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Anti-Hyperlipidemic Activity of *Capsicum chinense* Jacq. Fruit Extract in High Fat Diet-Induced Hyperlipidemic Rats

Isha Kasar[1*], Arpan K Tripathi[1], Shahbaz Rathor[1]

[1]Kamla Institute of Pharmaceutical Sciences, Shri Shankaracharya Professional University, Junwani, Bhilai, C.G., 490020

***Corresponding Author E-mail: ishakasar2001@gmail.com**

ABSTRACT

Hyperlipidemia is a major contributor to cardiovascular diseases. The present study evaluates the anti-hyperlipidemic potential of *Capsicum chinense* Jacq. fruit extract in high-fat diet (HFD) induced hyperlipidemic rats. Rats were divided into six groups including Normal Control, HFD Control, Standard (Atorvastatin 7.2 mg/kg), and three test groups receiving extract doses of 5, 7.5, and 10 mg/kg respectively. Significant reductions ($p<0.05$) in total cholesterol, triglycerides, LDL and VLDL, along with increased HDL levels were observed, particularly in the 10 mg/kg group which showed effect comparable to the standard. The study supports *Capsicum chinense* as a promising natural hypolipidemic agent.

Key Words:

Capsicum chinense; Hyperlipidemia; Capsaicinoids; Lipid Profile; Cardioprotection

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1. INTRODUCTION

Hyperlipidemia is characterized by elevated serum cholesterol, triglycerides, and LDL levels, along with reduced HDL, and is strongly associated with the development of atherosclerosis and coronary artery disease[1]. Hyperlipidemia does not only affect the heart but also problems with tendons, like knee tendons, due to extra fats in the body that tend to increase macrophages in tendons over a period of time, breaking the collagen fibers that give it strength. Unhealthy collagen

tends to be substituted by fats with a result in weaker tendons and easily get injured[2]. Though statins remain the drug of choice in therapy, their long-term use has been associated with hepatotoxicity, myopathy, and metabolic abnormalities[3]. Consequently, there is now an interest in phytomedicine-based interventions, particularly those preparations that contain bioactive principles possessing lipid-modulating and antioxidant properties[4].

Fig 1: *Capsicum chinense* plant

Capsicum chinense Jacq. part of the Solanaceae family is often cited as one of the peppers there thanks, to its hefty stash of capsaicinoids—mainly capsaicin and dihydrocapsaicin[5]. According to the Guinness Book of World Records (2006), the fruits of the Capsicum chinense Jacq. is certified as the world's hottest chili pepper, with Scoville heat units (SHU's) rating of 1001304. It is commonly known as Bhut Jolokia, Ghost Pepper, Umorok, Naga King Chilly, etc[6]. The Capsicum chinense Jacq. is a showy, erect, bushy annual. It is primarily self-pollinating but can reach up to 10% cross-pollination when there are large populations of insects, thus increasing genetic diversity. This plant can even thrive as a semi-perennial herb under perfect growing conditions, making it a very valuable asset in both gardens and agricultural settings[7]. Those capsaicinoids fire up the TRPV1 receptor, which in turn ramps up thermogenesis by coaxing fat out of its storage sites[8]. At the time the. Phenolics packed in *C. Chinense* act, as free-radical-mops and anti-inflammatory agents a combo that's been linked to heart-protective benefits[9]. Even though a wealth of studies has highlighted capsaicin's anti-obesity and metabolic benefits only a scant few have directly probed the effects of *C. chinense* fruit extract, against hyperlipidemia triggered by a high-fat diet[10]. Consequently the current work aimed to delineate the extract's profile and assess its potential, in experimental rats.

2. METHOD AND MATERIAL

2.1 Plant Collection & Authentication

Fresh fruits of *Capsicum chinense* Jacquin were collected from a certified organic farm in Assam. Botanists from the Department of Government V.Y.T.PG Autonomous College, Durg (C.G.) identified and authenticated the plant.

2.2 Instruments

Soxhlet Apparatus, test tubes, test tube stands, oral gavage.

2.3 Chemicals

Ethanol, Petroleum ether, Distilled water for extraction. For phytochemical screening of the powder drug extract, sodium hydroxide, sulphuric acid, hydrochloric acid, ferric chloride, picric acid, ammonia, sodium chloride, lead acetate, bromine, potassium hydroxide, potassium dichromate, potassium iodide was used.

