Development and Evaluation of a Herbal Spray for its Repellent and Insecticidal Effects Containing *Wedelia Chinensis*, Aloe Vera and Lavender Oil

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ABSTRACT

Wedelia chinensis extract, Aloe vera gel, and lavender oil as a safe and eco-friendly alternative to conventional chemical repellents. Ethanolic extract of Wedelia chinensis was Mosquito-borne diseases such as malaria, dengue, chikungunya, and Zika continue to pose significant public health challenges worldwide. Although synthetic mosquito repellents are effective, their prolonged use is associated with skin irritation, toxicity, environmental concerns, and the development of insect resistance. The present study aimed to formulate and evaluate a herbal mosquito repellent spray containing prepared by maceration and incorporated into the formulation along with Aloe vera gel, lavender oil, glycerine, polysorbate 80, and distilled water. The prepared formulation was evaluated for physicochemical parameters including pH, viscosity, and spreadability, followed by mosquito repellent activity, antimicrobial activity, insecticidal potential, and skin irritation testing. The formulation exhibited a skin-friendly pH of 5.5–6.5, good spreadability, and suitable viscosity for topical application. Mosquito repellent studies demonstrated approximately 85% repellency, indicating effective protection against mosquito bites. The formulation also showed moderate antimicrobial activity and insecticidal potential while producing no signs of skin irritation or allergic reactions during topical application. The synergistic combination of Wedelia chinensis, Aloe vera, and lavender oil provided enhanced repellent efficacy, skin-soothing effects, and improved formulation stability. These findings suggest that the developed herbal mosquito repellent spray is a safe, effective, biodegradable, and environmentally friendly alternative to synthetic mosquito repellents, with promising potential for further development as a commercial herbal product.

Keyword: Wedelia chinensis, Herbal mosquito repellent, Lavender essential oil, Aloe vera, Mosquito repellency, Biodegradable formulation, Vector control

INTRODUCTION

Mosquitoes are important vectors of several vector-borne diseases, including malaria, dengue, chikungunya, Zika, Japanese encephalitis, and lymphatic filariasis, posing a major public-health burden, particularly in tropical and subtropical regions such as India. The principal disease-transmitting mosquito genera include Anopheles, Aedes, and Culex, which can be differentiated by their characteristic morphology and resting posture. Anopheles mosquitoes are generally identified by their spotted wings and an inclined resting posture, with the body positioned at an angle to the surface; *Anopheles stephensi* is an important vector of malaria in urban India [1,2]. Aedes aegypti, the major vector of dengue, chikungunya, and Zika, can be recognized by its black-and-white banded legs and lyre-shaped markings on the thorax [2,3]. Aedes albopictus (Asian tiger mosquito) has a single prominent white stripe on the thorax and white-banded legs and is also an important vector of dengue and chikungunya [3]. Culex mosquitoes, including *Culex quinquefasciatus*, generally have a brownish appearance, unbanded legs, and a characteristic horizontal resting posture and are associated with diseases such as lymphatic filariasis and Japanese encephalitis [2,4].

Despite the effectiveness of synthetic mosquito repellents such as N, N-diethyl-meta-toluamide (DEET), prolonged or inappropriate use may cause skin irritation and raises concerns regarding environmental persistence and reduced efficacy associated with mosquito resistance [5]. Therefore, increasing attention has

been directed toward plant-based mosquito repellents, which may offer biodegradable and comparatively safer alternatives. *Wedelia chinensis* possesses reported antimicrobial and insect-repellent properties, while Aloe vera provides soothing and skin-protective effects. Glycerine acts as a humectant, improving moisture retention and contributing to formulation stability. The present study aims to develop a herbal mosquito-

repellent spray containing *Wedelia chinensis*, Aloe vera gel, and glycerine and to evaluate its physicochemical characteristics and mosquito-repellent activity. The study will further investigate whether the combination of these ingredients produces a synergistic repellent effect, with the objective of developing a safe, effective, biodegradable, and skin-friendly herbal mosquito-repellent formulation.

During the study, four mosquito species of medical importance, namely *Aedes albopictus, Anopheles stephensi* were collected and identified based on their characteristic morphological features. *Aedes albopictus* was identified by its single prominent white dorsal stripe on the thorax and white-banded legs and is an important vector of dengue, chikungunya, and Zika virus [2,3]. These identified mosquito species were subsequently considered for evaluating the repellent efficacy of the developed herbal formulation containing *Wedelia chinensis*, Aloe vera gel, and glycerine.

