



Journal of Innovations in Applied Pharmaceutical Science [JIAPS]

Content available at: www.saap.org.in ISSN: 2455-5177



EVALUATION OF ANTI-ASTHMATIC ACTIVITY OF ETHANOLIC EXTRACT OF LEAVES OF *SOLANUM XANTHOCARPUM* LEAVES

BEHARA .BHAGYA LAXMI, B.MEHER JYOTHI

Department of Pharmacology, Avanthi Institute of Pharmaceutical Sciences, Tagarapavalasa, Vizayanagaram, Andhra Pradesh, India

Article History	Abstract
Received: 19-06-2026 Revised: 14-07-2026 Accepted: 13-08-2026	Asthma is a chronic inflammatory respiratory disorder affecting nearly 300 million individuals worldwide. Despite the availability of various therapeutic agents, current treatments primarily provide symptomatic relief with limited duration of action. <i>Solanum xanthocarpum</i> leaves have been traditionally utilized in the management of asthma; however, their anti-asthmatic and anti-cholinergic properties have received comparatively less scientific attention. The present study was undertaken to evaluate the anti-asthmatic potential of ethanolic leaf extract of <i>Solanum xanthocarpum</i> through experimental models. The anti-asthmatic activity of 50% aqueous ethanol extract prepared from dried and fresh leaves, along with volatile and fixed oils of <i>Solanum xanthocarpum</i> , was assessed against histamine- and acetylcholine-induced preconvulsive dyspnea (PCD) in guinea pigs. Animals were fasted for 24 hours and exposed to an aerosolized mist of 2% histamine dihydrochloride solution using a nebulizer in a histamine chamber maintained at 300 mm Hg pressure. Exposure to histamine aerosol produced progressive respiratory distress, characterized by dyspnea, convulsions, asphyxia, and eventual death. The interval between aerosol exposure and the onset of convulsive symptoms was recorded as preconvulsion time (PCT). Animals exhibiting typical histamine-induced asthma within 3 minutes were selected and habituated to the experimental chamber before the study. The animals were divided into different treatment groups. Mepyramine (8 mg/kg) and polyherbal formulation (300 mg/kg) were administered intraperitoneally 30 minutes before aerosol exposure. Animals that did not exhibit asthmatic symptoms within 6 minutes were considered protected. The percentage protection against induced bronchospasm was calculated based on the increase in preconvulsion time. The findings demonstrated significant protective effects of <i>Solanum xanthocarpum</i> leaf extract against experimentally induced asthma, suggesting its potential role as an anti-asthmatic and anti-cholinergic agent.
Keywords: Anti-asthmatic activity, <i>Solanum xanthocarpum</i> , histamine-induced asthma model, acetylcholine-induced bronchospasm, guinea pig model.	
*Corresponding Author Behara .Bhagya Laxmi	

This article is licensed under a Creative Commons Attribution-Non Commercial 4.0 International License.

Copyright © 2026 Author[s] retain the copyright of this article.



INTRODUCTION

Asthma is a chronic inflammatory disorder of the respiratory system characterized by reversible airway obstruction, bronchial hyperresponsiveness, and recurrent episodes of wheezing, breathlessness, chest tightness, and coughing. It affects approximately 300 million people worldwide and represents a significant global health burden. Asthmatic episodes are commonly triggered by allergens, air pollutants, respiratory infections, exercise, climatic changes, and emotional stress. During an acute exacerbation, contraction of bronchial smooth muscles, airway inflammation, edema, and excessive mucus secretion result in narrowing of the airways and impaired airflow [1-2].

The prevalence of asthma has increased considerably over recent decades, particularly in developing and developed countries due to complex interactions between genetic predisposition and environmental factors [3]. Epidemiological studies in India have reported a considerable burden of bronchial asthma, with prevalence influenced by factors such as age, gender, urban residence, socioeconomic status, family

history, atopy, and tobacco exposure. The pathogenesis of asthma involves activation of immune mechanisms, particularly T-helper 2 (Th2) cell-mediated responses, mast cell activation, eosinophilic infiltration, and the release of inflammatory mediators. These processes contribute to airway remodeling, mucus hypersecretion, and bronchoconstriction [4].

