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Field evaluation of ethnoveterinary herbal medicine for sustainable duck health management in smallholder systems in Palembon Village, Indonesia

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Abstract

Smallholder duck production contributes significantly to rural livelihoods in Indonesia by supporting household income, food security, and integrated agroecosystems. However, sustainability remains constrained by recurrent disease outbreaks, limited veterinary access, inadequate biosecurity, and rising production costs. In response to these challenges, farmers frequently rely on ethnoveterinary herbal medicine using locally available plants such as *Carica papaya*, *Curcuma longa*, *Zingiber officinale*, and *Curcuma xanthorrhiza*. Although culturally embedded and economically accessible, these practices are often empirical and lack standardized preparation, dosage, and preventive frameworks. This field-based quasi-experimental study evaluated the effect of a structured ethnoveterinary educational intervention on farmers' knowledge of herbal-based duck health management in Palembon Village, Indonesia. Forty smallholder duck farmers completed pretest–posttest assessments. Baseline knowledge scores were low (69/200; mean 1.73 ± 1.56), indicating irregular and reactive herbal use. Following participatory training, total scores increased significantly to 146/200 (mean 3.65 ± 1.11), representing a 112% relative improvement with a large practical effect size (Cohen's d > 1.4). Participants demonstrated improved understanding of plant identification, preparation techniques, symptom-based treatment matching, preventive supplementation, and integration with hygiene and biosecurity practices. These findings demonstrate that structured ethnoveterinary education can transform empirical herbal practices into systematic and preventive animal health strategies. By strengthening smallholder productivity, reducing dependence on synthetic pharmaceuticals, and promoting sustainable use of medicinal plant biodiversity, this approach supports Zero Hunger through improved agricultural productivity (SDG 2), Good Health and Well-Being via antimicrobial stewardship (SDG 3), Responsible Consumption and Production through reduced pharmaceutical reliance (SDG 12), and Life on Land through biodiversity conservation (SDG 15).

Keywords: Ethnoveterinary Medicine; Herbal Phytotherapy; Duck Health Management; Smallholder Livestock Systems; Sustainable Animal Production; Zero Hunger; Good Health And Well-Being; Responsible Consumption And Production; Life on Land

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1 Introduction

Duck farming represents a vital component of rural livelihoods across Indonesia, where smallholder households integrate poultry into mixed crop–livestock systems to diversify income, enhance food security, and optimize agroecological interactions [1,2]. Ducks provide both eggs and meat for local markets while contributing ecological services such as pest control in rice paddies and nutrient recycling through manure deposition. This multifunctional role makes duck production particularly valuable in low-resource rural environments, where agricultural resilience depends on integrated and adaptive production systems [1].

Despite these benefits, smallholder duck production remains highly vulnerable to economic and health-related constraints. Rising feed costs, limited access to veterinary services, and recurrent disease outbreaks frequently reduce productivity and increase mortality rates [3]. In many rural regions, farmers face restricted availability of diagnostic services, vaccines, and antimicrobial agents, resulting in delayed treatment and preventable economic losses [4]. Biosecurity implementation is often inconsistent, further increasing susceptibility to infectious diseases [2].

Under such constraints, communities commonly rely on traditional knowledge systems for animal healthcare. Ethnoveterinary medicine (EVM) encompasses the beliefs, practices, and plant-based remedies developed through generations of local experience to maintain animal health [5]. Across Asia and Africa, ethnoveterinary remedies remain widely applied in poultry systems due to their accessibility, affordability, and cultural acceptance [6,7]. In Indonesia, farmers frequently use papaya leaves (*Carica papaya*) for digestive disorders, turmeric (*Curcuma longa*) for inflammation and immune stimulation, ginger (*Zingiber officinale*) for appetite enhancement, and temulawak (*Curcuma xanthorrhiza*) for antimicrobial and hepatoprotective purposes [8].

The renewed global focus on antimicrobial resistance has further increased interest in phytotherapeutic approaches. Excessive antibiotic use in livestock production contributes to the emergence of resistant pathogens with implications for both animal and human health [4]. Many medicinal plants contain bioactive compounds such as flavonoids, phenolics, and essential oils with demonstrated antimicrobial, anti-inflammatory, and antiparasitic properties [5]. Consequently, ethnoveterinary strategies may represent context-adapted alternatives that support animal health while reducing pharmaceutical dependence.