LIMITATIONS

- Allergies and skin irritation: May result in dermatitis, redness, burning, and itching, particularly on sensitive skin.
- Potential toxicity: Prolonged exposure or high concentrations may cause headaches, lightheadedness, and in rare instances, neurotoxic consequences.
- Unpleasant scent and greasiness: An unpleasant smell and greasy texture can make users less compliant.
- Material damage: Has the potential to disintegrate or harm timepieces, synthetic textiles, plastics, and painted surfaces.
- Not recommended for frequent use: Frequent application poses safety concerns, particularly in children and pregnant women
- Environmental issues: Chemical residues may linger in the environment and have an impact on ecosystems and non-target organisms.
- Resistance development: Since mosquitoes can grow tolerant over time, continuous application may lessen effectiveness.
- Limited extra benefits: Synthetic repellents typically lack skin-soothing, antibacterial, or medicinal qualities in contrast to herbal products [6].

Herbal Repellents

Because of their natural origin, biodegradability, and low toxicity, herbal repellents have become more important as safe, environmentally acceptable substitutes for synthetic insect repellents.

These repellents are made from plant sources that are high in volatile bioactive substances with insect-repelling qualities, such as alkaloids, terpenoids, essential oils, and flavonoids.Because of their demonstrated effectiveness, plants including Wedelia chinensis, Azadirachta indica, Cymbopogon citratus, and Ocimum sanctum are frequently utilized. Herbal repellents work primarily by releasing potent volatile chemicals that block insect olfactory receptors, either concealing human scents or keeping mosquitoes away from the treated area. Their superior safety profile makes them appropriate for repeated usage, particularly on delicate skin, even though their duration of action may be less than that of synthetic agents. Herbal repellents are frequently used with humectants like glycerine and bases like aloe vera gel in formulations to increase stability, spreadability, and retention time by slowing the active ingredients' quick evaporation. All things considered, herbal repellents provide a practical, sustainable, and easy-to-use method of preventing mosquito bites [7].

Wedelia Chinensis (Fig No.2)

The therapeutic and insect-repelling qualities of Wedelia chinensis are attributed to a wide variety of bioactive

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chemicals found in its phytochemistry. The plant is exceptionally rich in coumestans, particularly wedelolactone and demethylwedelolactone, which are thought to be important active ingredients. Along with alkaloids, triterpenoids, saponins, phenolic compounds, tannins, and essential oils, it also includes flavonoids like luteolin and apigenin.These phytoconstituents support a number of pharmacological actions, such as insect-repelling, antibacterial, anti-inflammatory, and antioxidant properties. Because they interfere with mosquito olfactory receptors and impede host detection, volatile chemicals and essential oils are particularly crucial for mosquito repellent effectiveness. Furthermore, these substances work in concert to improve the plant's overall effectiveness. The phytochemical content might change according on solvent systems, extraction techniques, and environmental elements including soil conditions and climate. All things considered, Wedeliachinensis's varied phytochemical profile validates its potential as a strong and multipurpose component in herbal mosquito repellent compositions [8].

Fig no.1

Aloevera (Fig no.2)

Aloe vera gel's phytochemistry shows that it is mostly made up of water (98–99%) and a variety of bioactive substances, including polysaccharides (acemannan and glucomannan), vitamins (A, C, E, and B-complex), amino acids, enzymes, and vital minerals like calcium, magnesium, and zinc. Its antibacterial, anti-inflammatory, antioxidant, and moisturizing qualities are further enhanced by the presence of anthraquinones, saponins, sterols, and phenolic compounds. Aloe vera gel can be used as a stabilizing and calming agent in topical herbal preparations, as well as for skin protection and hydration thanks to these components [9].

Fig no.2

Lavender Oil(Fig no.3)

Lavender oil (from Lavandula angustifolia) has a rich composition of volatile chemicals, primarily monoterpenes and their esters, which characterize its phytochemistry. Linalool and linalyl acetate, which give

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it its distinctive scent and biological properties, are among its main ingredients. Other ingredients include camphor, 1,8-cineole, borneol, terpinen-4-ol, and lavandulol. Lavender oil is extremely helpful in herbal formulations and mosquito repellent preparations because of these phytochemicals, which also contribute to its insect repellent, antibacterial, anti-inflammatory, antioxidant, and relaxing qualities [10].