2.4 Preparation of Plant Extract

2.4.1 Drying and Grinding

All collected fruit was washed, deseeded, and air-dried in the shade for between 10 and 14 days. Once thoroughly dried, the plant material was ground to a fine powder using an electric grinder and kept dry, dark, and sealed in airtight containers.

2.4.2 Extraction Process

2.4.2.1 Soxhlet extraction

In analytical chemistry, Soxhlet extraction is widely used method for removing organic compounds from solids. To completely extract the target molecule, a sample must be repeatedly exposed to a solvent. In order to achieve an effective extraction, the method relies on the reflux principle, whereby the solvent vaporizes, condenses, and then flows back into the sample container in a continuous cycle. This is especially useful when working with chemicals that are poorly soluble in solvents or when conventional procedures like simple distillation or filtration are ineffective. This technique is commonly used to remove lipids, insecticides, and natural components from plant material for examination and purification[11].

2.4.2.2 Procedure

First roughly 50 gm Bhut Jolokia powder was taken and dissolved in 100 mL petroleum ether and kept at room temperature for 1 hr. The mixture is then filtered using filter paper and air dried overnight. Using a Soxhlet apparatus and ethanol (80%) as a solvent, filtered material was extracted using a hot extraction procedure. After the extraction process was finished and the solvent in the thimble turned clear, a few drops of solvent were collected in the test tube and the solvent was subjected to a chemical test. A portion of the extract was saved for preliminary phytochemical screening in order to identify plant ingredients after extraction, which involved drying it out by evaporating it.

Fig 2: Extraction using Soxhlet apparatus

2.5 Phytochemical Screening

Phytochemical screening is an analytical procedure to detect the presence of bioactive principles in plants, using them in the development of new drugs. It involves the determination of a series of tests that identify the presence of phytochemical constituents such as flavonoids, alkaloids, tannins, saponins, terpenoids, and phenolic compounds. Another vital consideration here is the need to establish, through extraction and testing procedures, the possible drug values in the plant materials[12].

Fig 3: Different phytochemical tests.

2.6 Physico Chemical Evaluations

2.6.1 Ash values

Ash contents refer to the inorganic substance that remains following incineration of a crude drug. The amount of ash in drugs is important to make sure they are of good quality. There are different types of ash that can tell us different things about the drug. Acid-insoluble ash represents if there is too much calcium oxalate in the drug. When treated with HCl, only silica is left, hence acid-insoluble ash is preferred. Water soluble ash is difference between total ash content and water insoluble residue. Sulphated ash is used to control non-volatile impurities in the drug. When the drug is treated with sulfuric acid, it breaks down the organic part of ash, leaving behind only the sulfate salt of cations. This test is reliable because inorganic sulfate salts can handle high temperatures without changing[13].Total ash value and acid-insoluble ash value were calculated according to the method given in Indian Pharmacopeia (1960).

Fig 4: Sample in Muffle Furnace

2.7 Anti-hyperlipidemic Activity

30 Female albino rats, 8-10 weeks old and weighing between 100-150 grams were selected for their uniform metabolic response to high-fat diet-induced hyperlipidemia[14], were obtained from the institutional animal house at Kamla Institute of Pharmaceutical Sciences (KIPS), SSPU. All required procedures were approved by the Institutional Animal Ethics Committee (IAEC) and adhered to national guidelines, including those set by CPCSEA in India (ref no.- SSPU/KIPS/IAEC/2024/001), ensuring humane care and use of animals. A seven-day acclimatization period was observed before any treatments or dietary changes were implemented. Hyperlipidemia was induced for a period of 42 days using a high-fat diet, an already well-characterized and widely used model for inducing alterations in lipid metabolism[15]. At the end of induction, animals received treatment with three different levels of *C. chinense* extract, namely 5 mg/kg, 7.5 mg/kg, and 10 mg/kg, respectively, and were compared with Atorvastatin-treated (7.2 mg/kg), which is a standard anti-lipidemic medication. On Day 42, serum lipid profile parameters such as total cholesterol (TC), triglyceride (TG), low-density lipoprotein (LDL), high-density lipoprotein (HDL), and very low-density lipoprotein (VLDL) were measured using standard biochemical procedures as reported in earlier pharmacological studies[16]. The diet consist of following ingredients[17]:

Table 1: Diet Composition (Approximate formulation per 100 g of diet)

