

Antihypercholesterolemic Edible Flowers in Indonesia: A Review

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Abstract: Hypercholesterolemia is a major risk factor for cardiovascular diseases, including atherosclerosis and coronary heart disease, characterized by elevated levels of total cholesterol, Low-Density Lipoprotein (LDL), Triglycerides (TG), and oxidative stress. Although synthetic antihypercholesterolemic drugs are effective, their long-term use can cause side effects, highlighting the need for safer natural alternatives. Indonesia has a rich biodiversity of edible flowers, which are rich in bioactive compounds such as flavonoids, polyphenols, anthocyanins, carotenoids, tannins, saponins, alkaloids, and terpenoids, with potential lipid-lowering and antioxidant activities. This study aims to review the antihypercholesterolemic potential of edible flowers traditionally consumed in Indonesia. The literature review was conducted using the PICOS framework and the Google Scholar and PubMed databases. A systematic literature search was conducted using Scopus, PubMed, ScienceDirect, and Google Scholar databases covering publications from January 2020 to December 2025. A total of 230 records were identified; 25 studies met the eligibility criteria and were included in the final qualitative synthesis. The edible flowers reviewed included *Tagetes erecta*, *Rosa* spp., *Jasminum sambac*, *Hibiscus sabdariffa*, *Clitoria ternatea*, *Chrysanthemum morifolium*, and *Carthamus tinctorius*. Findings suggest that these flowers can reduce total cholesterol, LDL cholesterol, Triglycerides, Apolipoprotein B (ApoB), and Malondialdehyde (MDA), while increasing antioxidant parameters such as Superoxide Dismutase (SOD) and Glutathione (GSH). The proposed mechanisms involve inhibition of HMG-CoA reductase activity, prevention of LDL oxidation, improvement of lipid metabolism, and reduction of oxidative stress and inflammation. Overall, edible flowers in Indonesia show promising potential as functional foods and complementary natural therapies for the prevention and treatment of hypercholesterolemia and cardiovascular diseases.

Keywords: Antihypercholesterolemia; Antioxidant; Edible Flowers; Flavonoids; Indonesian Herbs.

Introduction

High total cholesterol levels are a risk factor for non-communicable diseases, such as atherosclerosis and various metabolic diseases. The increasing number of non-communicable diseases is a significant health problem worldwide, including in Indonesia. According to data from the World Health Organization (WHO), in 2008, 36 million of the 57 million global deaths were caused by non-communicable diseases. Cardiovascular disease accounted for the largest percentage of these deaths, approximately 39%. The surge in non-communicable diseases occurred most frequently in middle- and low-income countries. This mortality rate is predicted to continue to rise. Changes in people's dietary patterns that have occurred with progress are one of the main causes. These changes negatively impact health, including increased fast-food consumption. Fast food is usually high in fat, making it difficult to control total blood cholesterol levels.[1].

The *American Heart Association* (AHA) estimates that more than 100 million people in the United States have total cholesterol levels above 200 mg/dL, and more than 34 million adults have levels above 240 mg/dL, which is considered high and requires treatment. According to the 2018 Basic Health Research (Riskesdas), the proportion of Indonesians with cholesterol levels above the normal limit is

higher among women (20.7%) than among men (6.8%) [2]. Several factors that contribute to total cholesterol levels include a low-fiber diet, high-fat consumption, smoking, gender, excess weight, and physical activity levels. In Indonesia, the prevalence of hypercholesterolemia increases with age and remains a significant cardiovascular risk factor among adults [3]. In addition, dietary patterns differ between rural and urban communities in Indonesia, with changes in consumption of processed foods and high-fat foods occurring across regions [4].

The use of statin drugs can reduce the incidence of hypercholesterolemia by inhibiting HMG-CoA reductase, thereby reducing cholesterol synthesis in the liver [5]. However, the use of statin drugs can cause side effects on health, such as myalgia [6], Statin-Associated Muscle Symptoms (SAMS) [7], and even life-threatening rhabdomyolysis [8], so alternative therapies derived from herbal plants, especially edible flowers, are needed.

Edible flowers are safe for consumption and have been used since ancient times by civilisations in China, India, and Egypt as herbal teas to support health and treat various ailments. Examples of commonly used flowers include chamomile, roselle, and butterfly pea. In traditional medicine, these edible flowers offer many benefits, including reducing stress, improving sleep quality, reducing inflammation, boosting the immune system, and improving

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digestion. Some flowers, such as roselle and butterfly pea, also act as cholesterol-lowering agents due to their antioxidant content, which can help lower LDL (bad) cholesterol levels and protect blood vessels from fat accumulation. The cholesterol-lowering mechanism of edible flowers is influenced by the presence of flavonoids, anthocyanins, and phenolic compounds that function as antioxidants [9]. These compounds work by inhibiting the oxidation of LDL (bad cholesterol), reducing fat absorption in the digestive system, and improving fat metabolism. Furthermore, anthocyanins increase HDL (good cholesterol) levels, thereby helping remove cholesterol from the body. Their antioxidant and anti-inflammatory effects also play a key role in preventing atherosclerosis, which is caused by the accumulation of fat in blood vessels [10].

The purpose of this study on *Rosella* (*Hibiscus sabdariffa* L), papaya flowers, jasmine, roses, red hibiscus, chrysanthemum, periwinkle, butterfly pea flowers, cananga flowers, and *Camellia sinensis* is to collect and analyze various types of edible plants and flowers that can be used as functional foods and herbal medicines to lower cholesterol. This study aims to identify the active compounds in each plant, such as flavonoids, anthocyanins, polyphenols, tannins, saponins, alkaloids, and antioxidants, that help lower blood cholesterol levels. In addition, this study aims to explain how these compounds lower cholesterol by inhibiting fat and cholesterol absorption in the intestine, increasing fat metabolism, reducing LDL (bad cholesterol) oxidation, and increasing HDL (good cholesterol) levels. Furthermore, this study aims to determine the traditional benefits of these plants, which have long been used as herbal teas, health drinks, and alternative medicines in various communities.

Despite growing evidence regarding the antihypercholesterolemic effects of medicinal plants and natural antioxidants, existing reviews largely focus on herbal medicines, phytochemicals, or functional foods in general. To date, there has been no comprehensive review specifically synthesizing the antihypercholesterolemic potential of edible flowers traditionally consumed in Indonesia. Furthermore, available studies are scattered across various flower species, experimental models, and bioactive compounds, making it difficult to build a unified understanding of their mechanisms of action and therapeutic relevance.

Indonesia is recognized as one of the world's megabiodiversity countries and boasts a rich diversity of edible flowers traditionally used as food, beverages, herbal infusions, spices, and traditional medicines. However, scientific evidence on their cholesterol-lowering effects remains fragmented and has not been systematically evaluated within a single review. Therefore, a comprehensive synthesis is needed to identify promising edible flower species, summarize their bioactive constituents, and elucidate the biological mechanisms underlying their antihypercholesterolemic activity.

Despite the increasing number of studies investigating the lipid-lowering effects of medicinal plants, natural antioxidants, and functional foods, the available evidence remains fragmented across various plant species, phytochemical classes, and experimental models. Previous review articles have generally focused on herbal medicines, dietary antioxidants, or edible flowers from various

geographic regions without specifically addressing edible flowers traditionally consumed in Indonesia and their potential role in managing hypercholesterolemia. Consequently, the antihypercholesterolemic evidence associated with edible flowers in Indonesia remains scattered and difficult to interpret within a unified scientific framework.

