltons (Elgailani & Ishak, 2016).

Tomato Extraction Process

Liquid-Liquid Extraction

Liquid-liquid extraction utilizes partial solubility differences to separate liquid mixtures consisting of two or more components. This method is generally applied when distillation is not possible for certain reasons (Aji *et al*., 2018). Liquid-liquid extraction on tomato plants is carried out by soaking crushed tomatoes with hexane solvent (1:2) for 3 hours at a temperature of 65°C which is then washed using distilled water and transferred into a separating funnel to separate the extract from impurities. This extraction is performed to withdraw or obtain lycopene compounds from tomato plants (Tarigan *et al*., 2016).

Cold Extraction

One method of cold extraction is maceration. The maceration method is the most commonly used extraction technique for extracting active compounds from natural materials. This process is carried out at room temperature without heating to maintain the stability and integrity of the active compounds that are easily damaged by heat (Rahayu *et al*., 2020). The extraction of tomato fruit, both apple tomatoes and ordinary tomatoes, was carried out using water and 40% ethanol. This extraction procedure was performed by maceration for two days. The results of this study showed that both solvent extracts, namely, ethanol extracts from apple tomatoes, produced the highest yield values, and ordinary tomato extracts produced the lowest yields. Most red pigments in plants are soluble in polar solvents, including water (Maong *et al*., 2015).

Pharmacological Aspects of Tomato Plants

Based on the results of the literature review, tomato plants have several pharmacological effects, including antioxidant, anti-inflammatory, antimicrobial, antihyperglycemic, and burn-healing effects.

Antioxidants

Based on information from literature sources, consumption of tomato fruit can reduce the risk of developing chronic diseases owing to the presence of lycopene, flavonoids, and bioactive carotenoids. Tomato plants can prevent disease through detoxification, thus improving the immune system and stimulating the production of red and white blood cells (Junnaeni & Mahati, 2019). These benefits are supported by the results of research conducted previously by Junnaeni and Mahati (2019), who stated that the effect of giving tomato extract on GSH levels decreased with the treatment of 1 mg/200 grBB and 1.5 mg/200 grBB of tomato extract to male Wistar rats, but this did not produce significant differences in GSH levels of test animals.

Tomato juice is rich in antioxidants, especially lycopene, which is very effective in counteracting free radicals, such as ROS, due to physical activity. Lycopene has antioxidant power far exceeding β-carotene and vitamin E. After exercise, SOD levels increased to 408.39 U/mL in response to oxidative stress but decreased to 304.58 U/mL after tomato juice consumption, indicating that lycopene successfully neutralizes ROS so that the body no longer requires excess SOD production (Hasan, 2018). In addition, antioxidants in tomato juice, especially lycopene, play an important role in counteracting free radicals, such as NAPQI, generated from paracetamol metabolism. Lycopene increases the activity of the body's antioxidant enzymes such as SOD, GPx, and catalase, and suppresses the NF-kB inflammatory pathway. These mechanisms help to prevent oxidative stress, inflammation, and renal tissue damage. Administration of tomato juice provides a protective effect, and a dose of 800 mg/kgBB significantly reduced creatinine levels (from 0.73 to 0.41 mg/dl, even lower than the positive control of 0.59) (Vega *et al*., 2025).

Antimicrobial

Based on research (Suhartati & Nuryanti, 2015), the ethanol extract from tomato waste can inhibit the growth of *Staphylococcus aureus* bacteria in vitro at concentrations of 50%-100% with a minimum inhibitory concentration of 50%. In addition, tomato fruit has antibacterial properties against *P. acnes*. These results are in line with those (Purwati and Pratiti (2021), who showed that tomato fruit extract inhibits the growth of *P. acnes* bacteria, with an average diameter of 1.94, 3.74, and 5.14 mm at 20 %, 40%, and 60% concentrations, respectively, and average of 5.14 mm in the positive control clindamycin with an average of 9.15 mm. In addition, Hamida *et al*. (2022) showed that 96% ethanol extract of cherry tomato fruit has antibacterial activity against *Propionibacterium acnes* and *Staphylococcus aureus*. In the disc diffusion test, the 75% extract concentration showed a strong inhibition zone of 19.83 mm against *Staphylococcus aureus* (classified as strong) and a moderate 9.20 mm zone against *Propionibacterium acnes* (classified as moderate). Clindamycin, used as a positive control, produced an inhibition zone of >38 mm. The minimum inhibitory concentration (KHM) test showed that the extract effectively inhibited *S. aureus* at a concentration of 11.5% and *P. acnes* at 12.5% concentration.

The ethanol extract of tomato fruit (*Lycopersicum esculentum*) is also known to have antibacterial properties against Klebsiella pneumoniae, which causes pneumonia. Tests using the well diffusion method with five variations of extract concentration (3, 6.25, 12.5, 25, and 50%) showed that the increase in extract concentration was directly proportional to the diameter of the inhibition zone formed. The smallest zone of inhibition was recorded at 3% concentration at 2.83 mm, while the largest zone of inhibition was achieved at 50% concentration with a size of 11.50 mm. In comparison, ciprofloxacin used as a positive control produced an inhibition zone of 29.13 mm, while the negative control (DMSO) showed no inhibition zone (Maong *et al*., 2015).