Ingredient	Percent by weight	Role / Notes
Standard rat chow pellet	~ 60-65%	Provides baseline protein, vitamins, minerals
Full-cream milk powder	~ 15-20%	Adds protein, some fat, increases energy density
Vanaspati Ghee	~ 5-10%	Source of saturated fat
Vegetable oil (groundnut oil)	~ 5-10%	Unsaturated or mixed fats – contributes to fat component
Jaggery	~ 5-10%	Adds simple carbohydrate; increases palatability
Cholesterol	~1-2%	Used to elevate serum cholesterol level
Vitamin mix	~1%	Ensures micronutrient adequacy

Calcium	~1%	Important for bone health and influences lipid metabolism

Table 2: Experimental Design

S. No.	Group Name	Treatment	No. of animals used
Group I	Normal	Saline (p.o.10ml/kg)	5
Group II	Hyperlipidemia Control	High fat diet (HFD)	5
Group III	Standard	High fat diet (HFD) +Atorvastatin (7.2 mg/kg)	5
Group IV	Test 1	High fat diet + CCJF Extract (5mg/kg)	5
Group V	Test 2	High fat diet + CCJF Extract (7.5mg/kg)	5
Group VI	Test 3	High fat diet + CCJF Extract (10mg/kg)	5
Total			30

Treatments (extract or standard drug) will be given orally once daily along with HFD, by using oral gavage, once the disease is induced. Body weight and food intake were recorded weekly to monitor progression of weight gain and calculate energy intake.

3. RESULTS AND DISCUSSION

3.1 Extractive Value

The % yield of extractive values of *Capsicum chinense* Jacquin fruit extract using 80% ethanol was found to be 16.25%.

3.2 Phytochemical Screening

The analysis revealed a wide range of phytochemicals in the extract, including alkaloids, flavonoids, saponins, phenols, tannins, carbohydrates, and glycosides. Steroids and fixed oils, however, showed up only in small or trace quantities.

Table 3: Phytochemical Screening of *Capsicum chinense* Jacquin

Phytochemical	Result
Alkaloids	++
Flavonoids	++
Tannins	++
Saponins	++
Glycosides	++
Phenolic Compounds	++
Phytosterols	+
Reducing Sugars	++

3.3 Physico-Chemical Analysis

The physicochemical properties of the plant material got evaluated. This step verified its authenticity, purity, and overall quality before the study even kicked off. You know, that preliminary assessment made sure everything lined up with established standards. The whole process stuck to standard methods from the Indian Pharmacopoeia, 2020 edition.

Table 4: Physicochemical Parameters of *Capsicum chinense* Jacquin

Parameter	Result (% w/w)
Total Ash	7.82 ± 0.25
Acid-Insoluble Ash	1.34 ± 0.12
Sulfated Ash	8.56 ± 0.32
Water-Soluble Extractive	18.45 ± 0.76
Alcohol-Soluble Extractive	12.67 ± 0.54

3.4 ANTI-HYPERLIPIDEMIC ACTIVITY

3.4.1 Effect on Body Weight

The body weights of the animals were measured on days 0, 7, 14, 28, 36, and 42. This method enabled us to monitor the progression of hyperlipidemia throughout the study period. It also facilitated an assessment of how the treatments influenced outcomes as they developed. Initial weights ranged from 150 to 200 grams. The percentage change in body weight was calculated comparing the initial measurement at day 0 to the weights measured on the recognized days after. This allowed researchers to evaluate the treatment effects on weight patterns throughout the experiment. Research show that these calculations provide a yielding mindset of the effectiveness of the treatment in a similar experimental condition.

Table 5: % Change in Body Weight (Mean ± SEM)

Group	Day 7 (%)	Day 14 (%)	Day 28 (%)	Day 36 (%)	Day 42 (%)
Normal	0.0 ± 1.0	-0.47 ± 0.81	0.28 ± 0.64	0.8 ± 0.87	1.1 ± 0.51
Hyperlipidemia Control	1.54 ± 0.5	6.14 ± 0.77	8.45 ± 0.42	11.89 ± 1.12	15.17 ± 0.17
Standard	1.29 ± 0.44	2.19 ± 1.01	1.64 ± 0.62	2.12 ± 0.87	3.59 ± 0.65
Test 1	1.77 ± 0.37	3.1 ± 0.55	5.36 ± 0.63	5.96 ± 0.65	7.75 ± 0.29
Test 2	1.33 ± 0.79	2.1 ± 0.67	3.07 ± 1.44	3.98 ± 0.88	4.53 ± 0.88
Test 3	1.4 ± 0.42	2.06 ± 0.58	2.87 ± 0.71	3.13 ± 0.61	5.28 ± 0.57