Fig no.3

METHODOLOGY

Collection

Fresh leaves of Wedelia chinensis were collected from the local area near Marripalem, Visakhapatnam, Andhra Pradesh, during the month of January 2026. The collected leaves were washed thoroughly with distilled water to remove dirt and other impurities and then shade dried for further use.

Authentication

The collected plant material of Wedelia chinensis was authenticated by Andhra University and verified by S. B. Padal.

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CERTIFICATE

This is to certify that the plant specimen *Sphagneticola calendulacea* (L.) Pruski belong to family Asteraceae collected and deposited by G.Jaya Lakshmi, G.H. Rajkumar & K.Trinad, Raghu College of Pharmacy, Dakamarri at Herbarium (AUV), Department of Botany, Andhra University with Collection number 25470.

S.B.Padal

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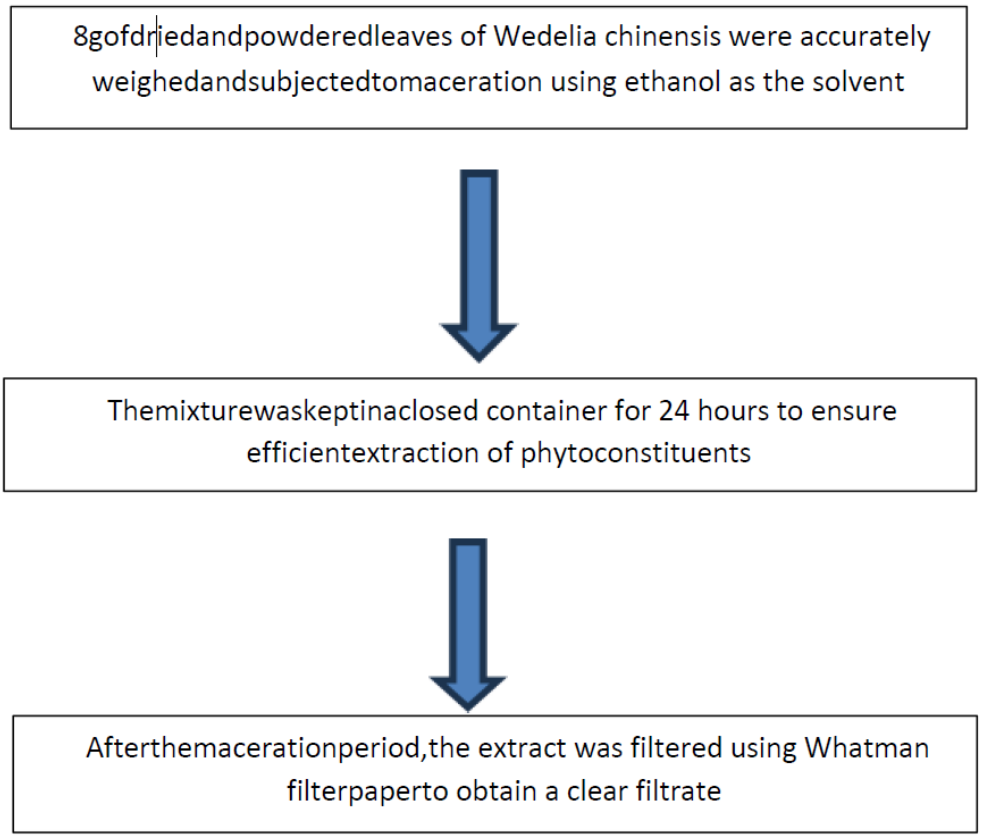
Extraction



Formulation

The formulation was prepared by using the ethanolic extract of Wedelia chinensis. To the obtained filtrate, 2% lavender oil was added as a fragrant and additional repellent agent, followed by the addition of 0.8% polysorbate 80 as a surfactant to ensure uniform mixing of oil and aqueous phases. The total volume of the formulation was then adjusted using distilled water. Subsequently, 4 ml of glycerine and 5 g of Aloe vera gel were incorporated into the mixture and stirred continuously to obtain a homogeneous formulation. The final product was transferred into suitable spray containers.

EVALUATION TEST

PH:

After evaluation, it was discovered that the pH of the herbal mosquito repellent spray was between 5.5 and 6.5, which is around the typical pH of human skin. This shows that the formulation is safe for frequent topical administration, does not irritate human skin, and is compatible with human skin. Its fitness for human use was confirmed by the absence of any redness, itching, or discomfort during application.