Indonesia is recognized as one of the world's megabiodiversity countries and boasts a rich diversity of edible flowers that have long been utilized as food, beverages, herbal infusions, spices, and traditional medicines. However, no previous review has comprehensively evaluated and compared the antihypercholesterolemic activities, bioactive constituents, and underlying mechanisms of these edible flowers in the Indonesian context. Furthermore, available studies vary widely in plant species, extraction methods, experimental designs, and outcome measures, posing challenges in identifying the most promising flower species and the mechanisms underlying their lipid-lowering effects. Therefore, a systematic synthesis of current evidence is needed to consolidate existing knowledge and identify future research directions.

The uniqueness of this review lies in its comprehensive synthesis of edible flowers traditionally consumed in Indonesia and their potential antihypercholesterolemic activities. Unlike previous reviews that broadly discussed medicinal plants, phytochemicals, antioxidants, or edible flowers from various regions, this review specifically integrates evidence regarding edible flower species in Indonesia, their key bioactive compounds, their mechanisms of action, and the level of scientific evidence. Furthermore, this review critically evaluates the strengths and limitations of existing studies and highlights future opportunities to develop edible flowers as functional foods and complementary strategies for cardiovascular disease prevention.

Given the increasing prevalence of hypercholesterolemia and the growing demand for safer natural interventions, edible flowers represent a promising yet underexplored source of bioactive compounds with potential cardioprotective benefits. Therefore, a systematic synthesis of current evidence is crucial to support future research, the development of functional foods, and the evidence-based utilization of Indonesia's edible floral biodiversity for improving cardiovascular health.

Research methods

Study Design

This study employed a Systematic Literature Review (SLR) approach following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines. The review was conducted to systematically identify, evaluate, and synthesize scientific evidence regarding the antihypercholesterolemic potential of edible flowers traditionally consumed in Indonesia. The review focused on edible flowers containing bioactive compounds with lipid-lowering, antioxidant, anti-inflammatory, and cardioprotective activities associated with hypercholesterolemia management.

Search Strategy

A comprehensive literature search was conducted using PubMed, Scopus, ScienceDirect, and Google Scholar databases. The search covered studies published between January 2020 and December 2025 to ensure the inclusion of recent scientific evidence. The search strategy combined *yyhy* (MeSH) and free-text keywords using Boolean operators (AND, OR). The primary search string was: ("Edible flower" OR "flower extract" OR "functional flower" OR "medicinal flower") AND ("hypercholesterolemia" OR "cholesterol" OR "LDL" OR "lipid profile" OR "dyslipidemia") AND ("Indonesia" OR "Southeast Asia"). Additional searches were performed using the scientific names of edible flowers identified in Indonesia, including *Clitoria ternatea*, *Hibiscus sabdariffa*, *Cananga odorata*, *Chrysanthemum morifolium*, *Carthamus tinctorius*, *Catharanthus roseus*, *Rosa* spp., *Jasminum sambac*, *Etlingera elatior*, and *Tagetes erecta*.

Eligibility Criteria

This study used a literature review method modified from previous studies related to edible flowers and antihypercholesterolemia activity [11]. This review was conducted using the PICOS (Population, Intervention, Comparison, Outcomes, and Study Design) framework. Literature searches were performed using Google Scholar and PubMed databases for articles published between January 2020 and December 2024. The search keywords included “hypercholesterolemia”, “edible flowers”, “antioxidant”, “flavonoids”, “cardiovascular disease”, “Indonesia”, and the scientific names of selected edible flowers.

Table 1. Eligibility Criteria

Criteria	Inclusion	Exception
Population intervention	Hypercholesterolemia, dyslipidemia, oxidative stress, atherosclerosis, cardiovascular disorders, increased LDL/triglycerides	Conditions unrelated to lipid metabolism or cardiovascular disorders
Intervention	Edible flowering plants from Indonesia	Non-edible plants or non-herbal interventions
Comparator	-	-
Results	Antihypercholesterolemic, hypolipidemic, antioxidant, antiatherosclerotic, and cardioprotective effects.	Studies not related to lipid lowering or cardiovascular protection.
Research design	Experimental studies (in vivo, in vitro, preclinical, clinical studies)	Review articles, editorials, and opinion papers.
Year	2020-2025	Before 2020 and after 2025
Language	Indonesian, English	Languages other than Indonesian and English

The literature selection process was carried out through screening of titles, abstracts, and full texts according to the inclusion and exclusion criteria shown in Table 1. The selected studies were then analyzed descriptively to evaluate the potential of edible flowers in Indonesia as natural antihypercholesterolemic agents through mechanisms such as inhibition of LDL oxidation, reduction of total cholesterol and triglyceride levels, inhibition of HMG-CoA reductase activity, antioxidant activity, and prevention of atherosclerosis.

Study Selection Process

The study selection process follows the four stages recommended by PRISMA 2020: Identification, Screening, Eligibility, and Inclusion. During the identification phase, the database search yielded 218 records from Scopus, PubMed, ScienceDirect, and Google Scholar. An additional 12 records were identified through manual searches of reference lists and related studies, bringing the total to 230 records. After removing 38 duplicate records, 192 records remained for title and abstract screening. A total of 128 articles were excluded during screening because they did not focus on edible flowers, antihypercholesterolemic activity, cardiovascular outcomes, or bioactive compounds relevant to lipid metabolism. Consequently, 64 full-text articles were assessed for eligibility.

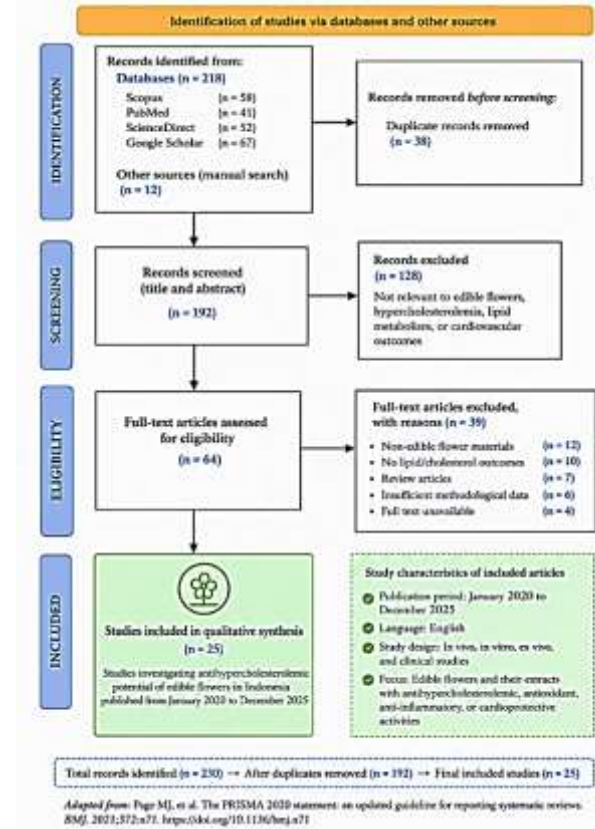


Figure 1. PRISMA 2020 Flowchart for Systematic Review of Antihypercholesterolemic Edible Flowers in Indonesia

During the eligibility assessment, 39 articles were excluded due to the use of inedible flower material, the absence of cholesterol-related outcomes, a review-only study design, inadequate methodological information, or inaccessible full text. Ultimately, 25 studies met all inclusion criteria and were included in the final qualitative synthesis.

Data Extraction and Synthesis

Data extraction was performed independently by the authors using a standard extraction form. Information collected included author names, year of publication, country of study, flower species, extraction method, bioactive compounds, experimental design, outcome variables, antihypercholesterolemic mechanisms, and key findings. The extracted evidence was synthesized narratively due to heterogeneity in study design, flower species, extraction methods, dosages, and outcome measures. Particular emphasis was placed on mechanisms related to cholesterol reduction, inhibition of LDL oxidation, antioxidant activity,

modulation of inflammation, and regulation of lipid metabolism.