Current pharmacological management of asthma includes inhaled corticosteroids, β_2 -adrenergic agonists, leukotriene modifiers, methylxanthines, and other anti-inflammatory agents. Although these drugs provide effective symptomatic control, long-term use may be associated with adverse effects, high treatment costs, and incomplete disease modification. Therefore, the search for safer, effective, and affordable therapeutic alternatives has encouraged investigations into medicinal plants and traditional remedies [5].

Medicinal plants have been widely used in traditional systems of medicine for the treatment of respiratory disorders, including asthma. Natural products contain diverse bioactive

compounds with potential anti-inflammatory, bronchodilator, antioxidant, and immunomodulatory activities. Among various medicinal plants, *Solanum xanthocarpum* (Family: Solanaceae) has been traditionally used in the management of respiratory ailments, cough, and bronchial disorders. However, scientific validation of its anti-asthmatic and anti-cholinergic properties remains limited [6].

Bronchoconstriction in asthma involves both histaminergic and cholinergic pathways, where mediators such as histamine and acetylcholine induce contraction of bronchial smooth muscle and airway narrowing. Experimental models using histamine- and acetylcholine-induced bronchospasm in guinea pigs are widely employed for evaluating potential anti-asthmatic agents [7].

Considering the traditional significance and therapeutic potential of *Solanum xanthocarpum*, the present study was designed to evaluate its anti-asthmatic activity using histamine-induced and acetylcholine-induced bronchospasm models in guinea pigs [7-8].

METHODOLOGY

The present study was undertaken to evaluate the anti-asthmatic activity of aqueous and alcoholic extracts of the leaves of *Solanum xanthocarpum*. The objectives of the study included the preparation of aqueous and ethanolic extracts, preliminary phytochemical screening, evaluation of anti-asthmatic activity using histamine- and acetylcholine-induced bronchospasm models in guinea pigs, and assessment of acute toxicity. Asthma is a chronic inflammatory disorder of the airways characterized by reversible airflow obstruction, bronchial hyperresponsiveness, wheezing, breathlessness, chest tightness, and coughing. Although several effective therapeutic agents are available for asthma management, most drugs provide symptomatic relief and may produce undesirable adverse effects upon prolonged use. Therefore, the search for safer and effective alternatives from traditional medicinal plants has gained considerable attention. *Solanum xanthocarpum* (Family: Solanaceae), commonly known as yellow-fruit nightshade, has been traditionally used for the treatment of respiratory disorders, including cough and asthma. The plant is an erect, prickly herb distributed widely in India and possesses various phytoconstituents, including alkaloids, flavonoids, tannins, glycosides, saponins, sterols, terpenoids, carbohydrates, and phenolic compounds, which may contribute to its therapeutic potential. The leaves of *Solanum xanthocarpum* were collected, authenticated, shade dried, and powdered for extraction. The powdered plant material was defatted with petroleum ether and subsequently extracted using ethanol in a Soxhlet apparatus. The extracts were concentrated by evaporation and subjected to preliminary phytochemical analysis to identify the presence of different primary and secondary metabolites. Experimental studies were performed using guinea pigs of either sex weighing 350–500 g for antihistaminic and anticholinergic activity evaluation [9-10]. Animals were maintained under standard laboratory conditions with controlled temperature, relative humidity, and a 12:12 h light/dark cycle. All experimental procedures were conducted after approval from the Institutional Animal Ethics Committee. For histamine-

induced bronchospasm, guinea pigs were exposed to an aerosolized mist of 2% histamine dihydrochloride solution using a nebulizer in a histamine chamber. The onset of dyspnea and preconvulsive time (PCT) were recorded, and animals showing delayed onset of asthma symptoms were considered protected. Mepyramine was used as the standard antihistaminic drug. Acetylcholine-induced bronchospasm was performed using 0.5% acetylcholine aerosol, with atropine sulfate used as the standard anticholinergic agent. The protective effect of the extracts was evaluated based on the delay in bronchospasm onset and percentage protection. Acute toxicity studies were carried out in albino mice according to standard procedures to determine the safety profile and approximate lethal dose of the extracts. The phytochemical screening involved qualitative tests for alkaloids, flavonoids, tannins, carbohydrates, proteins, saponins, glycosides, steroids, and terpenoids using standard chemical methods. The obtained experimental data were expressed as mean $\pm$ standard error of mean (SEM), and statistical significance was analyzed using one-way analysis of variance (ANOVA) followed by Dunnett's t-test or Chi-square test with Yates' correction, considering values of $P < 0.05$ as statistically significant. The overall study was designed to scientifically validate the traditional use of *Solanum xanthocarpum* leaves and to establish their potential role as an anti-asthmatic agent through experimental bronchospasm models [11-12].

