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Research Article

Evaluation of Efficacy of *Aparajita* (Clitoria ternatea Linn.) in the Management of Depression in Farmers of *Vida*rbha Region Chronically Exposed to Organophosphorus Compounds

Laxmikant Paymalle[1*], Nilima Wadnerwar[2]

1. Ph.D. Scholar, Department of Agadtantra, Datta Meghe Institute of Higher Education & Research (Deemed to be University), Wardha, Maharashtra, India. Associate Professor, Department of Agadtantra, Shri Gurudeo Ayurved College Hospital, Gurukunj Ashram, Mozari, Amravati, Maharashtra, India.
2. Professor, Department of Agadtantra, Mahatma Gandhi Ayurved College Hospital & Research Centre Salod (H), Datta Meghe Institute of Higher Education & Research (Deemed to be University), Wardha. India.

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Abstract

Introduction: India is an agrarian country where pesticides and insecticides are abundantly used in farming. Organophosphorus compounds are the most common class of pesticides, known to inhibit acetylcholinesterase, thereby increasing acetylcholine levels in the central nervous system. Chronic exposure results in neuropsychiatric manifestations such as depression, often associated with suicidal tendencies. In Ayurveda, several *Medhya Rasayana* drugs are indicated for mental health disorders. *Aparajita* (*Clitoria ternatea Linn.*), traditionally described as *Tridoshaghna, Aampachana,* and *Vishaghna*, also possesses *Sarpavishahara* (anti-venom) properties. Aim: To evaluate the efficacy of Aparajita Mool (*Clitoria ternatea Linn.*) in the management of depression among farmers chronically exposed to organophosphorus compounds. Methods: A community-based survey was conducted in the Wardha district of *Vidarbha*, Maharashtra, to identify farmers with more than 12 months of chronic exposure to organophosphorus compounds. Eligible participants were clinically assessed using Hamilton Depression Rating Scale, and serum cholinesterase levels were measured. A total of 40 farmers with mild to moderate depression were enrolled after informed consent. The intervention consisted of *Aparajita Mool Churna* (1 g daily) for 6 consecutive months. Follow-up assessments were conducted at the 3rd, 6th, and 9th months. Results: Comparison of baseline and 9-month follow-up values demonstrated a highly significant improvement ($p < 0.001$) in both serum cholinesterase activity and Hamilton depression scores. Conclusion: *Aparajita Mool* exhibited considerable efficacy in reducing depression severity and normalizing serum cholinesterase levels in farmers chronically exposed to organophosphorus compounds. This study supports its potential role as an effective Ayurvedic intervention for occupationally induced depression.

Keywords: *Aparajita Mool, Clitoria ternatea,* Organophosphorus exposure, Depression, Farmers, Cholinesterase activity

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Introduction

Agriculture has long been the backbone of India's economy, with approximately 60% of the population depending on it as their primary source of income. Farmer suicides have emerged as a serious public health issue, not only in Maharashtra but across India. According to the National Crime Records Bureau (NCRB), in 2022, a total of 11,290 individuals from the farming sector died by suicide, comprising 5,207 farmers/cultivators and 6,083 agricultural labourers in Maharashtra alone. This accounted for 6.6% of the total 1,70,924 suicide cases reported nationwide in that year (1). When comparing suicide rates across different occupations, farmers are found to have significantly higher rates than most others (2). Several researchers and scholars have extensively discussed this issue, identifying a range of contributing factors including erratic monsoon patterns, indebtedness, family conflicts, unsuitable government policies, and the extensive use of hybrid seeds and pesticides, all of which may contribute to poor mental health among farmers (3).

India, being an agriculturally dominant country, makes widespread use of pesticides and insecticides for cultivation. These chemicals are not only easily accessible to farmers but are often used over prolonged periods. Long-term exposure to pesticides has been associated with various mental health disorders, one of the most significant being depression (4). Among pesticides, organophosphates are the most commonly used. These compounds act on both the autonomic and central nervous

*** Corresponding Author:**
Laxmikant Paymalle
Ph.D. Scholar, Department of Agadtantra
Datta Meghe Institute of Medical Sciences (Deemed to be University), Sawangi (Meghe), Wardha, Maharashtra, India.
Email Id: lspaymalle@gmail.com

systems by increasing acetylcholine levels through inhibition of cholinesterase activity. On the autonomic nervous system, they exert parasympathomimetic effects—mimicking the action of the parasympathetic nervous system by inhibiting cholinesterase, thereby prolonging acetylcholine activity. Their central nervous system effect manifests as depression (5).