Viscosity

A viscometer was used to measure the viscosity of the prepared herbal insect repellent spray. The viscometer's spindle was submerged in a suitable container containing a sufficient amount of the formulation. The viscosity reading was taken once it stabilized, and the measurement was done at a steady speed [11].

Spreadability

The herbal mosquito repellent spray's spreadability was found to be good, meaning that it spreads easily and with little effort on human skin. Smooth application and improved coverage were ensured by the formulation's

consistent dispersion, which lacked stickiness or greasiness. Its appropriateness and acceptability for topical use on human skin were confirmed by the absence of irritation or residue following application.

Repellant Assay And Insecticidal Assay

Parameter	Filter Paper Method	Contact Toxicity Method
	[MOSQUITO REPELLANT ASSAY]	[INSECTICIDAL ASSAY]
Procedure	A predetermined amount of the prepared herbal insect repellent was applied to a filter paper and left to dry. A mosquito cage containing a predetermined number of mosquitoes was provided with the treated filter paper. The same procedure was followed using an untreated filter paper as the control. Over a predetermined period, the number of mosquitoes landing on the treated and untreated papers was counted. The duration and efficacy of the repellent activity were assessed by repeating the experiment at regular intervals [12].	The contact toxicity method was used to assess the insecticidal efficacy of the herbal spray against ants. Ants were placed in a cage or test chamber. A predetermined amount of the formulation was applied to filter paper or the interior surface of the chamber and left to dry. A formulation-free control setup was prepared similarly. The ants were exposed to the treated surface, and the number of knocked-down and dead ants was counted at regular intervals [13].
Formula	Repellency (%) = (C − T) / C × 100 Where: C = Number of mosquito landings on control T = Number of mosquito landings on treated sample	Mortality (%) = Number of dead ants / Total number of ants × 100
Observation	When compared to the control, there were substantially fewer mosquitoes landing on the treated filter paper. Mosquitoes avoided the treated surface, according to observations taken at regular intervals, although they frequently landed on the untreated control. The repelling effect persisted for a long time, suggesting that the formulation's activity was sustained	Ants exposed to the prepared herbal spray showed observable behavioural changes within a short period, including decreased mobility, loss of coordination, and progressive paralysis. Mortality in the treated group increased over time compared with the control group. The control ants remained active and showed no signs of toxicity. A steady increase in the number of dead ants confirmed the formulation's insecticidal activity through contact action.
Result	Approximately 80–90% of mosquitoes were repelled by the herbal repellent spray, which demonstrated high repellent activity. This suggests that the mixture can offer dependable defense against mosquito bites and is successful in stopping mosquito	A higher percentage of mortality indicated stronger insecticidal action of the formulation when administered through direct contact.

Filter Paper Method[14]



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Control Test

Group	Sample size(ml)	Total no of mosquito was taken	Time-wise Observation		
			5 minutes	15 minutes	30 minutes
Mosquitoes on Control Side(died)	1	20	0	0	0
Mosquitoes on Treated Side(died)	1	20	3	7	10
%Repellency(C−T)/C×100			85	65	50

Contact Toxicity Test[15]



Group	Sample size(ml)	Total no of mosquito was taken	Time-wise Observation		
			5 minutes	15 minutes	30 minutes
Insects on Control Side(died)	1	10	0	0	0
Insects on Treated Side(Died)	1	10	3	3	4
Mortality(%) (Number of dead Insects/ Total number of ants x 100)			30	30	40

PHARMACOLOGICAL EVALUATION

Antimicrobial Assay

The antimicrobial activity of the formulated herbal mosquito repellent spray was evaluated using the agar well diffusion method. Nutrient agar plates were prepared and sterilized, then inoculated uniformly with test microorganisms (bacteria such as Escherichia coli). Wells were made in the agar using a pen cap. A measured quantity of the formulation was

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introduced into each well, while a standard antimicrobial agent was used as control. The plates were incubated at 37°C for 24 hours. After incubation, the zone of inhibition around each well was observed and measured in millimeters [16].

Skin Irritation Test

A healthy human volunteer was used in the skin irritation test to evaluate the safety of the herbal mosquito repellent spray. The volunteer's forearm was marked with a little amount of the formulation. For a full day, the area was left unattended and exposed without being cleaned. Any indications of irritation, such as redness, itching, swelling, or discomfort, were noted on a frequent basis. For comparison, a control site devoid of application was also kept [17].