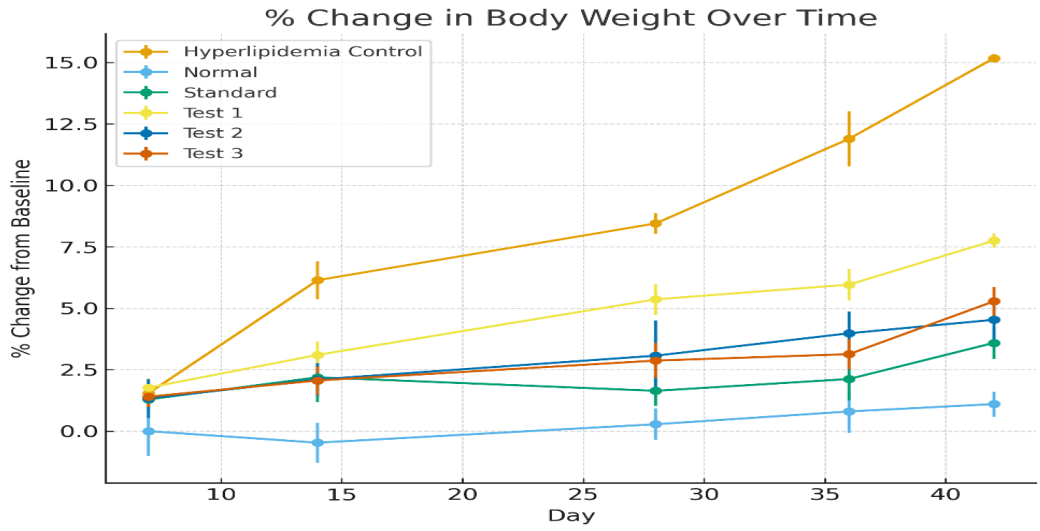

Fig 5: % Change in body weight over time

3.4.2 Lipid Profile Estimation

At the end of the experimental period, blood samples were collected from the sub-mandibular vein under mild anesthesia. Serum was separated by centrifugation and analyzed for lipid profile parameters — Total Cholesterol (TC), Triglycerides (TG), HDL, and LDL — and liver function markers (SGOT, SGPT, and ALP).

Table 6: Lipid Profile at Day 0 (Mean ± SEM, mg/dL)

Group	TC (mg/dL)	TG (mg/dL)	HDL (mg/dL)	LDL (mg/dL)	VLDL (mg/dL)
Normal	86.83 ± 0.78	94.07 ± 0.71	45.30 ± 0.47	24.61 ± 0.19	19.31 ± 0.12
Hyperlipidemia Control	87.75 ± 1.07	95.53 ± 1.50	45.20 ± 0.31	24.62 ± 0.26	18.93 ± 0.20
Standard	87.85 ± 0.79	95.66 ± 0.37	44.16 ± 0.21	24.16 ± 0.10	18.68 ± 0.09
Test 1	86.50 ± 0.42	94.07 ± 1.03	44.93 ± 0.44	24.86 ± 0.30	19.28 ± 0.18
Test 2	87.83 ± 0.42	95.65 ± 1.10	44.93 ± 0.24	24.00 ± 0.15	18.95 ± 0.19
Test 3	86.59 ± 0.97	94.02 ± 0.93	45.13 ± 0.17	24.37 ± 0.18	18.94 ± 0.11

Table 7: Lipid Profile at Day 42 (Mean ± SEM, mg/dL)

Group	TC (mg/dL)	TG (mg/dL)	HDL (mg/dL)	LDL (mg/dL)	VLDL (mg/dL)
Normal	121.64 ± 1.03	80.15 ± 1.87	55.31 ± 1.72	44.50 ± 2.11	13.91 ± 1.67
Hyperlipidemia Control	203.80 ± 2.61	159.07 ± 2.62	30.84 ± 1.84	118.35 ± 2.09	35.83 ± 3.99
Standard	127.52 ± 1.59	88.52 ± 2.45	52.21 ± 2.30	62.35 ± 2.42	20.68 ± 3.38
Test 1	139.24 ± 2.46	101.60 ± 2.71	43.18 ± 3.56	64.06 ± 1.26	20.29 ± 1.45

Test 2	131.43 ± 1.76	95.36 ± 1.50	51.64 ± 1.76	63.32 ± 1.94	22.48 ± 2.30
Test 3	126.80 ± 1.25	92.81 ± 0.68	51.90 ± 1.74	62.40 ± 1.57	19.60 ± 1.97