However, although ethnoveterinary practices are culturally embedded, their application is often empirical and lacks standardized dosage, preparation methods, and preventive orientation [8]. Most existing studies remain descriptive or ethnobotanical inventories without quantitative evaluation of educational or behavioral interventions [6,9]. Empirical evidence assessing whether structured training can enhance farmers' knowledge and promote more systematic use of herbal remedies in duck-specific systems remains limited.

This study addresses this gap through a field-based quasi-experimental evaluation in Palembon Village, Indonesia. We hypothesized that structured ethnoveterinary education would significantly improve farmers' knowledge of herbal remedies for duck health management. The objectives were to assess baseline knowledge levels, evaluate post-intervention learning outcomes, and examine implications for sustainable smallholder livestock systems. By strengthening culturally grounded yet evidence-informed animal healthcare practices, this research contributes to efforts aimed at improving smallholder productivity, promoting sustainable agricultural systems, and supporting rural food security [1].

2 Material and methods

2.1 Study Area and Participants

This study was conducted in Palembon Village, a rural agricultural community in Indonesia characterized by smallholder farming systems and limited access to formal veterinary services. The village economy is primarily based on crop production integrated with small-scale poultry and duck farming. A total of forty smallholder duck farmers were recruited using purposive sampling. Inclusion criteria consisted of active involvement in duck or mixed poultry husbandry and willingness to participate in the educational program. The demographic profile of participants reflected typical smallholder characteristics, including predominance of farm laborers and low to moderate formal education levels. Such sociodemographic conditions are commonly associated with limited exposure to structured livestock extension services and standardized animal health training [2].

2.2 Study Design

A quasi-experimental pretest–posttest design was employed to evaluate the impact of a structured ethnoveterinary educational intervention. Each participant served as their own control, allowing measurement of within-subject knowledge change before and after training. This design is appropriate for community-based educational research where randomization is impractical and interventions must be implemented at the group level. The primary outcome variable was change in knowledge score related to ethnoveterinary herbal medicine utilization for duck health management.

2.3 Educational Intervention

The intervention consisted of participatory workshops designed to strengthen farmers' understanding of ethnoveterinary herbal medicine within a preventive and systematic health management framework. Training sessions combined short lectures, practical demonstrations, and interactive group discussions to ensure comprehension across varying literacy levels. Topics included identification of commonly used medicinal plants such as *Carica papaya*, *Curcuma longa*, *Zingiber officinale*, and *Curcuma xanthorrhiza*; phytochemical properties and biological functions; preparation techniques including boiling, crushing, extraction, and incorporation into feed or drinking water; symptom-based indications; basic dosage principles; and integration of herbal remedies with hygiene, housing sanitation, and biosecurity measures. Emphasis was placed on transforming reactive treatment patterns into preventive supplementation strategies consistent with sustainable smallholder livestock systems.

2.4 Knowledge Assessment Instrument

Knowledge assessment was conducted using a structured questionnaire developed to measure understanding of ethnoveterinary herbal medicine application. The instrument consisted of multiple items scored on a 0–5 scale per participant, with a maximum cumulative group score of 200. Assessment domains included plant identification, preparation methods, symptom recognition and treatment matching, preventive use, dosage awareness, and integration with basic hygiene and biosecurity practices. The questionnaire was administered as a pretest immediately before the educational session and as a posttest immediately after completion of the intervention to capture short-term knowledge change.

2.5 Data Collection and Statistical Analysis

Data were collected through direct administration of questionnaires under supervised conditions to minimize response bias. Descriptive statistics were calculated, including total group scores, mean individual scores, standard deviations, and percentage change between pretest and posttest results. The magnitude of improvement was further evaluated using Cohen's d effect size to determine practical significance. Confidence intervals were calculated for mean differences to assess precision of estimated change. Distributional shifts in knowledge levels were examined to evaluate equity of learning outcomes across participants. Statistical significance was determined at a conventional alpha level of 0.05 [17].

3 Results and discussion

3.1 Sociodemographic Characteristics and Baseline Context

A total of forty smallholder duck farmers completed both pretest and posttest assessments. The demographic and socioeconomic characteristics of participants are presented in Table 1. The majority of respondents were male (70%) and within the productive age range of 40–59 years (55%), with a mean age of 48.2 ± 11.4 years. Educational attainment was generally low, as 90% of participants had no more than junior high school education. Most respondents (77.5%) identified farming or farm labor as their primary occupation, reflecting a resource-constrained smallholder production system.