Exposure to these pesticides leads to decreased cholinesterase activity (6), resulting in elevated levels of acetylcholine in the brain. This has been linked with the onset of depressive disorders and a heightened risk of suicidal tendencies (7). Chronic exposure to organophosphates has also been associated with neurodegenerative and psychiatric conditions such as Parkinson's disease, Alzheimer's disease, ADHD, anxiety disorders, and depression, especially in rural populations (8). Thus, a direct association can be established between pesticide exposure (primarily cholinesterase-inhibiting organophosphates), inhibition of acetylcholinesterase, and depression with suicidal ideation (9). Current management of depression generally includes antidepressants, electroconvulsive therapy (ECT), and psychosocial interventions. While antidepressants are commonly prescribed for mild to severe depression, there is no widely accepted pharmacological intervention that specifically restores cholinesterase levels in affected individuals.

In Ayurveda, to treat such mental disorders, various Medhya drugs are described to improve. mental abilities. *Aparajita* (Clitoria ternatea Linn) is a drug mentioned in the treatment of various mental health conditions and is also utilized as the key ingredient in *Medhya rasayana* formulation (10). While there isn't a plethora of research explicitly focusing on Ayurvedic drug recommendations for reducing pesticide poisoning in farmers, Some pharmacological and animal studies revealed that *Clitoria ternatea Linn* is an Antidepressant (11) with cholinergic action. (12). In Classical text, *Clitoria ternatea Linn* is described as *Vishghana* (Anti- poisonous) *Medhya* (Rejuvenating), and modern pharmacological and animal studies also proved the Cholinergic action and Antidepressant activity of this drug. Aparajita is attributed with properties such as *Tridoshshamaka, Aampachana, and Vishaghna*, particularly in its role as *Sarpvishahara* (antidote for snake venom) (13). It is considered a potent *medhya* herb, traditionally used to enhance memory, cognition, and emotional well-being. Phytochemical analysis of *Clitoria ternatea* Linn has led to the isolation of two active compounds, (Z)-9,17-octadecadienal and n-hexadecanoic acid, from its roots. These compounds show promise in developing selective MAO-A inhibitors, indicating potential use in managing depression and anxiety disorders (14,15).

Hence, this study is designed to find an authentic Ayurvedic interventional remedy for such a chronic social ailment at the base level. Study Rationale Apart from financial problems, exposure to pesticides causing depression is also ruled out as a cause of suicides, not only in farmers but also in adolescents in farmer families from other countries (16,17). The pesticides are organophosphorus compound, which decreases acetyl cholinesterase levels, causing depression, which may lead to suicidal tendencies. Hence, the association between pesticide exposure and depression has been established by numerous research studies. Still, there is no proven treatment regarding increasing the cholinesterase level in depressive victims like pesticide-exposed farmers. Only the preventive aspect is focused on avoiding exposure. Still, the cases of farmers' suicide are increasing in India.

Considering the above-discussed factors, it becomes evident that depression caused by chronic exposure to organophosphorus pesticides is a major health concern among Indian farmers. The association between organophosphorus pesticide exposure and depression has been established by various research studies. Organophosphates inhibit acetylcholinesterase activity, leading to increased acetylcholine concentration in the central nervous system, which contributes to depression and suicidal tendencies. While preventive measures to reduce exposure have been the primary focus, no standard or proven treatment is currently available to counteract the cholinesterase inhibition in exposed individuals. The increasing cases of farmer suicides in India call for a deeper investigation into therapeutic alternatives that can address the root neurochemical imbalance caused by such exposures.

Hence, this study is designed to explore the efficacy of *Aparajita* root as a therapeutic agent for depression in farmers chronically exposed to organophosphorus pesticides. It seeks to assess the grade of depression using the Hamilton Depression Rating Scale, to measure serum cholinesterase activity in depressed farmers, and to correlate the degree of depression with cholinesterase levels. Furthermore, it aims to evaluate whether administration of *Aparajita* root can reduce depression severity while simultaneously improving cholinesterase activity. In this context, the administration of *Aparajita* root serves as the independent variable, while the dependent variables include serum cholinesterase levels and the Hamilton Depression Rating Scale score.

Materials and Methods

Literary and Clinical Sources

Classical Ayurvedic texts (Samhitas), clinical registries, and peer-reviewed literature were consulted for references on *Vishada* (Ayurvedic corollary of depression). Pharmacological information on *Aparajita* (*Clitoria ternatea* Linn.) was sourced from Ayurvedic pharmacopoeias and contemporary scientific publications. Patients were selected from the Vidarbha region, specifically farmers showing symptoms of depression (screened using the Hamilton Depression Rating Scale) with a history of chronic exposure to organophosphorus (OP) pesticides.

Exposure and Screening

Exposure history was confirmed through structured interviews, occupational background checks, and records of local pesticide use. Screening included clinical interviews, the Hamilton Depression Rating Scale, and serum cholinesterase testing after informed consent.