Results and Discussion

This research identifies various edible flowers and plants that are beneficial for lowering cholesterol, including cloves, Roselle (*Hibiscus sabdariffa*), papaya, jasmine, roses, red hibiscus, pigeon pea, chrysanthemum, periwinkle, butterfly pea, cananga, and Camellia sinensis. These plants grow abundantly in Indonesia and are used in herbal teas and traditional medicines, as further explained in the Table 2.

Table 2. Article Review Results (Edible Flowers for Hypercholesterolemia in Indonesia)

No	Title/Author/Year	Journal Name	Research sample	Research methods	Research result
1	Effectiveness Test of Papaya Flower Extract on Cholesterol in Male Mice Induced with Sucrose.	JIMKesmas (Scientific Journal of Public Health Students)	Male Mice (25)	quasi-experimental laboratory with a post-test only control group design	The results of the study showed that the group with the greatest cholesterol reduction was the 400 mg/kg BW dose, at 4.80%. However, based on the Paired T-test, there was no significant reduction after administration of papaya flower extract [18].
2	Effect of a novel lavender extract on plasma lipid and lipoprotein metabolism, glucose tolerance and adipose tissue metabolic activation: A preclinical safety and efficacy study.	Nutrients	Male Rats (20 rats)	This research is a laboratory experimental research (true experimental)	Lavender extract exhibits dose-dependent effects on lipid profiles and glucose metabolism. A dose of 100× yields the best results, including reduced plasma cholesterol levels, increased antioxidant and anti-inflammatory activity of HDL, and improved glucose and adipose tissue metabolism [27].
3	Analysis of Chemical Constituents of Chrysanthemum morifolium Extract and Its Effect on Postprandial Lipid Metabolism in Healthy Adults.	Molecules	37 healthy adults were divided into a control group and a treatment group.	Laboratory experimental approach to analyze the content of bioactive compounds in <i>Chrysanthemum morifolium</i> extract.	The extract contains key flavonoids, including cynaroside and apigenin, which exhibit high antioxidant activity. Administering the extract helps reduce postprandial increases in glucose and triglyceride levels and increases the body's antioxidant capacity [19].
4	Phytochemical Screening and Chemical Analysis of Cloves (<i>Syzygium aromaticum</i>) Flower Buds.	Int. Res. J. Mod. Eng. Technol. Sci	dried clove flowers (<i>Syzygium aromaticum</i>)	An experimental approach in the laboratory to study the phytochemical content and chemical composition of clove essential oil. Compound analysis using GC-MC.	Clove flowers contain flavonoids, terpenoids, steroids, and essential oils, which have the potential to act as antioxidants, anti-inflammatories, antibacterials, and free radical scavengers [12].
5	Antioxidant Effectiveness of Kasumba Turate Flower Extract (<i>Carthamus tinctorius</i> L.) and Its Potential as an Antihypercholesterolemic Agent.	Scientific Journal of Science	cassumba turate flower (<i>Carthamus tinctorius</i> L.)	This research utilizes a laboratory approach.	Ethanol and ethyl acetate extracts of kasumba turate flowers contain <i>alkaloids, phenolics, flavonoids, saponins, tannins, and triterpenoids</i> [20].

6	Phytochemical Screening and Analysis of Jasmine Flower (<i>Jasminum sambac</i>) as Herbal Tea for Obesity.	Nutrients	jasmine flower (<i>Jasminum sambac</i>)	This research uses a laboratory experimental approach.	Jasmine tea helps improve blood lipid profiles, especially triglyceride and cholesterol levels [23].
7	Bioactivity and Drug Formulation of Tapak Dara (<i>Catharanthus roseus</i>).	Journal of Science and Applied Pharmacy	Tapak Dara Flower (<i>Catharanthus roseus</i>)	Literature review method used in writing	Periwinkle has potential as an antioxidant, anticancer, analgesic, antidiabetic, antibacterial, wound-healing, anti-inflammatory, hepatoprotector, and blood-fat-level reducer [21].
8	The Effect of Rosella Flower Extract (<i>Hibiscus sabdariffa</i> L.) on Cholesterol Levels in White Rats (<i>Rattus norvegicus</i>) Induced by LDL.	Bioscientist: Scientific Journal of Biology,	24 mice	This research uses a laboratory experimental method (true experimental) with a completely randomized design (CRD).	Rosella flower extract (<i>Hibiscus sabdariffa</i> L.) has been proven to be effective in reducing cholesterol levels in white rats induced by lard [15].
9	Edible Rose Flowers: A Doorway To Gastronomic And Nutraceutical Research.	Food Research International	Roses	Systematic review and laboratory testing	The anti-cholesterol mechanism involves inhibition of HMG-CoA reductase, increased bile acid excretion, and prevention of LDL oxidation [22].
10	The Effect of Butterfly Pea Flowers (<i>Clitoria ternatea</i> L.) on Total Cholesterol, LDL, HDL in Rats (<i>Rattus norvegicus</i>).	Syifa Sciences and Clinical Research Journal	30 male white mice	This research uses a laboratory experimental approach.	Butterfly pea flower extract lowers total and LDL cholesterol levels and increases HDL cholesterol levels. A dose of 400 mg/kg BW is the most effective and is nearly equivalent to <i>Simvastatin</i> [30].
11	Activity Test of Torch Ginger Flower Extract (<i>Etilingera elatior</i> Jack) as a Hypolipidemic Agent in Obese Wistar Rats.	Journal of Science and Applicative Technology	18 female white mice	This research uses a laboratory experimental approach.	Administration of the methanol extract of torch ginger flowers at a dose of 100 mg/kg BW has the potential to act as a hypolipidemic agent by reducing total cholesterol, triglyceride (TG), and LDL levels [25].
12	Evaluation of Hypolipidemic Activity of Hibiscus in High-Fat Diet Induced Hyperlipidemia in Wistar Rats.	Journal of Pharmaceutica l, Medical, and Health Sciences	30 male Wistar rats	This research applies the experimental method	Both the Rosuvastatin and Hibiscus groups experienced a significant decrease in total cholesterol (TC), triglyceride (TG), LDL-C, and VLDL-C levels ($p<0.001$) [16].
13	Anti-cholesterol Activity of Kemuning Leaf Extract (<i>Murraya paniculata</i> (L.) Jack.) Using Different Extraction Methods and Solvents.	Helium: Journal of Science and Applied Chemistry	Murraya paniculata leaves	This research uses the literature review method.	The Soxhlet method with ethanol as the solvent yields the highest levels of flavonoids and phenolics, thereby providing optimal anticholesterol activity, with an inhibition percentage of around 78% [28].
14	The Effect of Purple Roselle Tea (<i>Hibiscus sabdariffa</i> L.) on Lipid Profiles in Hypercholesterolemic Rats.	Indonesian Journal of Clinical Nutrition Physician	24 tourist rats	This research is a laboratory experimental research with a pre-post test design with a control group.	Giving rosella tea at a dose of 4450 mg/kg BW/day for 30 days significantly reduced triglyceride levels ($p<0.05$) [31].
15	Comparison between the protective effect of the orally administered atorvastatin and safflower (<i>Carthamus tinctorius</i>) in	Frontiers in Pharmacology	24 male white mice	This research is a laboratory experimental research.	Administration of atorvastatin and safflower improves biochemical and histological abnormalities associated with hyperlipidemia, returning them to near-normal levels [32].