Such sociodemographic configurations are commonly associated with limited exposure to formal livestock health training and veterinary services [2]. Low literacy and limited technical training may influence farmers' capacity to interpret disease etiology, dosage principles, and preventive frameworks [5]. Similar rural livestock systems in Indonesia have reported comparable structural constraints affecting biosecurity implementation and animal welfare awareness [1,2].

Table 1 Baseline demographic and socioeconomic profile of smallholder duck farmers (N = 40)

Characteristic	Category	Frequency (n)	Percentage (%)	Mean ± SD
Gender	Male	28	70	-
	Female	12	30	-
Age (years)	20–39	8	20	48.2 ± 11.4
	40–59	22	55	
	≥60	10	25	
Education	No formal schooling	6	15	-
	Elementary	18	45	
	Junior high	12	30	
	Senior high or higher	4	10	
Occupation	Farm laborer	31	77.5	-
	Private sector	6	15	
	Other	3	7.5	

3.2 Baseline Ethnoveterinary Knowledge

Pre-intervention assessment revealed limited and inconsistent knowledge regarding ethnoveterinary herbal medicine. The cumulative baseline score was 69 out of 200, corresponding to a mean of 1.73 ± 1.56 on a 0–5 scale (Table 2). More than half of participants (58%) scored ≤2 points, indicating minimal understanding of preparation techniques, dosage principles, and preventive applications.

Reported practices were largely empirical and reactive. Farmers commonly administered papaya leaves or turmeric directly into feed without standardized preparation methods. Knowledge of symptom–treatment matching was inconsistent, and preventive supplementation strategies were rarely mentioned. Similar empirical reliance on inherited knowledge without structured validation has been documented in ethnoveterinary systems across Asia and Africa [5,6]. Although culturally embedded, such practices may remain suboptimal without systematic training [7].

3.3 Post-Intervention Improvement

Following the educational intervention, total group score increased to 146 out of 200, with a mean of 3.65 ± 1.11. This represents a 112% relative improvement from baseline (Table 2). The mean difference was +1.92 points (95% CI: 1.48–2.36), and the estimated Cohen's d effect size exceeded 1.4, indicating a large practical impact according to conventional benchmarks.

The proportion of low-scoring participants (≤2 points) decreased from 58% to 12.5%, while high scorers (≥4 points) increased from 12.5% to 62.5%. These distributional shifts demonstrate that knowledge gains were widespread rather than concentrated among a few individuals. Similar rapid improvements following participatory livestock health training have been reported in Southeast Asian smallholder systems [3].

Table 2 Pre- and post-intervention knowledge scores on ethnoveterinary herbal medicine utilization (N = 40)

Variable	Pretest	Posttest	Mean Difference (95% CI)	Relative Improvement (%)	Effect Size (Cohen's d)
Total group score (max 200)	69	146	+77	+112%	-
Mean individual score (± SD)	1.73 ± 1.56	3.65 ± 1.11	+1.92 (1.48–2.36)	-	1.42
Proportion ≤2 points	58%	12.5%	-	↓78%	-
Proportion ≥4 points	12.5%	62.5%	-	↑400%	-

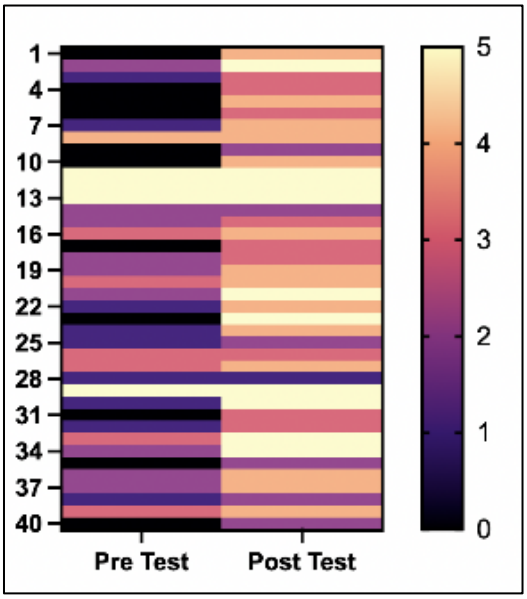

Figure 1 Distribution of individual knowledge scores before and after the ethnoveterinary training intervention