Observation

Periodically, the skin was checked for any obvious alterations or discomfort.

Result

No signs of irritation, redness, or allergic reaction were observed on the test area, indicating that the formulation is safe and suitable for topical application on human skin.

Comparative Study of Developed and Marketed Mosquito Repellent Formulations

Parameter	Herbal Formulation	Marketed Herbal Product [18]		
		Herbal Armor	Buzz Away Extreme	Skin Smart
Repellency (%)	80	90	>90	90
Mortality (%)	>80	90	90	9

RESULTS AND DISCUSSION

Result

The assessment results of the herbal mosquito repellent spray with Wedelia chinensis, Aloe vera gel, and glycerine were satisfactory. The formulation's pH was found to be between 5.5 and 6.5, suggesting that it is suitable for skin application. Good spray ability and ease of application were ensured by the low to moderate viscosity. Because of the formulation's exceptional spreadability, it could be applied evenly to the skin. The formulation demonstrated about 85% repellency in the mosquito repellent assay, suggesting good defense against mosquito bites. A detectable zone of inhibition was seen in the antimicrobial activity, indicating moderate antimicrobial qualities. The formulation is safe for human usage because the skin irritation test showed no indications of redness, itching, or inflammation.

Discussion

The proposed formulation is efficacious and appropriate for topical administration, according to the results. Minimal irritation and good compatibility are guaranteed by the pH range that is similar to human skin. Easy application and improved skin surface covering are facilitated by the low to moderate viscosity and good spreadability. Wedelia chinensis contains bioactive chemicals that disrupt mosquito host-seeking behaviour, which may be the cause of the notable repellency seen. Aloe vera gel promotes the calming and moisturizing properties, and glycerine prolongs the formulation's activity by improving moisture and skin retention. The formulation's protective properties are further supported by the reported antibacterial activity. All things considered, the combination of these organic components offers a reliable, secure, and sustainable substitute for artificial insect repellents.

SUMMARY AND CONCLUSION

The goal of the current study was to create and assess a herbal mosquito repellent spray including Wedelia chinensis, Aloe vera gel, and glycerol (glycerine) as essential ingredients. The study's goal was to provide a safe, efficient, and environmentally responsible substitute for synthetic insect repellents. To extract the

bioactive components that give Wedelia chinensis its insect-repelling properties, fresh leaves were gathered, processed, and extracted using ethanol. Glycerine was used as a humectant to improve the formulation's hydration, stability, and skin retention, while aloe vera gel was used as a natural foundation because of its calming, hydrating, and skin-protective qualities

Numerous physicochemical and biological tests were performed on the prepared spray.

The formulation's pH was discovered to be between 5.5 to 6.5, which is around the pH of human skin naturally. This indicates high compatibility and little chance of irritation. Low to moderate viscosity was noted, guaranteeing appropriate spray capability and application ease. Additionally, the formulation demonstrated good spreadability, which is necessary for the active chemicals to be evenly distributed across the skin's surface

When the formulation's mosquito repellent activity was assessed using conventional techniques, the results demonstrated a significant level of repellent efficacy, with about 85% protection against mosquito landings.

Wedelia chinensis contains volatile phytoconstituents such flavonoids, coumestans, and essential oils that interfere with mosquitoes' olfactory receptors and interfere with their host-seeking behavior. By increasing adherence to the skin and lowering the rate at which active compounds evaporate, the addition of glycerine and aloe vera gel improved the formulation's effectiveness and extended its duration of action.

The zone of inhibition seen during antimicrobial tests demonstrated the formulation's moderate antimicrobial qualities in addition to its repellent activity. This implies that the mixture might offer extra defense against cutaneous microbial infection.

The skin irritation test conducted on human volunteers showed no signs of redness, itching, or inflammation, confirming that the formulation is safe, non-toxic, and suitable for regular topical use. Overall, the study demonstrates that the combination of Wedelia chinensis, aloe vera gel, and glycerine results in a stable, effective, and user-friendly herbal mosquito repellent spray. The formulation not only provides protection against mosquito bites but also offers added benefits such as skin hydration, soothing effect, and antimicrobial activity. Compared to synthetic repellents, this herbal formulation is safer, biodegradable, and environmentally sustainable.

In conclusion, the developed herbal mosquito repellent spray represents a promising natural alternative to conventional chemical repellents. With further optimization and large-scale studies, this formulation has the potential to be developed into a commercially viable product for effective mosquito control and improved public health.

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