	hypercholesterolemic male rats.				
16	Therapeutic effects of anthocyanin-rich <i>Hibiscus sabdariffa</i> L. extract on body mass index, lipid profile and fatty liver in obese-hypercholesterolaemic rat model.	International Journal of Basic & Clinical Pharmacology	30 male white mice	This research is a laboratory experimental research (true experimental)	Administration of roselle anthocyanin extract for 3 weeks significantly reduced BMI, improved lipid and liver enzyme profiles, and improved liver histopathology. [41].
17	Ethanol Extract of Marigold Flower (<i>Tagetes Erecta</i> L.) Decreases The Total Cholesterol, Low Density Lypoprotein (LDL), Malondialdehyde (MDA), and Apolipoprotein B (APOB) on Hyperlipidemia Rat Models.	Folia Medica Indonesiana	48 brown rats (<i>Rattus norvegicus</i>)	This research is a laboratory experimental research (true experimental)	Ethanol extract of gemitir flowers at doses of 200 mg/kg BW and 400 mg/kg BW significantly reduced total cholesterol, LDL, MDA, and ApoB levels ($p < 0.05$). [33].
18	A review of the effectiveness of hibiscus for treatment of metabolic syndrome.	Journal of Ethnopharmacology	Hibiscus species (Family: Malvaceae)	Literature review method used in writing	Hibiscus has been reported to improve blood glucose levels, total cholesterol, HDL, triglycerides, blood pressure, body weight, lipid absorption, and fatty acid oxidation. [34].
19	Effect of Rosella (<i>Hibiscus sabdariffa</i> L.) Consumption on Total Cholesterol Levels.	Trop J Nat Prod Res	36 People	The experimental method used a pretest-posttest design to measure plasma cholesterol levels before and after consuming one glass of rosella infusion once daily for 14 days.	Consuming roselle tea once a day for 14 days is associated with a decrease in total cholesterol levels ($R = -0.378$, $R^2 = 0.143$). [35].
20	A comparative study on the Antihyperlipidemic and antibacterial potency of the shoot and flower extracts of <i>Melastoma malabathricum</i> Linn's.	Clinical Phytoscience	30 female white mice	This research is a laboratory experimental research (true experimental)	<i>Melastoma malabathricum</i> has potential as an alternative for treating hyperlipidemia due to its strong antihyperlipidemic activity. [36].
21	Hypolipidemic Effects and Preliminary Mechanism of Chrysanthemum Flavonoids, Its Main Components Luteolin and Luteoloside in Hyperlipidemia Rats.	Antioxidants	50 male white mice	This research is a laboratory experimental research (true experimental)	Chrysanthemum flavonoids, luteolin, and luteoloside have been shown to reduce body weight and total cholesterol (TC), triglyceride (TG), and LDL-C levels, while increasing HDL-C levels and reducing liver steatosis [37].
22	Testing the Activity of Butterfly Pea Flower Extract (<i>Clitoria Ternatea</i> Linn.) as an Antihypercholesterolemic Agent in Mice (<i>Mus Musculus</i>).	Scientific Journal of Pharmacy Service	12 male white mice	This study used a pre-test and post-test experimental method with male mice (<i>Mus musculus</i>) as research subjects.	Butterfly pea flower extract at a dose of 400 mg/kgBW provided the largest percentage reduction in cholesterol levels (47%), while a dose of 100 mg/kgBW provided the lowest reduction (37.7%) [38].
23	The Effect of Ethanol Extract of Torch Ginger Flowers (<i>Etlingera elatior</i> (Jack) RM Sm.)	Indonesian Journal of Pharmaceutical Research	15 male white mice	This research is a laboratory experimental research (true experimental)	Administration of the ethanol extract of torch ginger flowers for 14 days can reduce serum MDA levels and subsequently decrease

	on Malondialdehyde (MDA) Levels in Hyperlipidemic Male White Mice.				cholesterol levels. The best effect was observed at doses of 200 mg/kg BW and 400 mg/kg BW [39].
24	Activity of Torch Ginger Flower Extract (<i>Etlingera elatior</i>) as a Hypolipidemic Agent in Obese Wistar Rats and Identification of Its Active Compounds.	Chemical Chakra	24 white mice	The research design used was a randomized post-test only control group design in mice.	Torch ginger flower extract at doses of 100 mg/kgBW/day and 200 mg/kgBW/day acts as a hypolipidemic by reducing total cholesterol, LDL, triglycerides, and the total cholesterol ratio, and increasing HDL in mice fed a high-cholesterol diet [42].
25	The Effect of Torch Ginger Flower Extract (<i>Etlingera elatior</i>) on Blood Sugar and Cholesterol Levels in White Rats (<i>Rattus novergicus</i>) Induced by Alloxan.	Wahana-Bio: Journal of Biology and Its Learning	25 male mice	The research method used a completely randomized design (CRD) with 25 male rats in five treatment groups.	Torch ginger flower extract can significantly reduce blood glucose and cholesterol levels, with the greatest effect at a dose of 400 mg/kg BW [40].

Clove Flower (*Syzygium aromaticum*)

Clove flower (*Syzygium aromaticum*) is plant spice from family Myrtaceae utilized as spice cooking, ingredients standard industry food, as well as drug traditional. Dried flower parts contain oil essential oils in concentration tall so that produces a distinctive aroma and becomes source various compound bioactive. For a long time, cloves used in treatment traditional For help overcome Sick teeth, disorders channel digestion, infection, cough, and inflammation [41]. In addition that, flower cloves are also often processed become herbal drinks because own activity potential biological support health body, especially as antioxidants and antimicrobials [42].

Compound main content in oil essential oils clove is eugenol, accompanied by other components such as β -caryophyllene, eugenol acetate, isoeugenol, and various compound phenolic. Combination compound the play a role as antioxidant, anti-inflammatory, antibacterial, antifungal, analgesic, and potentially give effect. Activity the antioxidant eugenol is capable of catch radical free and inhibits the lipid peroxidation process, including oxidation Low-Density Lipoprotein (LDL) which is one of the factor risk formation plaque atherosclerosis. Therefore that, consumption clove in the right amount potential support maintenance health cardiovascular [43].

Results screening phytochemicals show that flower clove contain various metabolit secondary, including flavonoids, terpenoids, steroids, tannins, saponins, oils essential oils, And compound phenolic. Content metabolit the give capacity high antioxidants so that capable protect cell from damage consequence stress oxidative. In addition that, activity antibacterial, antifungal, and anti-inflammatory from component bioactive clove make it potential developed as material standard food functional and phytopharmaceuticals [42]. Results of the analysis chemistry show existence various compound phytochemicals important like flavonoids, terpenoids, steroids, tannins, saponins, oils essential oils, and compound phenolic in flowers cloves that contribute to activity its biology [12].

Butterfly Pea Flower (*Clitoria ternatea* L.)

Pea Flower Butterfly (*Clitoria ternatea* L.) is plant from the Fabaceae family which has long been used as material food functional, dye natural, and drug traditional. Plants this known contain various compound bioactive, especially flavonoids such as anthocyanin, ternatin, as well as saponins, tannins, and terpenoids. The content the play a role important as antioxidants that are capable of ward off radical free and protected cell from damage consequence stress oxidative [44].

Besides activity antioxidants, compounds in flower telang also contributes to effect antihyperlipidemic. *Flavonoids* and anthocyanins can hinder LDL oxidation, while saponins help increase excretion cholesterol through binding sour bile in the duct digestion. On the other hand, some compound its activity is also known can pressing activity HMG-CoA reductase enzyme which plays a role in synthesis cholesterol in the liver, so that help lower level total and LDL cholesterol as well increase HDL [45].