Anti-inflammatory

Based on research conducted by Mustika and Subandi (2018), the administration of tomato juice after exposure to cigarette smoke can reduce the number of inflammatory cells in alveolar tissue. The Pearson correlation test results showed that higher doses (1.15, 2.3, and 4.6 mL/day) decreased the number of inflammatory cells in the alveoli ($r = -0.868$; $p=0.000$).

Antihyperglycemic

Hyperglycemia is a sign of diabetes mellitus (DM), a metabolic disease. The combination of tomato and bitter melon juices is beneficial as a blood sugar-lowering agent. The results of research in group 5 (tomato juice 16.8 g/kgBB: bitter melon juice 17.4 g/kgBB) (Wulandari, 2016) showed that blood sugar levels decreased more than with the consumption of a single juice. In addition, another combination of cucumber and tomato juice also has the potential as an antihyperglycemic, based on research (Suntoro *et al*., 2017), which suggests that a combined dose of cucumber and tomato (28 g/KgBB;16.8 g/KgBB) can reduce glucose concentrations in rats. The lycopene content in tomatoes can allegedly increase insulin concentration, reduce hydrogen peroxide (H_2O_2) levels, and protect the pancreas from free radicals, making it useful as an antidiabetic (Wulandari, 2016).

Burns

Antioxidants in ripe tomatoes effectively limit hyperoxidative stress and the duration of inflammatory procedures. In addition, tomato extract can increase the migration of keratinocytes and fibroblasts to accelerate the wound healing process (Wulandari, 2016). Studies using tomato fruit extracts at concentrations of 50, 60, and 70% have demonstrated healing effects on burn wounds in rabbits. This is known based on the healing parameters, namely the diameter of the proliferative phase, which is getting smaller, with the most optimal effect obtained at a concentration of 60%, with an average wound size of 1.63 (Ervianingsih & Razak, 2017).

Toxicity

In addition to being efficacious for health, tomato plants also have harmful effects, namely, disrupting the performance of cell membranes and inhibiting the activity of acetylcholinesterase and butylcholinesterase, similar to other glycoalkaloid compounds. The absorption of tomato plants in the digestive tract is poor because they form a complex that is not absorbed by the intestine. According to a previous study (Nguenang *et al*., 2020), administration of tomato leaf extract at doses of 250, 500, and 1000 mg/kg caused subacute toxicity effects, and there were symptoms of poisoning in test animals, namely, gastrointestinal symptoms. Doses >5000 mg/kg can cause acute toxicity. In addition, tomato seed extract is known to have a toxic effect at a concentration of 400 ppm, with an LC_{50} value of 432 ppm. The *Brine Shrimp Lethality Test* (BSLT) was used, and the toxicity of this test is based on the death that occurs in shrimp larvae test animals (Alfarabi & Triani, 2016).

In contrast to the above studies, the results of tests conducted (Iswari *et al.*, 2019) showed that tomato extract (*Solanum lycopersicum*) did not cause acute toxicity effects on the liver of *Sprague Dawley* rats even though it was given up to a high dose (16000 mg/head). Biochemical examinations, such as AST, ALT, ALP, and GGT, remained within normal limits, and histopathological analysis showed no liver tissue damage. Although there was a slight widening of intercellular spaces at the high dose, this did not indicate toxic damage. Thus, based on the results of this study, tomato extract is safe and not acutely hepatotoxic.

DOSAGE FORMULATION

In the process of developing a new drug, active ingredients and additives are combined after a preformulation study. Conventional formulation methods change one variable or factor at a time. The first step in the formulation process is to understand the effect of composition and process variables on the dosage form by changing one factor at a time while keeping the other variables constant. Next, optimization was performed based on the evaluation data to obtain the most effective formula (Hidayat *et al.*, 2020). Various dosage formulations from tomato plants are presented in Table I.

Table III. Formulation of Preparations From Tomato Plants

Preparations	Formulation	Results	Reference
Sunscreen Lotion	Tomato extract (0.4–1.5%), Lotion base (Terfose 63, paraffin, preservatives, water)	Good physical stability for 28 days; extract concentration 1–1.5% shows potential sunscreen activity	(Sopyan *et al.*, 2017)
Cream	Tomato fruit lyophilizate (1%, 3%, 5%), Cream base (emulsifiers, emollients, preservatives, fragrance, water)	Physically stable. Cream with 5% extract increases skin moisture by 39%.	(Yusuf *et al.*, 2018)
Liquid Soap	Tomato extract 2.5%, Liquid soap base (Carbopol variations, KOH, surfactant, Vitamin E, water, fragrance)	Antioxidant liquid soap; best formula is F3 with 6% carbopol based on evaluation test.	(Agustina *et al.*, 2017)
Hand And Body Lotion	Tomato juice (5%, 10%, 15%), Lotion base (emulsifiers, humectants, preservatives, fragrance, water)	Strong antioxidant activity. Best activity in formula with 15% tomato juice (lowest IC_{50} = 23,162 mg/L). All formulas passed physical tests (pH, homogeneity, spreadability).	(Romadhon *et al.*, 2023)
Serum	Tomato extract + watermelon rind extract (various ratios), Serum base (polymer thickener,	Best antioxidant activity obtained in F3 (tomato:watermelon = 2:1) with IC_{50} of 69.33 µg/mL. Collagenase inhibition not yet tested.	(Purwanti *et al.*, 2022)