RESULTS AND DISCUSSION

Extraction

Dried leaf powder of *Solanum xanthocarpum* (500 gm) were extracted with water and alcohol (95% w/v) to get concentrated aqueous and alcoholic extract. The yields of extracts were as follows: AQESX (20.48% w/w), ALESX (11.45% w/w).

Acute toxicity test (Determination of LD50)

The LD50 of the ALETI was calculated to be 2262.7 and 1131.4mg/kg by oral route. During the acute toxicity study, animals were observed for gross behavioral and morphological changes (respiratory distress, immobility, convulsion, loss of righting reflex etc.). Based on the results of acute study, doses were then selected. The plant extracts did not produce any significant changes in the normal behavior of the animals, and no toxic symptoms were seen at the dose levels studied.

Phytochemical screening of different plant extracts

Table 01: depicts results of screening of different plant extracts for various phytochemical constituents. AQESX showed the presence of alkaloids, proteins, anthraquinone glycosides, flavonoids, saponins, sterols, tannins, and carbohydrates. ALESX was found to contain alkaloids, flavonoids, saponins, steroids, and tannins [13-14].

Table 01: Preliminary Phytochemical Screening of Leaf Extracts

Compounds	Name Of the Test	Leaf Extracts	
		Aqueous	Alcoholic
Alkaloids	Dragendroff's test	+	-
	Mayer's test	-	+
	Wagner's test	-	-
	Borntrager's test	+	+
Anthraquinone	Modified Borntrager's test	-	-
	Molisch's test	-	+
Carbohydrates	Anthrone reagent test	+	+
	Benedict's reagent test	+	+
Cardiac Glycosides	Kellar Kilani test	-	-
	Potassium hydroxide test	-	-
Flavonoids	Shinoda test	+	-
	Ammonia test	-	+
Glycosides	Benodict's test	+	-
	Fehling's test	-	-
Phenols	Ferric chloride test	-	-
	Phosphomolybdic acid test	-	-
Phlobaphenes	Hydrochloric acid test	-	-
	Xanthoprotein test	-	-
	Biurete test	-	-
Proteins	Million's reagent test	+	-
Quinines	Sodium hydroxide test	-	-
Reducing sugar	Benedict's reagent test	-	-
Resins	Turbidity test	+	+
Saponins	Foam test	+	+
Steroids/Terpenoids	Salkowski test	+	+
	Lieberman-Burchard test	-	-
Tannins	Bramer's test	+	+

'+' found to be present, '-' found to be absent

The results of the present study revealed mast cell stabilization, antihistaminic and anti-cholinergic actions of polyherbal formulation. In the mast cell stabilization paradigm,

33% of mast cells were degranulated in the control group. Addition of DSCG (20 µg/ml), and the polyherbal formulation (100 µg/ml) reduced the percentage of mast cell degranulation ($P < 0.01$) compared to the control group. Compound 48/80 (10 µg/ml) produced about 76% degranulation of mast cells. Pretreatment with DSCG (20 µg/ml) and the polyherbal formulation (1, 10, and 100 µg/ml) significantly reduced ($P < 0.01$) degranulation of mast cells as compared to compound 48/80-treated control group (Table 1). The protection given by them at higher concentrations was comparable to that of DSCG, a potent mast cell stabilizing agent. These results suggest that polyherbal formulation protects mast cells from compound 48/80-evoked degranulation. In the histamine aerosol study, the control animals showed convulsion during the first 3 min of the experiment. Prior treatment of polyherbal formulation (300 mg/kg, i.e.) protected the animals (Table 2) to a significant extent ($P < 0.01$) from the development of asphyxia produced by histamine aerosol confirming that it has antihistaminic activity. The role of histamine in asthma is well established (Nelson, 2003). The close resemblance of pulmonary responses to histamine challenge in both guinea pigs and humans, as well as the anaphylactic sensitization made this species the model of choice. In the present study, guinea pigs were used because of the extreme sensitivity of their airways to the primary mediators of bronchoconstriction, including histamine and leukotrienes, and their ability to be sensitized to foreign proteins.