Utilization flower telang as alternative therapy dyslipidemia the more get attention because drug reducer cholesterol statins, such as simvastatin, can cause effect side If used in term long. Some study show that extract flower telang capable repair lipid profile, namely lower total and LDL cholesterol as well increase HDL in test animals, by comparable effectiveness with simvastatin at a dose certain. Besides that, extract this is also reported can lower body weight and blood lipid levels in high-fat diet conditions through mechanism antioxidants and repair lipid metabolism, so that potential developed as therapy more supporters safe For prevention dyslipidemia and disease cardiovascular [13].

Ylang-Ylang Flower (*Cananga odorata*)

Ylang-ylang flowers (*Cananga odorata*) are plant tropical from family *annonaceae* grows in Southeast Asia. Besides known as plant decoration with a distinctive aroma, flowers this is also starting get attention as material potential natural consumed in form processed certain. Some

study show that ylang-ylang flowers contain compound potential bioactives give effect physiological, including activity antioxidant and anti-inflammatory related with health metabolic [14] [46].

In a way phytochemicals, flowers *Cananga odorata* contain various compound volatiles and metabolites secondary such as linalool, β -caryophyllene, germacrene D, as well as compound derivative phenolic compounds. This known own activity diverse biological, including ability as antioxidants that can help pressing stress oxidative in body. linalool, for example, has been reported own effect relaxation and potential modulation system nerves, while β -caryophyllene shows activity anti-inflammatory that can contribute in guard balance response immunity and metabolism body [14].

Besides that, some studies show that compound bioactive from ylang-ylang flowers have potential play a role in arrangement lipid metabolism. Activity antioxidants and anti-inflammatory properties it has can help reduce lipid oxidation and supports decline level cholesterol in body through mechanism inhibition stress oxidative as well as repair function metabolic. This is make attractive ylang-ylang flowers. For reviewed more carry on as material experience supporters of a healthy diet, especially in effort control cholesterol [46].

Composition compound bioactives in ylang-ylang flowers can changed along with stage development interest. Changes this influence profile potential metabolites determine activity biologically. With Thus, the election time proper harvest become factor important. For get content compound optimal activity, especially if flower this will utilized as material food functional or supplement natural [47].

Rosella flower (*Hibiscus sabdariffa* L)

Rosella flowers (*Hibiscus sabdariffa* L.) are plants that are included in family Malvaceae and many growing in the area climate tropical and subtropical, including Indonesia. The petal part the flowers has long been used as material herbal drinks, food functional, as well as treatment traditional. Because own content nutrients and compounds sufficient bioactive high. Rosella is known contain various vitamins such as vitamins C, A, and B complex, as well as important minerals such as potassium, calcium, magnesium, and other substances iron. Besides that, the plant this is also rich in compound phenolic like anthocyanin, flavonoids, acids phenolics and tannins which play a role in various activity biological, including as antioxidant, antihypertensive, antidiabetic, and reducer blood lipid levels [48].

Study results phytochemicals show that extract Rosella petals have concentration tall flavonoid and anthocyanin compounds, accompanied by existence tannin as well as polyphenols others. Compounds the own ability as antioxidants that work with method ward off radical free, inhibits the lipid peroxidation process, as well as protect Low-Density Lipoprotein (LDL) from oxidation. The LDL oxidation process itself is one of the stage beginning formation plaque atherosclerosis of the blood vessels blood. With mechanism said, rosella has the potential help guard balance fat metabolism in body at a time lower risk occurrence disease cardiovascular [48] [49].

Besides that, the effect lipid reduction from rosella is suspected involving a number of mechanism biological interconnectedness related. Flavonoid and polyphenol compounds known can hinder work enzyme HMG-CoA reductase, namely enzyme key in the process of formation cholesterol in the liver. Anthocyanins also play a role in prevent LDL oxidation, repair lipoprotein metabolism, as well as reduce accumulation cholesterol in the tissues body. While that, tannin help lower absorption of fat in the gastrointestinal tract digestion with method bind lipids so that increase his expenses through feces. Combination mechanism this makes rosella potential as agent experience in help control blood lipid levels [15].

Hibiscus flower (*Hibiscus rosa-sinensis*)

Flowers shoes (*Hibiscus rosa-sinensis*) is plant from family many malvaceae utilized in treatment traditional in various regions of Asia because own various activity pharmacological. Study results phytochemicals show that plant this contain diverse metabolit secondary, such as flavonoids, saponins, tannins, terpenoids, alkaloids, phlobatnin, steroids, as well as phytosterols (β -sitosterol). In addition that, flower this is also rich in compound phenolic and anthocyanin pigments, including derivative cyanidin, quercetin, and kaempferol which play a role as antioxidants natural. Content bioactive the support various activity biological, such as antioxidant, anti-inflammatory, antimicrobial, antidiabetic, anti-obesity, to antihyperlipidemic [50].

Activity antihyperlipidemic from *Hibiscus rosa-sinensis* related with mechanism work compound phytochemicals in it. Flavonoids and anthocyanins play a role as antioxidants that are capable of pressing formation radical free as well as hinder oxidation Low-Density Lipoprotein (LDL), so can reduce risk formation plaque atherosclerosis. In addition, flavonoids have also been reported can hinder enzyme HMG-CoA reductase, which plays a role important in synthesis cholesterol in the liver. Saponins help lower level cholesterol with tie sour bile in the duct digestion so that increase excretion, whereas *phytosterols* such as β -sitosterol compete with cholesterol in the absorption process in the intestine. The combination mechanism the contribute in repair lipid profile and decrease risk disease cardiovascular [16] [50] [51].

Extract *Hibiscus rosa-sinensis* own effect significant antihyperlipidemic and antioxidant effects in animal models. Administration extract proven lower level total cholesterol, triglycerides, and LDL, as well as increase level High-Density Lipoprotein (HDL) effects. This associated with ability compound phenolic in pressing stress oxidative, repair lipid metabolism, as well as prevent accumulation of fat in the tissues heart and blood vessels blood. Activity high antioxidants also play a role in protect cell from damage consequence lipid peroxidation. Water extract of flowers shoes in wistar rats fed a high-fat diet were able to lower level total cholesterol, Triglycerides (TG), LDL, and VLDL, as well as increase HDL significant. Besides that happened decline Atherogenic Index (AI) which shows decline risk atherosclerosis, so that plant this potential as therapy complementary in management hyperlipidemia and prevention disease cardiovascular [16] [51] [52].

Papaya Flower (*Carica papaya* L.)

Papaya flowers (*Carica papaya* L.) are part plant from family *Caricaceae* in abundance growing in the area tropical and has long been used in treatment traditional. Plant parts This known contain various metabolit secondary such as flavonoids, alkaloids (carpaine), saponins, tannins, terpenoids, glycosides, and compounds phenolics that play a role as antioxidants natural. Content the give various activity pharmacological, including antioxidant, anti-inflammatory, antidiabetic, antimicrobial, hepatoprotective, and antihyperlipidemic potential in prevention disease metabolic like hypercholesterolemia [53] [54].

Activity reducer cholesterol flower pawpaw especially originate from flavonoids and compounds phenolic which can hinder LDL oxidation as well as pressing activity HMG-CoA Reductase Enzyme in synthesis cholesterol. In addition that, saponin helps tie cholesterol and acid bile so that increase excretion through feces, whereas tannin lower absorption of fat in the intestine. Carpaine alkaloids and compounds bioactive others also play a role in lower stress oxidative and repair lipid metabolism, so that support effect antihyperlipidemic in a way overall [54].