	humectant, preservative)		
Tomato Fruit Juice Instant Drink Powder	Dried tomato extract (2.5%, 10%, 20%), Powder base (citric acid, sucrose, maltodextrin, glycerin)	Formula with 10% dried tomato extract (F2) is most preferred (taste, aroma, color) and shows good antioxidant activity (90.30 ppm).	(Zaddana *et al.*, 2021)
Tomato Fruit Extract Gel with Variation of HPMC Concentration	Tomato fruit extract, Gel base (HPMC, propylene glycol, ethanol, methyl paraben, propyl paraben, purified water)	Formula 2 (PMC 4%) demonstrates the most favorable physical characteristics, stable pH, acceptable viscosity, homogeneous appearance, and no irritation.	(Setiani & Endriyatno, 2023)
Tomato Fruit Extract Gel for Incision Wounds	Tomato fruit extract, Gel base (CMC-Na, propylene glycol, methyl paraben, purified water)	The 16% extract concentration provides the most optimal wound-healing effectiveness.	(Supit *et al.*, 2021)
Sunscreen Formulation of Tomato Lycopene Microemulsion Antioxidant Cream	Tomato lycopene extract, Cream base (Tween 80, glycerin, VCO, distilled water)	The microemulsion shows stable pH, suitable viscosity, and good physical stability during storage.	(Sulastri *et al.*, 2017)

Sunscreen Lotion

Tomato (*Solanum lycopersicum*) has properties as a sunscreen consisting of lycopene which can provide ultraviolet (UV) irradiation in sunlight and protect the skin from UV B rays that induce *photodamage*. Based on the results of research (Sopyan *et al.*, 2017), tomato extract concentrations in sunscreen *lotions* with SPF values close to SPF 15 from extracts that are 1% and 1.5% tomato extract with SPF values of 18.84 and 22.24. Physical observation of the lotion was performed by organoleptic observation, pH and viscosity measurement, centrifugation, and freeze liquefaction. The qualitative test showed a stable profile during 28 days of storage.

Cream

Tomato plants contain high levels of antioxidants that are beneficial for nourishing and protecting the skin. Tomato plants can be formulated into lyophilized cream preparations (Yusuf et al., 2018). The results of the physical stability evaluation showed that all the formulas (F1, F2, and F3) remained stable during the test period. The moisture test showed an increase in moisture content as the concentration of tomato fruit lyophilizate increased, which was 11% in F1 (1%), 22% in F2 (3%), and 39% in F3 (5%). Formula III proved to be the most effective in increasing skin moisture, with an increase of 39% at a concentration of 5%.

Liquid Soap

Based on the results of research conducted by Agustina *et al.* (2017), variations in the amount of carbopol were used to optimize the formula. Antioxidant activity was measured by

1,1-diphenyl-2-picrylhydrazyl (DPPH) test. The best soap formulation used carbopol at a 6% concentration.

Hand and Body Lotion

Three lotion formulations made from fruit juice with varying concentrations of 5%, 10%, and 15% were studied. Based on the organoleptic test, the three formulations showed good consistency (thick), distinctive odor (oleum citri), and an increasingly pale color as the tomato concentration increased. Based on the homogeneity evaluation, all lotions were flat and did not contain coarse particles. In the spreadability test, the average was between 5 and 5.5 cm, the adhesion of the three formulas was in the ideal range (more than 4 s), and the total pH of the formula was 6. However, the stability test results showed that all formulations experienced oil and water phase separation owing to the high water content in tomato juice, indicating that the emulsion was unstable. The data showed that formula III (15%) had the best antioxidant potential of the other two formulas, with an IC_{50} value of 23,162.01 mg/L (Iswari *et al*., 2019).

Serum

Based on previous research (Purwanti *et al*., 2022), no previous studies have proven the effectiveness of the combination of tomato extract and watermelon rind in inhibiting collagenase. However, formulation F3 (tomato:watermelon ratio 2:1) showed the best activity with an IC_{50} value of 69.33 ppm, which was superior to F1 and F2.

Tomato Fruit Juice Instant Drink Powder

The results obtained showed that formula 2 (10%) is the best instant drink powder because it meets the quality test of ar content, ash content, total plate count, and antioxidant activity of 90.30 ppm (Zaddana *et al*., 2021).