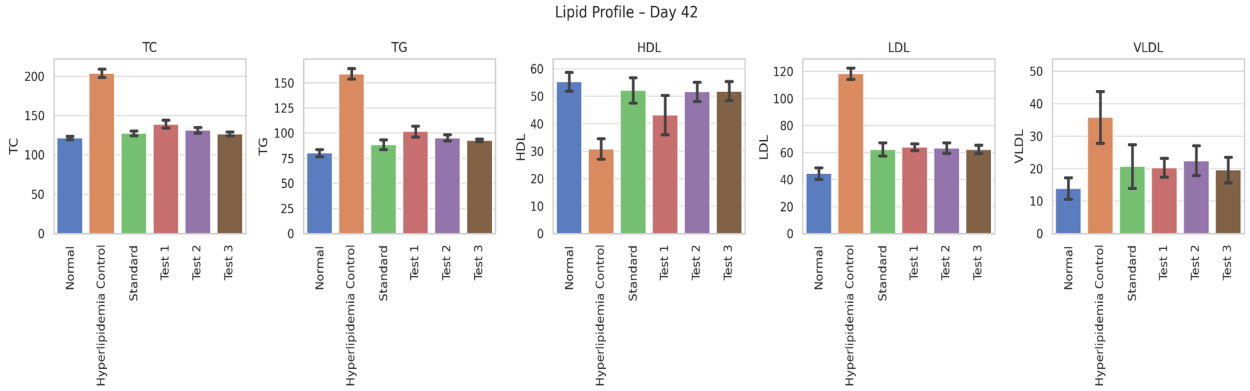

Fig 6: Effect of *Capsicum chinense* Jacq. extract on lipid profile (TC, TG, HDL, LDL, VLDL) at Day 42.

Table 8: Atherogenic Index (AI) and Cardiac Risk Ratio (CRR) at Day 42

Group	AI (TC-HDL/HDL)	CRR (TC/HDL)	Remarks
Normal	0.93	2.10	Normal
Hyperlipidemia Control	3.37	6.63	High Risk
Standard	1.26	2.47	Improved
Test 1	1.46	2.73	Moderate Risk
Test 2	1.57	2.60	Improved
Test 3	1.00	2.31	Near Normal

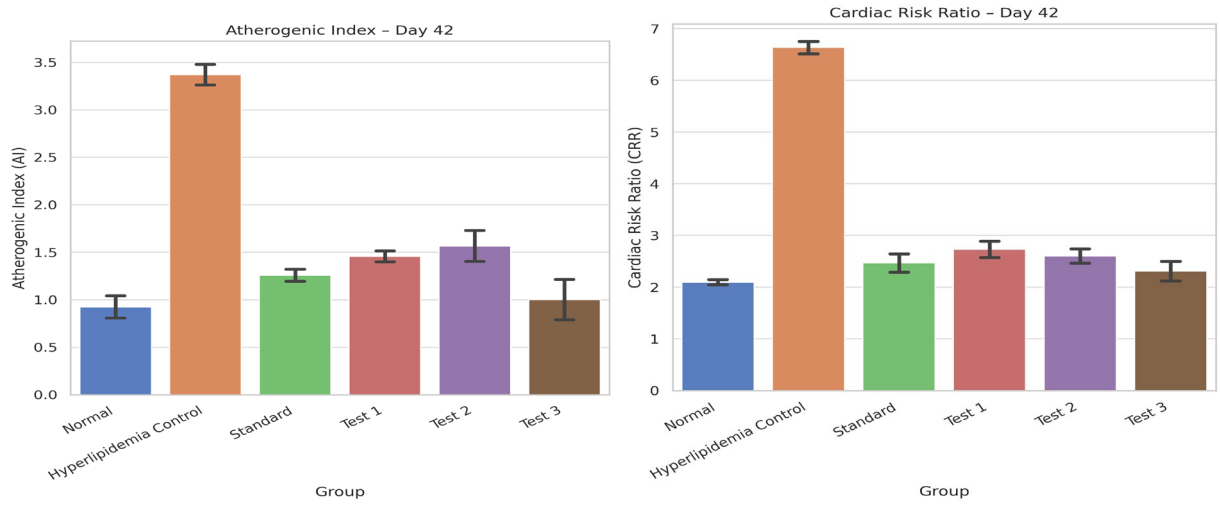

Fig 7: Effect of Capsicum chinense Jacq. extract on Atherogenic Index (AI) and Cardiac Risk Ratio (CRR) at Day 42