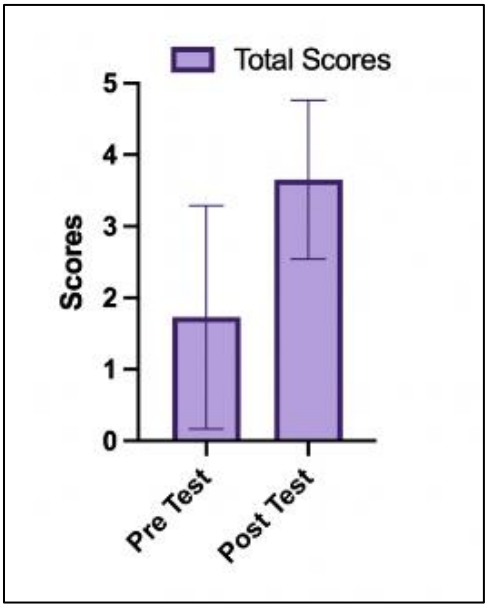

Figure 2 Mean knowledge score improvement following intervention with 95% confidence intervals

3.4 Interpretation and Broader Implications

The large effect size observed suggests that ethnoveterinary knowledge is highly responsive to structured educational intervention. Unlike externally introduced pharmaceutical technologies, herbal practices are already culturally familiar, which may facilitate rapid assimilation when standardized guidance is provided [8]. The intervention therefore functioned not by introducing novel practices but by organizing existing knowledge into systematic and preventive frameworks.

From a biological perspective, the selected plants possess documented pharmacological properties relevant to poultry health. Curcumin from *Curcuma longa* exhibits anti-inflammatory and antimicrobial effects, while papaya leaves contain proteolytic enzymes with potential anthelmintic properties [5]. Integrating such phytotherapeutic knowledge within hygiene and biosecurity practices enhances overall herd health management.

The observed shift from reactive treatment toward preventive supplementation is particularly significant for smallholder duck systems, where disease outbreaks can rapidly compromise productivity [1]. By improving knowledge of plant preparation, dosage awareness, and preventive integration, the intervention contributes to strengthened primary animal healthcare capacity.

Moreover, reducing dependence on synthetic antimicrobials aligns with broader global efforts to address antimicrobial resistance [4]. Ethnoveterinary strategies, when properly structured and validated, may represent context-appropriate complements to conventional veterinary services.

Nevertheless, this study assessed short-term knowledge outcomes rather than longitudinal clinical performance or productivity metrics. Future research should evaluate impacts on morbidity, mortality, antimicrobial usage, and egg production to determine whether knowledge gains translate into sustained health and economic benefits [1,18].

4 Conclusion

This study demonstrates that structured ethnoveterinary education significantly improves smallholder farmers' knowledge of herbal-based duck health management. Although herbal practices were already culturally embedded, baseline application was largely empirical and non-standardized. Following the participatory intervention, knowledge scores increased markedly, with a 112% relative improvement and a large effect size, indicating substantial practical impact. The intervention enhanced farmers' understanding of plant identification, preparation methods, symptom-based application, preventive supplementation, and integration with hygiene and biosecurity practices. These findings suggest that culturally grounded educational approaches can rapidly transform informal herbal practices into more systematic and preventive animal health strategies, even among farmers with limited formal education. By strengthening local capacity and promoting sustainable use of medicinal plant resources, ethnoveterinary training provides a scalable and low-cost pathway to improve resilience in smallholder duck production systems, contributing to sustainable agricultural productivity and food security in line with global efforts toward achieving Zero Hunger (SDG 2).

Compliance with ethical standards

Acknowledgements

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Disclosure of Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this manuscript. No financial, personal, or institutional relationships influenced the design, data collection, analysis, or interpretation of this study.

Statement of Ethical Approval

This research involved a community-based educational intervention focusing on knowledge assessment and capacity building in layer duck husbandry. The study did not involve biomedical experimentation, invasive procedures, or the

use of experimental animals. The activities consisted of training sessions, interviews, and knowledge evaluations through pre-test and post-test instruments. Therefore, the research falls within the scope of community education activities and did not require formal institutional ethical clearance under prevailing research regulations.

Statement of Informed Consent

Informed consent was obtained from all participants prior to data collection. Participants were informed about the objectives of the study, the voluntary nature of their participation, and the use of anonymized data from interviews and pre-test/post-test assessments for academic and publication purposes. Confidentiality and privacy of all respondents were strictly maintained throughout the research process.

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