Tomato Fruit Extract Gel with Variation of HPMC Concentration

The sunscreen activity of tomato fruit is caused by flavonoid and lycopene compounds. Research (Setiani & Endriyatno, 2023) has confirmed that tomato fruit extract can be formulated into gel preparations with different variations in HPMC concentration. The results of this study indicate that the variation in HPMC concentration as a gelling agent influences the physical properties of the preparation. The results of this study also show that the best formula is F2. Formula 2 has formula 2 (PMC 4%) has the best physical properties of the preparation compared to formulas 1 and 3. Formula 2 has organoleptic properties which are orange in color, has a distinctive aroma of tomatoes, has a thick texture and a homogeneous preparation. The pH is 6.42, viscosity is 429 Dpas, spreadability is 5.52 cm, stickiness is 4 seconds, does not irritate, and has good stability (Setiani & Endriyatno, 2023).

Tomato Fruit Extract Gel for Wounds

Research related to the manufacture of gels with tomato fruit extracts at concentrations of 8, 12, and 16% showed that the gel preparations made can provide healing to cut wounds in groups of rats. Group III using tomato fruit extract gel with a concentration of 8% showed an average healing time of 8 days. Group IV with 12% concentration took approximately 10.6 days, while the 16% concentration showed the fastest healing time with an average of 7.3 days. Based on these results, the 16% concentration gel is a preparation that has the best formulation compared to other formulas (Supit *et al*., 2021).

Sunscreen Formulation of Tomato Lycopene Microemulsion Antioxidant Cream

The results of research (Sulastri *et al*., 2017) showed that a stable tomato lycopene extract microemulsion formula consisted of 0.3% tomato lycopene extract, 15% VCO, 80% tween, and 35% glycerin. Lycopene was formulated in the form of microemulsion using VCO as the oil phase, Tween 80 as surfactant, and glycerin as cosurfactant. The physical stability test results of the selected tomato lycopene extract microemulsion formula showed characteristics such as aromatic aroma, orange color, thick consistency, globule size less than 5 µm, viscosity ranging from 600.33 ± 69.29 to 746 ± 8.32 cPs, and pH between 6.27 ± 0.20 and 6.79 ± 0.10. This formula also showed very strong antioxidant activity with an IC_{50} value of 29.07 ppm, proving the effectiveness of the formulation in maintaining and enhancing the potency of lycopene as an antioxidant. Therefore, this study shows that microemulsions are a potential dosage form to increase the bioavailability of lipophilic compounds such as lycopene, and can be further developed for pharmaceutical or cosmetic preparations that utilize natural antioxidants from tomatoes.

CONCLUSION

Based on literature studies, tomato plants (*Solanum lycopersicum*) have great potential in the field of pharmaceuticals and herbal cosmetics because of their bioactive compounds, such as lycopene, flavonoids, vitamin C, and tomatin, which provide pharmacological effects such as antioxidant, anti-inflammatory, antimicrobial, antihyperglycemic, and wound healing. In addition, tomatoes have been formulated into various dosage forms, such as sunscreen lotions, creams, liquid soaps, serums, gels, and instant drink powders, which show good effectiveness and stability. Despite the potential for toxicity at high doses, most studies have shown that the use of tomatoes in topical and oral preparations is relatively safe, thus supporting their use as natural active ingredients in pharmaceutical and cosmetic products.

ACKNOWLEDGMENTS

The authors would like to thank the Faculty of Pharmacy of Ahmad Dahlan University and the Pharmacy Study Program of Aisyah Pringsewu University for providing support to complete this review.

REFERENCES

Agustina, L., Yulianti, M., Shoviantari, F., & Sabban, I. F. (2017). Formulasi Dan Evaluasi Sabun Mandi Cair Dengan Ekstrak Tomat(Solanum Lycopersicum L.) Sebagai Antioksidan. *Jurnal Wiyata*, *4*(2), 104–110.

Aji, A., Bahri, S., & Tantalia, T. (2018). Pengaruh Waktu Ekstraksi Dan Konsentrasi Hcl Untuk Pembuatan Pektin Dari Kulit Jeruk Bali (Citrus Maxima). *Jurnal Teknologi Kimia Unimal*, *6*(1), 33. Https://Doi.Org/10.29103/Jtku.V6i1.467

Alfarabi, M., & Triani, S. M. (2016). *Majalah Kedokteran Uki 2016 Vol Xxxii No.4 Oktober - Desember Artikel Singkat Uji Toksisitas Dan Identifikasi Fitokimia Ekstrak Biji Tomat (. Xxxii*(4), 175–178.

Andriani, E. S., & Hintono, A. (2018). Perubahan Fisik Tomat Selama Penyimpanan Pada Suhu Ruang Akibat Pelapisan Dengan Agar-Agar Physical Changes Of Tomatoes During Storage At Room Temperature Due To Coating With Agar. *Jurnal Teknologi Pangan*, *2*(2), 176–182. Www.Ejournal-S1.Undip.Ac.Id/Index.Php/Tekpangan.