Extract ethanol flower pawpaw capable lower level cholesterol in induced mice sucrose, with dose 400 mg/kgBW as most effective dose. Effects This allegedly originate from synergy various compound bioactives that work hinder synthesis cholesterol, increase excretion, and protect lipoproteins from oxidation. In overall, interest pawpaw male potential as therapy complementary hyperlipidemia, although still clinical trials are required more carry on For ensure its effectiveness and safety in humans [17] [53] [54].

Chrysanthemum Flower (*Chrysanthemum morifolium*)

Chrysanthemum flowers (*Chrysanthemum morifolium*) are plant from the numerous *Asteraceae* family used in treatment traditional East Asian medicine as a herb and drink health. Plants This No only functioning as plant decorative, but also has various activity pharmacological like antioxidant, anti-inflammatory, antidiabetic, hepatoprotective, antimicrobial, as well as potential in repair disturbance lipid metabolism. Activity the related with content metabolit secondary, especially flavonoids, acids phenolics, terpenoids, and polysaccharides that play a role in protect cell from stress oxidative [55].

In a way *phytochemicals*, flowers chrysanthemum own higher flavonoid content tall compared to part stems and leaves. Compounds main thing found includes *luteolin*, *apigenin*, *cynaroside*, and *acacetin* which have activity antioxidants strong. Compound This capable ward off radical free, inhibit lipid peroxidation, as well as help guard balance level cholesterol and triglycerides in body. Besides In addition, flavonoids also play a role in regulations lipid metabolism and reduction fat accumulation [56].

Research by Chen et al. (2023) shows that extract flower *chrysanthemum* own activity antioxidants tall based on DPPH, ABTS, and Hydroxyl Radical tests. Consumption extract This together food high fat can lowerlevel *Triglycerides* and glucose postprandial as well as increase activity enzyme antioxidants such as SOD and GSH [18]. overall, mechanism This show that *Chrysanthemum*

morifolium potential as material food functional For help prevent dyslipidemia and lower risk disease cardiovascular through effect antioxidants and regulation lipid metabolism.

Kasumba Turate Flower (*Carthamus tinctorius* L.)[20]

Casumba flower turate is plant family A lot of *Asteraceae* used as drug traditional and dyes natural. In treatment traditional, plants This utilized For disturbance circulation blood, disease cardiovascular, inflammatory, and as antioxidants natural. Activities pharmacology originate from content metabolit such as flavonoids, phenolics, saponins, tannins, terpenoids, carotenoids, and hydroxysafflor yellow A (HSYA) which has effect antioxidant, anti-inflammatory, and cardioprotective [19][57][59]. Effects antihypercholesterolemia plant This especially related to flavonoids, phenolics, and HSYA. Flavonoids and phenolics play a role hinder LDL oxidation as well as repair function vessels blood, while saponins and tannins help lower absorption cholesterol. *Hydroxysafflor yellow A* (HSYA) is also known influence track lipid metabolism and stress oxidative so that potential protect system cardiovascular [58][57].

Extract sumba turate contain various compound bioactive such as alkaloids, flavonoids, phenolics, and triterpenoids which contribute to the activity antioxidant. The DPPH test shows faction ethyl acetate own activity highest with IC_{50} 53.59 μ g/mL, which indicates potential strong in hinder lipid oxidation and prevent hypercholesterolemia [19]. In general overall, *Carthamus tinctorius* own more of 300 compounds bioactives that work synergistic in repair lipid metabolism, suppressing inflammation, and protect system cardiovascular. Therefore, plants this potential developed as material food functional or therapy supporter of hyperlipidemia, although still required study clinical more carry on For ensure its effectiveness and safety [59][58].

Tapak Dara Flower (*Catharanthus roseus*)[21]

Tapak flower dara (*Catharanthus roseus*) is plant drug from family Apocynaceae which originates from Madagascar and many grows in tropical regions, including Indonesia. This plant this contain various compound active such as alkaloids, flavonoids, phenolics, saponins, and terpenoids. The main alkaloids, vincristine and vinblastine, are known as agent anticancer, while compound other play a role as antioxidant, antidiabetic, antimicrobial, and anti-inflammatory. All part plants, especially leaves, have activity biological Because content metabolit secondary. *Flavonoids* and *phenolics* functioning ward off radical free as well as prevent LDL oxidation plays a role in atherosclerosis. *Saponins* can hinder absorption cholesterol, while terpenoids help reduce inflammation, so that plant This potential support repair lipid profile and health cardiovascular [20] [60].

Extract leaf footprint virgin own activity antioxidant, antimicrobial, cytotoxic, and capable induce apoptosis. This is caused by the content of *alkaloids*, *flavonoids*, *phenolics* and *terpenoids* which work in a way synergistic in protect cell from stress oxidative and damage [61]. Overall, *Catharanthus roseus* is plant drug with potential big in prevention disease degenerative, especially related with

disturbance lipid and cardiovascular metabolism. However, it is necessary study advanced For ensure its effectiveness and safety in humans.

Edible roses (*Rosa spp.*)

Roses (*Rosa spp.*) are plant the Rosaceae family which is not only used as plant decoration, but also as material food and medicine. The petals often utilized in form tea, syrup, jam and drinks because of the aroma and content bioactive. Rose contain compound such as flavonoids, polyphenols, anthocyanins, and vitamin C which play a role as antioxidant, anti-inflammatory, and potential support health metabolic [63]. Activity antihypercholesterolemia rose related with his abilities hinder LDL oxidation and suppress formation radical free. Compound polyphenols can also hinder HMG-CoA reductase enzyme as well as help lower absorption cholesterol, so that contribute to the decline level total cholesterol, triglycerides, and LDL [21].

Besides that, the processing process like fermentation can increase content phenolics and flavonoids so that activity antioxidant and anti-inflammatory become morestrong. This is show that rose potential as material food functional that can help prevent disturbance lipid metabolism and disease cardiovascular [62]. In general overall, various compound bioactive in flower rose Work in a way synergistic in lower stress oxidative, repair lipid profile, and protect system cardiovascular. Therefore that rose potential developed as food functional, although Still required study more carry on For ensure its effectiveness and safety in humans [64].

Jasmine (*Jasminum sambac*)

Jasmine (*Jasminum sambac*) is plant family Oleaceae are common in the area tropical and used as herbal tea as well drug traditional. Plants This contain compound bioactive like flavonoids, polyphenols, catechins, and oils essential oils that have activity antioxidant, anti-inflammatory, antidiabetic, and antihyperlipidemic, so that potential as material food functional [65] [66]. Compounds polyphenols and flavonoids in jasmine play a role in lower obesity with method increase fat oxidation, inhibiting lipogenesis, and pressing inflammation through decrease in TNF- α and IL-6. In addition that, activity antioxidants help reduce stress oxidative and repair lipid profile [67].

Tea jasmine can lower weight loss, improve lipid levels, increasing tolerance glucose, as well as balance gut microbiota in high- fat diet conditions, so that contribute to effect antiobesity [22]. In overall, *Jasminum sambac* potential as drink functional with effect antioxidant, anti-inflammatory, anti-obesity, and anti-hyperlipidemic, although still required study clinical more carry on For ensure its effectiveness and safety.

Torch Ginger Flower (*Etlingera Elatior* Jack)

Ginger flower torch (*Etlingera elatior*) is plant family Zingiberaceae which is abundant found in Southeast Asia, including Indonesia. This plant this not only utilized as spices and plants decoration, but also as drug traditional Because contain compound bioactive like flavonoids, phenolics, tannins, saponins, alkaloids, terpenoids, steroids, and oils essential oils that have activity antioxidant, anti-

inflammatory, antimicrobial, antidiabetic, and antihyperlipidemic effects. antihyperlipidemic especially originate of flavonoids and phenolics that inhibit oxidation LDL as well as pressing lipid peroxidation. Saponins, steroids, and tannins also help lower absorption cholesterol in the intestines, while compound phenolic increase system antioxidants body so that repair lipid metabolism [68].