Ethical and Regulatory Clearance

- **Ethical Approval:** Approved by the Institutional Ethics Committee, MGACHRC, on 10th July 2021 (Ref: MGACHRC/IEC/JULY 2021/259).
- **Trial Registration:** Clinical Trials Registry – India (CTRI), Registered on 14th June 2022 (CTRI/2022/06/043261).

Study Design

A single-arm interventional analytical correlation study was conducted to evaluate the efficacy of *Aparajita* root powder in managing depression among farmers with chronic OP compound exposure.

Drug Material and Preparation

The *Aparajita* plant was collected from a forest area with the help of local farmers. Roots were cleaned, shade-dried, and powdered following Good Manufacturing Practices (GMP) at *Dattatraya Rasashala*, MGACH & RC. Authentication was done by the Foundation for Revitalisation of Local Health Traditions (FRLHT), Bengaluru (Certificate No. 5698/2022). The final powder was sieved for uniformity and stored in airtight containers.

Analytical Evaluation

Analytical testing was conducted at the Quality Control Proforma Laboratory, *Dattatraya Rasashala.* Parameters assessed:

- **Organoleptic:** Appearance, colour, odour
- **Physicochemical:** Loss on drying, total ash, water-insoluble ash, alcohol-soluble extract, pH
- **Microbial:** Total bacterial/fungal counts
- **Pathogens:** *E. coli*, *Salmonella* spp., *S. aureus*, *Pseudomonas aeruginosa*

Sample Size

Sample size was decided based on results obtained through pilot study.

Using an equivalence trial formula:

- $\alpha = 0.05$ ($Z_a = 1.96$), Power = 90% ($Z_\beta = 1.28$), $\sigma = 2.25$, $\delta = 2$
- n = 27; considering a 10% dropout rate, final sample size = 40

Intervention Plan

Table 1: Intervention Details

Sr. No.	Particulars	Details
1	Study Group	Single-arm interventional group
2	Drug	*Aparajita* root powder
3	Dose	1 gram twice daily (This dose was fixed after dose escalation study)
4	*Anupana*	*Koṣhṇa jala* (lukewarm water)
5	*Bhaiṣajyakala*	After meals (*Bhojanottara)*
6	Duration	6 consecutive months
7	Follow-Up	At 3rd, 6th, and 9th month

Subject Eligibility

Inclusion Criteria

- Age 18–50 years
- Written informed consent
- Chronic OP exposure ≥12 months
- Mild to moderate depression (Hamilton score 8–23)
- Serum cholinesterase <8 U/mL

Exclusion Criteria

- Depression from addiction or chronic illness
- Major systemic illnesses (e.g., DM, HIV, CVD)
- OP exposure <12 months
- Other psychiatric diagnoses
- Severe depression (score ≥24)
- Cholinesterase within normal limits (8–18 U/mL)

Withdrawal Criteria

- Voluntary withdrawal
- Adverse events necessitating referral to higher care

Dietary Instructions

No specific diet was prescribed; participants continued their regular dietary habits.

Observations and Statistical Analysis

- Software Used: GraphPad Prism 5 and Microsoft Excel
- Confidence Interval: 95%
- Significance Level (α): 5%
- Tests Applied: Paired and unpaired t-tests, one-way ANOVA

Table 2: Serum Cholinesterase Levels (U/mL) Over Follow-Up

Time Point	Mean	Standard Deviation
0th Day	3.978	1.802
3rd Month	4.046	1.470
6th Month	4.513	1.188
9th Month	4.536	1.182

- **One-way ANOVA:**
  - $P = 0.20$
  - F-value = 1.557
  - Interpretation: Increase noted, but not statistically significant over time.

Graph 1: Serum Cholinesterase Levels (U/mL) at Each Follow-Up

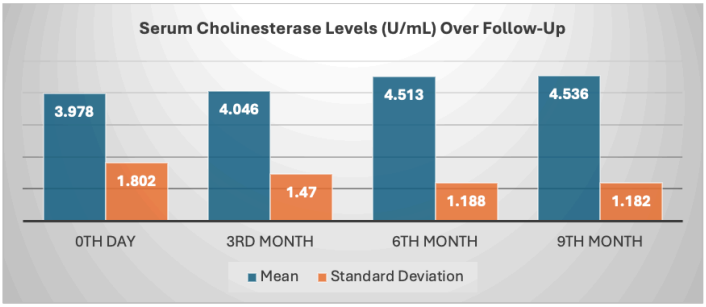

Table 3: Paired t-test – Cholinesterase Value Comparisons

Comparison	P value	P value Summary	t, df	Interpretation
0th vs 3rd Month	0.8165	Not Significant	t=0.23, df=39	No significant difference
0th vs 6th Month	0.0419	Significant	t=2.104, df=39	Significant improvement
0th vs 9th Month	0.0024	Highly Significant	t=3.259, df=36	Highly significant improvement

Table 4: Hamilton Depression Rating Scale Scores Over Follow-Up

Time Point	Mean	Standard Deviation
0th Day	11.40	2.827
3rd Month	11.50	2.612
6th Month	10.45	2.112
9th Month	10.03	1.860

- **One-way ANOVA:**
  - $P < 0.0001$
  - F-value = 20.8
  - Interpretation: Statistically highly significant reduction in depression score over time.