Arifulloh. (2016). Ekstraksi Likopen Dari Buah Tomat (Lycopersicum Esculentum Mill.) Dengan Berbagai Komposisi Pelarut. *Berkala Saintek*, *4*(1), 15–18.

Astuti, Z. M., Ishartani, D., & Muhammad, D. R. A. (2021). The Use Of Low Calorie Sweetener Stevia In Velva Tomato (Lycopersicum Esculentum Mill). *Jurnal Teknologi Hasil Pertanian*, *14*(1), 31. Https://Doi.Org/10.20961/Jthp.V14i1.43696

Athinodorou, F., Foukas, P., Tsaniklidis, G., Kotsiras, A., Chrysargyris, A., Delis, C., Kyratzis, A. C., Tzortzakis, N., & Nikoloudakis, N. (2021). Morphological Diversity, Genetic Characterization, And Phytochemical Assessment Of The Cypriot Tomato Germplasm. *Plants*, *10*(8), 1–24. Https://Doi.Org/10.3390/Plants10081698

Billi, J., Dwiannur, F. R., & Assalafy, A. H. (2024). Formulasi Sediaan Lip Cream Dari Ekstrak Buah Tomat (Lycopersicum Esculentum Mill) Sebagai Pewarna Alami. *Journal Of Social Science Research*, *4*, 1306–1318.

Chaudhary, P., Sharma, A., Singh, B., & Nagpal, A. K. (2018). Bioactivities Of Phytochemicals Present In Tomato. *Journal Of Food Science And Technology*, *55*(8), 2833–2849. Https://Doi.Org/10.1007/S13197-018-3221-Z

Elgailani, I. E. H., & Ishak, C. Y. (2016). Methods For Extraction And Characterization Of Tannins From Some Acacia Species Of Sudan. *Pakistan Journal Of Analytical & Environmental Chemistry*, *17*(1). Https://Doi.Org/10.21743/Pjaec/2016.06.007

Ernest, E., Onyeka, O., A.C., O., & R.O., O. (2017). Comparative Assessment Of The Effect Of Ripening Stage On The Vitamin C Contents Of Selected Fruits Grown Within Nsukka Axis Of Enugu State. *International Journal Of Environment, Agriculture And Biotechnology*, *2*(2), 712–714. Https://Doi.Org/10.22161/Ijeab/2.2.19

Ervianingsih, & Razak, A. (2017). Uji Efektivitas Ekstrak Buah Tomat (Solanum Lycopersicum)Terhadap Penyembuhan Luka Bakar Pada Hewan Uji Kelinci (Oryctolaguscuniculus). *Borneo Journal Pharmascientech*, *01*(02), 1–9.

Fernandes, M. De O., Bianchi, P. A., Da Silva, L. R. A., Vianna, L. S., Santos, E. A., & Moulin, M. M. (2018). Morpho-Agronomic Characterization And Analysis Of Genetic Divergence Among Accessions Of Tomatoes (Solanum Lycopersicum L.). *Ciencia Rural*, *48*(11). Https://Doi.Org/10.1590/0103-8478cr20180433

Grozeva, S., Nankar, A. N., Ganeva, D., Tringovska, I., Pasev, G., & Kostova, D. (2021). Characterization Of Tomato Accessions For Morphological, Agronomic, Fruit Quality, And Virus Resistance Traits. *Canadian Journal Of Plant Science*, *101*(4), 476–489. Https://Doi.Org/10.1139/Cjps-2020-0030

Hamida, F., Kalaw, O. I., & Fahrudin, F. (2022). Efektivitas Antibakteri Ekstrak Etanol 96 % Buah Tomat Cherry (Solanum Lycopersicum Var . Cerasiforme) Terhadap Propionibacterium Acnes Dan Staphylococcus Aureus Penyebab Jerawat. *Semnas Bio*, *Vol. 2*, *No*, 380–387.

Hasan, A. K. (2018). Pengaruh Pemberian Jus Buah Tomat (Solanum Lycopersicum) Terhadap Kadar Antioksidan Pada Ibu Hamil Trimester Ketiga Pascasenam Hamil. *Jurnal Kesehatan Poltekkes Kemenkes Ri Pangkalpinang*, *6*(1), 16–22. Https://Doi.Org/10.32922/Jkp.V6i1.42

Herison, C., Sutjahjo, S. H., Sulastrini, I., Rustikawati, & Marwiyah, S. (2018). Genetic Diversity Analysis In 27 Tomato Accessions Using Morphological And Molecular Markers. *Agrivita*, *40*(1), 36–44. Https://Doi.Org/10.17503/Agrivita.V40i1.726

Hidayat, I. R., Zuhrotun, A., & Sopyan, I. (2020). Design-Expert Software Sebagai Alat Optimasi Formulasi Sediaan Farmasi. *Majalah Farmasetika*, *6*(1), 99–120. Https://Doi.Org/10.24198/Mfarmasetika.V6i1.27842

Iswari, R. S., Yuniastuti, A., & Widiatningrum, T. (2019). Acute Toxicity Of Tomato Extract (Lycopersicum Esculentum) On Rat’ Liver. *Kne Social Sciences*, *2019*, 554–561. Https://Doi.Org/10.18502/Kss.V3i18.4746

Junnaeni, J., & Mahati, E. (2019). Ekstrak Tomat (Lycopersicon Esculentum Mill.) Menurunkan Kadar Glutation Darah Tikus Wistar Hiperurisemia. *Jurnal Kedokteran Diponegoro*, *8*(2), 758–767.