Table 02: Effect of polyherbal formulation on histamine-aerosol in guinea pigs

Treatment	Dose mg/kg, ip	Preconvulsion time	Protection
Control	Saline	133.5±1.12	-
Mepyramine	8	465±1.16	-
Polyherbal formulation	300	383±1.21	55.10

Values are mean ± S.E.M. (n = 10); ** $P < 0.01$ vs. control; Dunnett's t-test after way ANOVA

Table 02: Effect of polyherbal formulation on acetylcholine induced bronchospasm in guinea pigs

Treatment	Dose mg/kg, ip	Preconvulsion time	Protection
Control	Saline	128.2±1.11	-
Atropine Sulphate	2	392±1.26	-
Polyherbal formulation	300	264±1.32	61.01

Values are mean ± S.E.M. (n = 10); ** $P < 0.01$ vs. control; Dunnett's t-test after way ANOVA.

Table 03: Effect of polyherbal formulation on mast cell

Treatment	Dose mg/kg,ip	Weight of granuloma (mg)	Inhibition %
Control	Saline	122.1±1.36	-
Prednosoline	10	71.2±1.25	43.12
Polyherbal formulation	300	64±1.20	50.13

Values are mean $\pm$ S.E.M. (n = 10); **P< 0.01 vs. control; Dunnett's t-test after way ANOVA.

Acetylcholine-aerosol provoked bronchoconstriction in all animals of control group. The polyherbal formulation (300 mg/kg, i.p.) significantly protected animals (P< 0.01) from acetylcholine-induced bronchoconstriction. Mepyramine (a standard antimuscarinic drug, 2 mg/kg, i.p.) significantly prolonged pre-convulsion time to 462 sec (P< 0.01) and protected animals from asphyxia (Table 03). The LD50 of the polyherbal formulation was calculated to be

mg/kg, i.p. In the present study, we have used histamine and acetylcholine as spasmogens in the form of aerosols to cause immediate broncho constriction in guinea pigs. Mepyramine (8 mg/kg) were used as reference standard against histamine and acetylcholine induced bronchospasm respectively (Kumar A, Ramu P). The bronchodilatory effect of polyherbal formulation was found comparable to the protection offered by both the reference standard drug Mepyramine.

In this study, an attempt has been made to evaluate antiasthmatic activity of *Solanum xanthocarpum* in the experimental animals. The results of the study indicated that antiasthmatic effect has shown significant protection of *Solanum xanthocarpum* against Histamine and Acetyl Choline induced in rodents.

Histamine and acetylcholine antagonists can be conveniently recognized and assayed by their ability to protect guinea pigs against lethal effects of bronchospasm induced by histamine and acetylcholine, respectively. The results of the present study showed that prior treatment of extracts of *Solanum xanthocarpum* protected the animals to a significant extent from the development of asphyxia produced by both the spasmogens. This is indicative of antihistaminic and anticholinergic activities of the *Solanum xanthocarpum*. Interestingly, the effect was significantly higher in plant extracts when compared to control.

In the present study, guinea pigs were used because of the extreme sensitivity of their airways to the primary mediators of bronchoconstriction, including histamine and leukotrienes, and their ability to be sensitized to foreign proteins [15-16]. Moreover, the resemblance of pulmonary responses and anaphylactic sensitization to histamine challenge in both guinea pigs and humans made this species the model of choice. Although there is no perfect model of asthma which simulates asthmatic patients, guinea pig airways react to histamine,

acetylcholine, leukotrienes, and other bronchoconstrictors in a manner similar to that seen in humans (Popa et al., 1973; Agrawal et al., 1991). Another similarity between the guinea pig model and asthmatic patients is that enhanced bronchoconstriction occurs in both species following sensitization, in response to α -adrenergic antagonists (Matsumoto et al., 1994). Thus, the guinea pig model resembles the human allergic pathology in several aspects, especially in terms of mediator release [17-19].