Extract *Etlingera elatior* can lower total cholesterol, LDL, and apolipoprotein B-100 in Rats obesity, as well as increase enzyme antioxidants SOD and GSH which protect heart from damage [23]. Extract *Etlingera elatior* also has activity antioxidants high support healing wounds and inhibits aging skin through protection to stress oxidative. [69]. In overall, *Etlingera elatior* potential as plant medicine and food functional Because activity antioxidant, anti-inflammatory, and antihyperlipidemic properties. However, it is necessary study clinical more carry on for ensure its effectiveness and safety in humans.

Marigold Flower (*Tagetes Erecta* L)

Marigold flowers (*Tagetes erecta* L.) or gemitir is plant the common Asteraceae family used as plant decoration, coloring natural and medicinal traditional. Plants This contain various compound bioactive such as flavonoids, carotenoids (lutein, zeaxanthin, β - carotene), phytosterols, tocopherols, and compound phenolics that play a role as antioxidants and has potential pharmacological, including effect antihyperlipidemic [71]. Activity lipid lowering properties of marigold are suspected originate from Work synergistic compound active. Carotenoids and flavonoids help hinder LDL oxidation and suppress formation radical free, whereas phytosterols and compounds phenolic can hinder HMG-CoA reductase enzyme as well as reduce absorption cholesterol in the intestine. Mechanism This contribute in repair lipid profile and prevention atherosclerosis [70].

Extract ethanol marigold flowers are capable lower level total cholesterol, LDL, MDA, and ApoB in mice hyperlipidemia, especially at doses of 200–400 mg/ kgBW. These results confirm existence effect antioxidants at a time repair lipid profile through decline stress oxidative [24]. In whole, *Tagetes erecta* potential as agent antihyperlipidemic experience because content its phytochemicals that work in a way synergistic in lower cholesterol, inhibits lipid oxidation, and increase activity antioxidants. However, it is necessary study morefurther in humans for ensure its effectiveness and safety.

Lavender Flower (*Lavandula angustifolia*)

Lavandula angustifolia is plant from family Many Lamiaceae utilized as plant medicine, aromatherapy, and food functional. Various species *Lavandula* contain compound bioactive such as flavonoids, polyphenols, acids phenolics, as well as oil essential oils dominated by linalool and linalyl acetate. These compounds the own activity antioxidants and anti-inflammatories that play a role in protect cell from stress oxidative as well as support health system cardiovascular and lipid metabolism (Batiha et al., 2023; Allouani et al., 2025). [72] [73]. Administration lavender extract is able to repair profile metabolic in test animals, which is characterized with decline level plasma

cholesterol, increased function *High-Density Lipoprotein* (HDL), as well as repair tolerance glucose. Lavender extract also reduces level cytokines proinflammatory TNF- α , increases activity antioxidants, and activates network adipose chocolate so that fat and energy metabolism become more optimal. [25].

Overall, potential lavender antihyperlipidemic is suspected originate from work synergistic *flavonoids*, *polyphenols*, *linalool*, and *linalyl acetate* which are capable of hinder lipid peroxidation, reducing inflammation, repair lipoprotein metabolism, as well as increase capacity antioxidants body. With content phytochemicals and profile good safety, *lavandula angustifolia* potential developed as material experience for help prevention hypercholesterolemia and disease cardiovascular.

***Murraya paniculata* L.**

Murraya paniculata (L.) Jack. is plant from family Rutaceae a lot utilized as plant medicine in the area tropical plants This contain various metabolit secondary, such as *flavonoids*, *alkaloids*, *coumarins*, *terpenoids*, *saponins*, *tannins*, and compounds known phenolics own activity antioxidant, anti-inflammatory, antidiabetic, anticancer, and potential as antihyperlipidemic activity antioxidants from compounds the play a role in hinder stress oxidative and prevent oxidation *Low-Density Lipoprotein* (LDL) which is one of the factor main formation plaque atherosclerosis [74].

Flavonoids and compounds phenolic in kemuning known capable hinder activity enzyme HMG-CoA reductase so that synthesis cholesterol in the liver can pressed. Besides that, saponin plays a role tie cholesterol and acid bile in the duct digestion so that reduce absorption cholesterol and increase excretion. Mechanism the support potential *Murraya paniculata* as agent experience in repair lipid profile and lower risk disease cardiovascular [75].

Murraya paniculata own good prospects as material standard phytopharmaceuticals for help prevention and management hypercholesterolemia. However, research more carry on through in vivo testing and clinical trials Still required for ensure effectiveness and safety its use in humans [26].

Sensat flower (*Melastoma malabatricum*)

Melastomas malabathricum L. or flower sitting is plant from family Many *Melastomataceae* found in Southeast Asia and has long been used in treatment traditional for overcome diarrhea, diabetes, hypertension, inflammation, wounds, and disorders heart. Plants it is rich in metabolit secondary such as *flavonoids*, *compounds phenolics*, *tannins*, *saponins*, *alkaloids*, *terpenoids*, and *anthocyanins* which play a role as antioxidants as well as own activity anti-inflammatory, antimicrobial, hepatoprotective, and antihyperlipidemic [76].

Extract ethanol shoots and flowers *M. malabathricum* capable repair lipid profile in mice hyperlipidemia with lower level total cholesterol, *Triglycerides*, and LDL as well increase HDL levels. Extract it also reduces activity enzyme liver (ALT, AST, and ALP) as well repair description histopathology liver, heart, and kidneys, so that show effect protective to organ damage due to hyperlipidemia [27].

Effect antihyperlipidemic flower sitting allegedly related with flavonoid and compound content phenolic capable hinder LDL oxidation, reducing lipid peroxidation, as well as increase system defense endogenous antioxidants [77]. Based on content phytochemicals and evidence available preclinical, *M. malabathricum* potential developed as material experience for help management hypercholesterolemia and prevention disease cardiovascular, although still human clinical trials are needed for ensure its effectiveness and safety.

Potential Molecular Mechanisms Underlying the Antihypercholesterolemic Effects of Indonesian Edible Flowers

Inhibition of HMG-CoA Reductase Activity

One of the main mechanisms responsible for the antihypercholesterolemic activity of edible flowers is the inhibition of 3-hydroxy-3-methylglutaryl coenzyme A (HMG-CoA reductase), the rate-limiting enzyme involved in endogenous cholesterol biosynthesis. Several edible flowers reviewed in this study contain *flavonoids*, *anthocyanins*, *tannins*, and polyphenolic compounds that can interfere with the cholesterol synthesis pathway. Roselle (*Hibiscus sabdariffa* L.) contains abundant *flavonoids* and *anthocyanins* that have been reported to inhibit HMG-CoA reductase activity, thereby reducing hepatic cholesterol production and preventing excessive cholesterol accumulation in blood vessels. In addition, *flavonoids* help maintain cholesterol homeostasis by regulating cholesterol absorption and transport pathways [15].

A comparable lipid-lowering effect was also observed in butterfly pea flowers (*Clitoria ternatea* L.), which significantly reduced total and LDL cholesterol concentrations in an animal model of hyperlipidemia. These findings suggest that flavonoid-rich edible flowers may exert cholesterol-lowering effects through a mechanism analogous to statins, albeit with potentially fewer side effects [13,15].