Karim, D. D. A., Safutri, W., Hammami, A., & Chandra, A. A. (2023). Literature Review: Pharmacological And Toxicological Effects Of Plants From The Solanaceae Family. *Jurnal Aisyah : Jurnal Ilmu Kesehatan*, *8*(3), 1777–1793. Https://Doi.Org/10.30604/Jika.V8i3.2417

Lestari, E., & Lagiono, L. (2018). Pemanfaatan Tanaman Sebagai Obat Oleh Masyarakat Desa Karang Dukuh Kecamatan Belawang Kabupaten Barito Kuala. *Jurnal Pendidikan Hayati*, *4*(3), 114–119. Https://Doi.Org/10.33654/Jph.V4i3.309

Madona, M., Setyaningrum, E., Pratami, G. D., & Kanedi, M. (2020). Efektivitas Ekstrak Daun Tomat (Solanum Lycopersicum L.) Sebagai Ovisida Nyamuk Aedes Aegypti. *Jurnal Ilmu Kedokteran Dan Kesehatan*, *7*(1), 368–374.

Maisarah, M., Chatri, M., & Advinda, L. (2023). Karakteristik Dan Fungsi Senyawa Alkaloid Sebagai Antifungi Pada Tumbuhan. *Jurnal Serambi Biologi*, *8*(2), 231–236.

Maong, R., Rorong, J. A., & Fatimah, F. (2015). Aktivitas Ekstrak Buah Tomat (Lycopersicum Esculentum Mill) Sebagai Penstabil Oksigen Singlet Dalam Reaksi Fotooksidasi Asam Linoleat. *Jurnal Mipa*, *4*(2), 60. Https://Doi.Org/10.35799/Jm.5.1.2016.12288

Martí, R., Roselló, S., & Cebolla-Cornejo, J. (2016). Tomato As A Source Of Carotenoids

And Polyphenols Targeted To Cancer Prevention. *Cancers*, *8*(6), 1–28. Https://Doi.Org/10.3390/Cancers8060058

Mustika, D., & Subandi, S. (2018). Pengaruh Pemberian Jus Tomat (Solanum Lycopersicum) Terhadap Jumlah Sel Radang Di Alveolus Tikus Wistar (Rattus Norvegicus) Yang Dipapar Asap Rokok Kretek Subkronik. *Journal Of Islamic Medicine*, *2*(1), 16. Https://Doi.Org/10.18860/Jim.V2i1.5010

Nguenang, G. S., Ntyam, A. S. M., & Kuete, V. (2020). Acute And Subacute Toxicity Profiles Of The Methanol Extract Of Lycopersicon Esculentum L. Leaves (Tomato), A Botanical With Promising In Vitro Anticancer Potential. *Evidence-Based Complementary And Alternative Medicine*, *2020*. Https://Doi.Org/10.1155/2020/8935897

Nuraini, Safrida, & Hasanuddin. (2021). Pemanfaatan Tumbuhan Tradisional Sebagai Obat Diare Pada Masyarakat Kecamatan Terangun Kabupaten Gayo Lues. *Jurnal Jeumpa*, *8*(April), 501–515.

Nurzaman, F., Djajadisastra, J., & Elya, B. (2018). Identifikasi Kandungan Saponin Dalam Ekstrak Kamboja Merah (Plumeria Rubra L.) Dan Daya Surfaktan Dalam Sediaan Kosmetik. *Jurnal Kefarmasian Indonesia*, *8*(2), 85–93. Https://Doi.Org/10.22435/Jki.V8i2.325

Lestari, F., Djajadisastra, J., & Elya, B. (2018). Identifikasi Kandungan Saponin Dalam Ekstrak Kamboja Merah (Plumeria Rubra L.) Dan Daya Surfaktan Dalam Sediaan Kosmetik. *Jurnal Kefarmasian Indonesia*, *8*(2), 85–93. Https://Doi.Org/10.22435/Jki.V8i2.325

Odinita, C. A., Aiwansoba, R. O., Osawaru, M. E., & Ogwu, M. C. (2017). Morphological Evaluation Of Tomato (Solanum Lycopersicum Linn.) Cultivars. *Makara Journal Of Science*, *21*(2). Https://Doi.Org/10.7454/Mss.V21i2.7421