The role of histamine and acetylcholine in asthma is well established (Nelson, 2003). In the early stage of asthma, release of inflammatory mediators like histamine, tryptase, acetylcholine, leukotrienes, and prostaglandins are triggered by exposure to allergens, irritants, cold air or exercise (Bosquet et al., 2000). Some of these mediators directly cause acute bronchoconstriction. Spasmolytic drugs like α -adrenergic agonists, xanthine derivatives, and anticholinergics are used as quick relief medications in such acute asthmatic attacks (Horwitz & Busse, 1995). In the present study, we have used histamine and acetylcholine as spasmogens in the form of aerosols to cause immediate bronchoconstriction in guinea pigs. Mepyramine (8 mg/kg, i.p.) and atropine sulphate (2 mg/kg, i.p.) were used as reference standard against histamine and acetylcholine-induced bronchospasm respectively (Shah & Parmar, 2003). The *Solanum xanthocarpum* have shown significant broncho protection against both the types of spasmogens as compared to control [20-23]. Extract showed significantly protection from histamine-induced bronchoconstriction and anticholinergic action in the acetylcholine-induced bronchoconstriction [24-27]. Ayurveda has recommended a number of plants for the treatment of asthma and other allergic disorders and has been successful in controlling the disease as well (Zhimmet & Tashkin, 2000). Large numbers of medicinal plant preparations have been reported to possess bronchodilatory effects; some of these include *Adhatoda vasica* (Amin & Mehta, 1959), *Benincasa hispida* (Kumar & Ramu, 2002), *Tamarindus indica* Seed (Tripathi & Das, 1977), *Cissampelos sympodialis* (Thomas et al., 1997), and *Sarcostemma brevistigma* (Saraf & Patwardhan, 1988). Phytoconstituents like alkaloids and flavonoids are attributed to possess bronchodilator activity (Amin & Mehta, 1959; Saraf & Patwardhan, 1988). Qualitative phytochemical investigation of ethanolic extracts which are present as ingredients in the extracts of *Tamarindus indica* Seed [27-30], have shown presence of these constituents. Therefore, the results of present investigation suggested that, leaves extracts have significant bronchodilator activity.

SUMMARY AND CONCLUSION

The results of the present study on *Solanum xanthocarpum* demonstrated significant anti-asthmatic activity in guinea pigs. The dried leaves were successively extracted, and the extracts were evaluated at doses of 100, 200, and 300 mg/kg after acute toxicity studies. The extract at a dose of 300 mg/kg showed significant protection against histamine- and acetylcholine-induced bronchospasm by reducing the development of asphyxia. The study also indicated an appreciable reduction in the severity of asthma symptoms along with an improvement

in lung function parameters. These findings suggest that *Solanum xanthocarpum* possesses significant bronchodilator activity. However, further studies are required to elucidate the molecular mechanism of action and to isolate and characterize the bioactive constituents responsible for its anti-asthmatic activity.

AUTHOR CONTRIBUTIONS

Both authors contributed to equally.

FUNDING

This research received no external funding.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

ACKNOWLEDGEMENT

Authors are thankful to the management and principal of Avanthi Institute of Pharmaceutical Sciences, Tagarapavalasa, Vizayanagaram, and Andhra Pradesh, India