Prevention of LDL Oxidation

Oxidative modification of LDL particles plays a central role in the initiation of atherosclerosis. Oxidized LDL promotes endothelial dysfunction, macrophage activation, foam cell formation, and vascular inflammation, ultimately leading to plaque development. Several edible flowers included in this review exhibit potent antioxidant properties capable of protecting LDL particles from oxidative damage.

Roselle flowers contain anthocyanins that act as potent free radical scavengers and inhibit the lipid peroxidation process associated with LDL oxidation [15]. Similarly, *Chrysanthemum morifolium* contains flavonoids and other antioxidant compounds that improve post-meal lipid metabolism and reduce markers of oxidative stress associated with dyslipidemia [19]. The antioxidant activity of rose and other polyphenol-rich edible flowers may further contribute to the stabilization of LDL particles and the reduction of atherogenic risk. Collectively, these findings suggest that inhibition of LDL oxidation is one of the major cardioprotective mechanisms of edible flowers.

Modulation of Inflammatory Pathways

Chronic inflammation is increasingly recognized as a critical contributor to the progression of hypercholesterolemia and cardiovascular disease. Elevated cholesterol levels stimulate inflammatory signaling pathways that increase cytokine production, endothelial dysfunction, and plaque instability. Therefore, suppression of inflammatory responses constitutes an important therapeutic target.

Cananga odorata possesses several bioactive constituents, including *linalool*, *benzyl acetate*, *geranyl acetate*, and *beta-caryophyllene*, which exhibit anti-inflammatory properties. Experimental studies demonstrated that ylang-ylang essential oil reduced leukocyte activation and exerted anti-inflammatory and anti-hyperalgesic activities [14]. Furthermore, *beta-caryophyllene* has been associated with modulation of inflammatory responses and reduction of oxidative stress. Similar anti-inflammatory effects have been reported for flavonoid-containing edible flowers such as rosella, chrysanthemum, and jasmine, suggesting that anti-inflammatory effects may synergistically contribute to their antihypercholesterolemic actions [14,15,19].

Enhancement of the Endogenous Antioxidant Defense System

Hypercholesterolemia is frequently accompanied by excessive production of *Reactive Oxygen Species* (ROS), resulting in oxidative stress, lipid peroxidation, endothelial injury, and progression of atherosclerosis. Consequently, enhancement of endogenous antioxidant defense systems represents another important mechanism through which edible flowers may improve cardiovascular health.

Several studies reviewed in this article demonstrated that edible flower extracts increased antioxidant biomarkers while reducing oxidative stress indicators. *Tagetes erecta* was reported to decrease *Malondialdehyde* (MDA) levels and increase *Superoxide Dismutase* (SOD) activity, indicating improved antioxidant defense capacity [26]. Similar antioxidant effects were reported for rosella, chrysanthemum, and kasumba turate flowers, which contain *flavonoids*, *anthocyanins*, *carotenoids*, and *phenolic* compounds capable of neutralizing free radicals and suppressing lipid peroxidation [15,19,20].

Kasumba turate (*Carthamus tinctorius* L.) demonstrated particularly strong antioxidant potential due to its high flavonoid and phenolic content, which may contribute to cholesterol reduction by attenuating oxidative stress [20]. Overall, enhancement of endogenous antioxidant systems appears to be a common mechanism shared by multiple edible flower species and may explain their ability to reduce cardiovascular risk associated with hypercholesterolemia.

Clove flower (*Syzygium aromaticum* L.) is particularly rich in eugenol and phenolic compounds, which exhibit strong antioxidant activities. These compounds may inhibit lipid peroxidation and protect LDL particles from oxidative modification, thereby reducing the initiation of atherosclerotic plaque formation. The antioxidant capacity of clove flower complements the protective effects observed in

Hibiscus sabdariffa, *Clitoria ternatea*, and *Chrysanthemum morifolium*.

Table 3. Proposed Antihypercholesterolemic Mechanisms of Indonesian Edible Flowers

Mechanism	Examples of Edible Flowers
HMG-CoA reductase inhibition	<i>Hibiscus sabdariffa</i> , <i>Clitoria ternatea</i> , <i>Rosa</i> spp.
Prevention of LDL oxidation	<i>Syzygium aromaticum</i> , <i>Hibiscus sabdariffa</i> , <i>Clitoria ternatea</i> , <i>Chrysanthemum morifolium</i>
Anti-inflammatory activity	<i>Jasminum sambac</i> , <i>Cananga odorata</i> , <i>Hibiscus sabdariffa</i>
Increased endogenous antioxidant defenses	<i>Syzygium aromaticum</i> , <i>Tagetes erecta</i> , <i>Carthamus tinctorius</i> , <i>Chrysanthemum morifolium</i>

Taken together, the available evidence suggests that edible flowers exert antihypercholesterolemic effects through multiple complementary mechanisms involving inhibition of cholesterol biosynthesis, prevention of LDL oxidation, modulation of inflammatory pathways, and enhancement of endogenous antioxidant defenses. These mechanisms operate synergistically to improve lipid homeostasis and reduce cardiovascular risk, highlighting the potential of Indonesian edible flowers as functional foods and complementary therapeutic agents for the management of hypercholesterolemia.

The antioxidant activity of clove flower is largely attributed to its high eugenol content, which contributes to the scavenging of *Reactive Oxygen Species* (ROS) and suppression of oxidative stress. Previous studies have demonstrated that clove-derived phenolic compounds may enhance endogenous antioxidant defenses and reduce lipid peroxidation markers, supporting cardiovascular protection and cholesterol homeostasis.

Conclusion

This systematic review demonstrates that several edible flowers traditionally consumed in Indonesia, including *Hibiscus sabdariffa*, *Clitoria ternatea*, *Chrysanthemum morifolium*, *Tagetes erecta*, *Jasminum sambac*, *Rosa* spp., and *Carthamus tinctorius*, contain bioactive compounds such as *flavonoids*, *anthocyanins*, *polyphenols*, *carotenoids*, and other phytochemicals that exhibit potential antihypercholesterolemic activities. The available evidence suggests that these flowers may contribute to cholesterol reduction through multiple mechanisms, including inhibition of HMG-CoA reductase activity, prevention of LDL oxidation, modulation of lipid metabolism, suppression of inflammatory pathways, and enhancement of endogenous antioxidant defenses. Among the reviewed species, several flowers demonstrated promising lipid-lowering, antioxidant, and cardioprotective effects in experimental studies. However, the current evidence base is predominantly derived from in vitro experiments and animal studies, while well-designed human clinical trials remain limited. Furthermore, substantial heterogeneity exists among studies regarding plant materials, extraction methods, phytochemical characterization, dosage regimens, and outcome

measurements, which limits direct comparison and generalization of findings. Therefore, although Indonesian edible flowers represent promising candidates for development as functional foods and complementary approaches for hypercholesterolemia management, the current findings should be interpreted with caution. Future research should prioritize standardized phytochemical analyses, mechanistic investigations, safety evaluations, and randomized controlled clinical trials to establish efficacy, optimal dosage, and long-term safety in human populations. Such studies will be essential to support evidence-based utilization of Indonesia's edible flower biodiversity for cardiovascular health promotion and disease prevention.

Author Contribution

I.N.B.A. Kresnapati: Conceptualization, methodology and literature collection. I.G.A. Adnyana: Methodology, validation, review writing and editing. M. Ariasti: validation and manuscript review. S.W. Sofya: interpretation of the reviewed studies and scientific discussion of the manuscript. L.B. Muhsin: data analysis and writing the original draft. Juniartini: final approval of the manuscript.

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