Purwanti, R. A., Farida, Y., & Taurhesia, S. (2022). Formulasi Sediaan Serum Anti Aging Dengan Kombinasi Dari Ekstrak Buah Tomat (Lycopersicum Esculentum L.) Dan Ekstrak Kulit Buah Semangka (Citrullus Lanatus Thunb.). *Jurnal Fitofarmaka Indonesia*, *9*(2), 19–24. Https://Doi.Org/10.33096/Jffi.V9i2.864

Purwati, E., & Pratiti, N. (2021). Uji Aktivitas Antibakteri Ekstrak Buah Tomat (Solanum Lycopersicum L.) Terhadap Bakteri Propionibacterium Acnes. *Jurnal Farmasi Indonesia | Afamedis*, *Ii*(2), 20–31. Https://Www.Journal-Afamedis.Com

Putri, A., Chatri, M., Advinda, L., & Violita. (2023). Karakteristik Saponin Senyawa Metabolit Sekunder Pada Tumbuhan. *Jurnal Serambi Biologi*, *8(2)*(2), 251–258.

Rahayu, N. K. T., Permana, I. G. M., & Puspawati, G. A. K. D. (2020). Pengaruh Waktu Maserasi Terhadap Aktivitas Antioksidan Ekstrak Daun Pegagan (Centella Asiatica (L.) Urban). *Jurnal Ilmu Dan Teknologi Pangan (Itepa)*, *9*(4), 482. Https://Doi.Org/10.24843/Itepa.2020.V09.I04.P12

Raveen, R., Ahmed, F., Pandeeswari, M., Reegan, D., Tennyson, S., Arivoli, S., Jayakumar, M., & Rajasingh Raveen Associate Professor, C. (2017). Laboratory Evaluation Of A Few Plant Extracts For Their Ovicidal, Larvicidal And Pupicidal Activity Against Medically Important Human Dengue, Chikungunya And Zika Virus Vector, Aedes Aegypti Linnaeus 1762 (Diptera: Culicidae). *~ 17 ~ International Journal Of Mosquito Research*, *4*(4), 17–28.

Romadhon, F. A., Wilapangga, A., & Fatwami, E. F. (2023). Formulasi Dan Uji Fisik Hand And Body Lotion Sari Buah Tomat (Solanum Lypersicum L.) Yang Berkhasiat Sebagai Antioksidan. *Indonesian Journal Of Pharmaceutical Education (E-Journal)*, *3*(3), 2775–3670. Https://Doi.Org/10.37311/Ijpe.V3i3.22744

Rosmaniar, L., Ningsih, W., Ayu, N. P., & Nanda, H. (2018). Penentuan Kadar Vitamin C Beberapa Jenis Cabai (Capsicum Sp.) Dengan Spektrofotometri Uv-Vis. *Jurnal Kimia Riset*, *3*(1), 1. Https://Doi.Org/10.20473/Jkr.V3i1.8874

Sacco, A., Ruggieri, V., Parisi, M., Festa, G., Rigano, M. M., Picarella, M. E., Mazzucato, A., & Barone, A. (2015). Exploring A Tomato Landraces Collection For Fruit-Related Traits By The Aid Of A High-Throughput Genomic Platform. *Plos One*, *10*(9). Https://Doi.Org/10.1371/Journal.Pone.0137139

Safnowandi, S. (2022). Pemanfaatan Vitamin C Alami Sebagai Antioksidan Pada Tubuh Manusia. *Biocaster : Jurnal Kajian Biologi*, *2*(1), 6–13. Https://Doi.Org/10.36312/Bjkb.V2i1.43

Sari, L. D. A., Kurniawati, E., Ningrum, R. S., & Ramadani, A. H. (2021). Kadar Vitamin C Buah Tomat (Lycopersicum Esculentum Mill) Tiap Fase Kematangan Berdasar Hari Setelah Tanam. *Jurnal Farmasi Dan Ilmu Kefarmasian Indonesia*, *8*(1), 74. Https://Doi.Org/10.20473/Jfiki.V8i12021.74-82

Setiani, I., & Endriyatno, N. C. (2023). Formulasi Gel Ekstrak Buah Tomat (Solanum Lycopersicum L.) Dengan Variasi Konsentrasi Hpmc Serta Uji Fisiknya. *Indonesian Journal Of Pharmaceutical Education (E-Journal)*, *3*(3), 2775–3670. Https://Doi.Org/10.37311/Ijpe.V3i3.21186

Sopyan, I., Gozali, D., & Tiassetiana, S. (2017). Formulation Of Tomato Extracts (Solanum Lycopersicum L.) As A Sunscreen Lotion. *National Journal Of Physiology, Pharmacy And Pharmacology*, *8*(3), 1. Https://Doi.Org/10.5455/Njppp.2017.7.1039921112017

Suhartati, R., & Nuryanti, D. (2015). Potensi Antibakteri Limbah Tomat (Lycopersicum Esculentum Mill) Terhadap Bakteri Staphylococcus Aureus. *Jurnal Kesehatan Bakti Tunas Husada: Jurnal Ilmu-Ilmu Keperawatan, Analis Kesehatan Dan Farmasi*, *13*(1). Https://Doi.Org/10.36465/Jkbth.V13i1.32