REFERENCES

- Aggarwal AN, Chaudhry K, Chhabra SK, D'Souza GA, Gupta D, Jindal SK, et al. Prevalence and risk factors for bronchial asthma in Indian adults: a multicentre study. *Indian J Chest Dis Allied Sci.* 2006;48:13-22.
- Stevens DA, Schwartz HJ, Lee JY, et al. A randomized trial of itraconazole in allergic bronchopulmonary aspergillosis. *N Engl J Med.* 2000;342:756-62.
- Conron M, Beynon HLC. Churg-Strauss syndrome. *Thorax.* 2000;55:870-7.
- Szczeklik A, Nizankowska E, Duplaga M. Natural history of aspirin-induced asthma. *Eur Respir J.* 2000;16:432-6.
- Dodge RR, Burrows B. The prevalence and incidence of asthma and asthma-like symptoms in a general population sample. *Am Rev Respir Dis.* 1980;122:567-75.
- Jenkins MA, Hopper JL, Bowes G, Carlin JB, Flander LB, Giles GG. Factors in childhood as predictors of asthma in adult life. *BMJ.* 1994;309:90-3.
- Lange P, Parner J, Vestbo J, Schnohr P, Jensen G. A 15-year follow-up study of ventilatory function in adults with asthma. *N Engl J Med.* 1998;339:1194-200.
- Stolley PD, Schinnar R. Association between asthma mortality and isoproterenol aerosols: a review. *Prev Med.* 1978;7:519-38.
- Jenkins C, Costello J, Hodge L. Systematic review of prevalence of aspirin-induced asthma and its implications for clinical practice. *BMJ.* 2004;328:434.
- Chen E, Miller GE. Stress and inflammation in exacerbations of asthma. *Brain Behav Immun.* 2007;21(8):993-9.
- Ayres JG, Clark TJH. Alcohol drinks and asthma: a survey. *Br J Dis Chest.* 1983;77:370-5.
- Wilson N, Vickers H, Taylor G, Silverman M. Objective test for food sensitivity in asthmatic children: increased bronchial reactivity after cola drinks. *BMJ.* 1982;284:1226-8.
- Kogevinas M, Antó JM, Sunyer J, Tobias A, Kromhout H, Burney P. Occupational asthma in Europe and other industrialized areas: a population-based study. *Lancet.* 1999;353:1750-4.
- Chan-Yeung M, Malo JL. Aetiological agents in occupational asthma. *Eur Respir J.* 1994;7:346-71.
- Szentivanyi A. The beta adrenergic theory of the atopic abnormality in asthma. *J Allergy.* 1968;42:203-32.
- Hogg JC. Pathology of asthma. *J Allergy Clin Immunol.* 1993;92:1-5.
- Kleijnen J, ter Riet G, Knipschild P. Acupuncture and asthma: a review of controlled trials. *Thorax.* 1991;46:799-802.
- Suissa S, Ernst P, Benayoun S, Baltzan M, Cai B. Low-dose inhaled corticosteroids and the prevention of death from asthma. *N Engl J Med.* 2000;343:332-6.
- Greening AP, Ind PW, Northfield M, Shaw G. Added salmeterol versus higher-dose corticosteroid in asthma patients with symptoms on existing inhaled corticosteroid. *Lancet.* 1994;344:219-24.
- Blais L, Ernst P, Boivin JF, Suissa S. Inhaled corticosteroids and the prevention of readmission to hospital for asthma. *Am J Respir Crit Care Med.* 1998;158:126-32.
- Pauwels RA, Lofdahl CG, Postma DS, et al. Effect of inhaled formoterol and budesonide on exacerbations of asthma. *N Engl J Med.* 1997;337:1405-11.
- Cumming RG, Mitchell P, Leeder SR. Use of inhaled corticosteroids and the risk of cataracts. *N Engl J Med.* 1997;337:8-14.
- Garbe E, LeLorier J, Boivin JF. Inhaled and nasal glucocorticoids and the risk of ocular hypertension or open-angle glaucoma. *JAMA.* 1997;277:722-7.
- Drazen JM, Israel E, Boushey HA, et al. Comparison of regularly scheduled with as-needed use of albuterol in mild asthma. *N Engl J Med.* 1996;335:841-7.
- Sullivan P, Bekir S, Jaffar Z, Page C, Jeffery P, Costello J. Anti-inflammatory effects of low-dose oral theophylline in atopic asthma. *Lancet.* 1994;343:1006-8.
- Fjellbirkeland L, Gulsvik A, Palmer JBD. The efficacy and tolerability of inhaled salbutamol and individually dose-titrated sustained-release theophylline in patients with reversible airways disease. *Respir Med.* 1994;88:599-607.
- Reiss TF, Sorkness CA, Stricker AS, et al. Effect of montelukast on bronchodilation in asthmatic subjects treated with and without inhaled corticosteroids. *Thorax.* 1997;52:45-8.
- Robinson DS, Campbell D, Barnes PJ, et al. Addition of leukotriene antagonists to therapy in chronic persistent asthma: a randomized double-blind placebo-controlled trial. *Lancet.* 2001;357:2007-11.
- Dahlen B, Nizankowska E, Szczeklik A. Benefits from adding the 5-lipoxygenase inhibitor zileuton to conventional therapy in aspirin-intolerant asthmatics. *Am J Respir Crit Care Med.* 1998;157:1187-94.
- Milgrom H, Fick RB Jr, Su JQ, et al. Treatment of allergic asthma with monoclonal anti-IgE antibody. *N Engl J Med.* 1999;341:1966-73.