Graph 2: Hamilton Depression Scores at Each Follow-Up

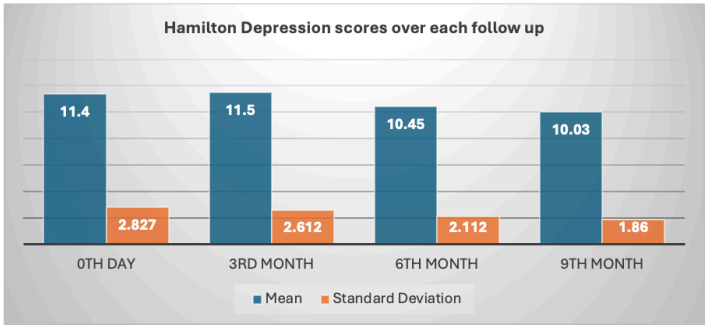

Table 5: Paired t-test – Hamilton Score Comparisons

Comparison	P value	P value Summary	t, df	Interpretation
0th vs 3rd Month	0.6433	Not Significant	t=0.47, df=39	No significant change
0th vs 6th Month	0.0006	Highly Significant	t=3.717, df=39	Significant reduction
0th vs 9th Month	<0.0001	Highly Significant	t=4.850, df=39	Strong improvement in symptoms

Discussion

a) Demographics

- Majority of participants (47.5%) were between 31–40 years of age.
- 50% had OP exposure for 5–10 years, 22.5% for >15 years, 20% for 10–15 years, and 7.5% for <5 years.

Principal Findings

Serum Cholinesterase

- Gradual increase observed in mean cholinesterase values across all follow-ups.
- Statistically significant increase noted after 6 months ($p = 0.0419$) and highly significant after 9 months ($p = 0.0024$).
- Indicates a positive influence of Aparajita root on serum cholinesterase levels over time.

Hamilton Depression Score

- No significant change at 3 months.
- Statistically significant decrease at 6 months ($p = 0.0006$) and highly significant at 9 months ($p < 0.0001$).
- Suggests that the intervention had a gradual antidepressant effect.

Pharmacological Basis of *Aparajita*

- Rasa (Taste): Kaṭu, Tikta, Kaṣhaya
- Guna (Quality): Laghu, Ruksha
- Virya (Potency): Sheeta
- Vipaka (Post-digestive effect): Kaṭu
- Karma (Action): Tridoṣa shamaka, Vishaghna, Medhya, Manasroga hara

According to Ayurvedic pharmacology, *Aparajita* possesses properties that antagonize the qualities of *Visha* (toxins), especially through its *Sheeta Virya* and *Tikta-Kaṣaya Rasa*, counteracting the dominant *Agni* properties of poison. It has been traditionally indicated in conditions like *Sarpaviṣa*, and modern studies support its cholinergic, antidepressant, and neuroprotective actions (18-24).

Conclusion

The primary objective of this study was to evaluate the efficacy of *Aparājitā* root in managing depression among farmers chronically exposed to organophosphorus pesticides.

- A significant increase in serum cholinesterase levels was observed after 6 months, and a highly significant increase after 9 months.
- Hamilton Depression Scores showed a highly significant reduction after 6 and 9 months of intervention.
- The study confirms that farmers with low cholinesterase levels due to OP exposure show depressive symptoms, and that Aparajita root has both cholinesterase-enhancing and antidepressant effects.
- Thus, Aparajita (Clitoria ternatea Linn.) appears to be a safe and effective Ayurvedic intervention for depression associated with chronic pesticide exposure.

Conflict of Interest-The authors declare that there is no conflict of interest regarding the publication of this article.

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Abbreviations Used

Abbreviation	Full Form
OP	Organophosphorus
GMP	Good Manufacturing Practices
CTRI	Clinical Trials Registry – India
FRLHT	Foundation for Revitalisation of Local Health Traditions
MGACH & RC	Mahatma Gandhi Ayurved College Hospital & Research Centre
ANOVA	Analysis of Variance
U/mL	Units per Milliliter
CNS	Central Nervous System
pH	Potential of Hydrogen
HIV	Human Immunodeficiency Virus

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