Sulastri, E., Ikram, M., & Yuliet, Y. (2017). Uji Stabilitas Dan Aktivitas Antioksidan Mikroemulsi Likopen Tomat (Solanum Lycopersicum L.). *Jurnal Farmasi Galenika (Galenika Journal Of Pharmacy) (E-Journal)*, *3*(1), 10–17. Https://Doi.Org/10.22487/J24428744.2017.V3.I1.8134

Suntoro, Susanti, R., & Robiyanto. (2017). Uji Efektivitas Antihiperglikemia Kombinasi Jus Mentimun (Cucumis Sativus) Dan Tomat (Solanum Lycopersicum L) Terhadap Tikus Wistar Jantan. *Jurnal Penelitian Dan Pengembangan Borneo Akcaya*, *4*(1), 16–23.

Supit, S. F., Bodhi, W., & Sari Lebang, J. (2021). Uji Efektivitas Gel Ekstrak Buah Tomat (Solanum Lycopresicum L) Terhadap Luka Sayat Pada Tikus Putih Jantan (Rattus Novergicus). *Pharmacon*, *10*(4), 1081–1086. Https://Ejournal.Unsrat.Ac.Id/V3/Index.Php/Pharmacon/Article/Download/37401/34499/79516

Sutapa, N., & Kasmawan, G. I. (2016). *Efek Induksi Mutasi Radiasi Gamma 60 Co Pada Pertumbuhan Fisiologis Tanaman Tomat (Lycopersicon Esculentum L.)*. *1*, 5–11. Www.Batan/Ptkmr/Jrkl

Tareen, H., Ahmed, S., Mengal, F., Masood, Z., Bibi, S., Mengal, R., Shoaib, S., Irum, U., Akbar, S., Mandokhail, F., & Taj, R. (2015). Estimation Of Vitamin C Content In Artificially Packed Juices Of Two Commercially Attracted Companies In Relation To Their Significance For Human Health. *Biological Forum–An International Journal*, *7*(2), 682–685. Www.Researchtrend.Net

Tarigan, S. F. G., Sinaga, D. C. S., & Zuhrina, M. (2016). Kristalisasi Antisolvent. *Jurnal Teknik Kimia*, *5*(2), 9–14.

Vega, A., Lubis, A. A., & Yunus, M. (2025). *Pengujian Efek Proteksi Jus Tomat (Solanum Lycopersicum (L .)) Terhadap Fungsi Ginjal Tikus Yang Diinduksi Parasetamol*. *April*.

Wahyuni, R. R., Sari, I., & Yusuf, E. Y. (2018). Pengaruh Pemberian Konsentrasi Terusi (Cuso4) Terhadap Produksi Tomat (Lycopersicum Esculentum Mill) Pada Media Gambut. *Jurnal Agro Indragiri*, *1*(01), 244–254. Https://Doi.Org/10.32520/Jai.V1i01.635

Waluyo, T. (2020). Analisis Finansial Aplikasi Dosis Dan Jenis Pupuk Organik Cair Terhadap Produksi Tanaman Tomat (Lycopersicum Esculentum Mill). *Jurnal Ilmu Dan Budaya*, 8357–8372.

Wang, T. Yang, Li, Q., & Bi, K. Shun. (2018). Bioactive Flavonoids In Medicinal Plants: Structure, Activity And Biological Fate. *Asian Journal Of Pharmaceutical Sciences*, *13*(1), 12–23. Https://Doi.Org/10.1016/J.Ajps.2017.08.004

Wulandari, W. (2016). Uji Efektivitas Antihiperglikemia Kombinasi Jus Pare (Momordica Charantia L) Dan Jus Tomat (Solanum Lycopersicum L) Pada Tikus Wistar Jantan

Dengan Metode Toleransi Glukosa. *Pharmaceutical Sciences And Research*, *3*(3), 145–154. Https://Doi.Org/10.7454/Psr.V3i3.3269

Yuniastri, R., Atkhiyah, V. M., & Al Faqih, K. (2020). Tomato Physical And Chemical Damage Characteristics. *Journal Of Food Technology And Agroindustry*, *2*(1), 1–8.

Yusuf, N. A., Hardianti, B., & Dewi, I. (2018). Formulasi Dan Evaluasi Krim Liofilisat Buah Tomat (Solanum Lycopersicum L) Sebagai Peningkat Pelembab Pada Kulit (Formulation And Evaluation Of Tomato (Solanum Lycopersicum L) Fruits Lyophilisate Cream For Increase Moisturizing In Skin). *Journal Of Current Pharmaceutical Sciences*, *2*(1), 2–7.

Zaddana, C., . A., & Meida, U. (2021). Formulasi Dan Aktivitas Antioksidan Serbuk Minuman Instan Sari Buah Tomat (Solanum Lycopersicum). *Fitofarmaka: Jurnal Ilmiah Farmasi*, *11*(1), 87–98. Https://Doi.Org/10.33751/Jf.V11i1.2819