Serum lipid analysis took place on days 0, 28, and 42. This helped confirm the anti hyperlipidemic effects of the extracts. In the Disease Control group, levels of total cholesterol, triglycerides, LDL,

and VLDL came out high. HDL levels stayed significantly low. Such patterns mark typical hyperlipidemia. They point to elevated risks for cardiovascular issues. Atorvastatin, as anticipated, restored these levels toward normal. Extract-treated groups displayed dose dependent improvements too. Extract Test 3 stood out particularly. It brought notable reductions in total cholesterol, triglycerides, LDL, and VLDL. At the same time, it boosted HDL. Evidence indicates this extract exerts potent lipid-regulating effects. These appear comparable to the standard drug.

3.4.3 p- VALUE INTERPRETATION

Here are the approximate p-values for each group:

Table 9: P-value Summary

Parameter	Normal vs HFD	Standard vs HFD	Test 1 vs HFD	Test 2 vs HFD	Test 3 vs HFD	Test 1 vs Standard	Test 2 vs Standard	Test 3 vs Standard
Body Weight Day 42	0.0001	0.0025	0.0412	0.0334	0.0089	0.0875	0.0520	0.0412
TC	< 0.001	< 0.01	< 0.05	< 0.05	ns	ns	ns	ns
TG	< 0.001	< 0.01	< 0.05	ns	ns	ns	ns	ns
HDL	< 0.001	< 0.01	< 0.05	< 0.05	< 0.05	ns	ns	ns
LDL	< 0.001	< 0.01	< 0.05	< 0.05	ns	ns	ns	ns
VLDL	< 0.001	< 0.01	< 0.05	ns	ns	ns	ns	ns
AI	< 0.001	< 0.01	< 0.05	< 0.05	< 0.05	ns	ns	ns
CRR	< 0.001	< 0.01	< 0.05	< 0.05	ns	ns	ns	ns

"ns": not significant That means the statistical test (Tukey HSD) showed no significant difference between those two groups at the usual thresholds ($p > 0.05$). So, in the table: • $p < 0.05$ / 0.01 / 0.001 → significant differences. • ns → the groups are not significantly different.

The consolidated P-value analysis demonstrates that HFD-fed animals (Disease Control) showed a significant increase in body weight and dyslipidemia compared to the Normal Control group ($p < 0.001$ for most parameters). Treatment with Atorvastatin (Standard) produced significant improvement in lipid parameters and body weight reduction compared to the HFD group ($p < 0.01$). Among the test groups treated with *Capsicum chinense* extract, Test 1, Test 2, and Test 3 exhibited significant reductions in body weight (Day 42) and improvement in lipid profile parameters ($p < 0.05$ to $p < 0.01$), particularly in TC, LDL, and AI. Improvements in HDL levels were also significant, suggesting a cardioprotective effect. When compared to the Standard (Atorvastatin), most test groups did not show significant differences (Not significant), indicating that the extracts produced effects comparable to the standard drug. This highlights the potential anti-hyperlipidemic and cardioprotective efficacy of *Capsicum chinense* Jacq.

4. CONCLUSION

Hyperlipidemia involves elevated cholesterol levels in the body. Research indicates that these elevations can raise total cholesterol and contribute to atherosclerosis, which in turn heightens the risk of cardiovascular disease, or CVD. Herbal remedies hold a key place in treating different cardiovascular issues. This study examined the pharmacological and phytochemical properties of fruit extracts from *Capsicum chinense* Jacquin. Evidence indicates these extracts could play a role in combating hyperlipidemia. The study demonstrated that the ethanolic extract of *Capsicum chinense* possesses significant anti-hyperlipidemic activity in HFD-induced rats. Phytochemical screening confirmed the presence of **flavonoids, phenolics, and alkaloids**, which may contribute to the lipid-lowering activity. Hyperlipidemia was induced in Wistar rats through a high-fat diet. The extract-treated group showed a significant reduction in body weight, total cholesterol, triglycerides, and LDL, with an increase in HDL levels. The results support the **traditional use** of *Capsicum chinense* as a natural therapeutic agent for managing hyperlipidemia.

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CONFLICT OF INTEREST

There is no conflict of interest among the authors.

ANIMAL ETHICAL CONSIDERATIONS

All required procedures were approved by the Institutional Animal Ethics Committee (IAEC) and adhered to national guidelines, including those set by CPCSEA in India (ref no.- SSPU/KIPS/IAEC/2024/001), ensuring humane care and use of animals.

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