Plant-Based Anthelmintic Strategies for Goats: Evaluating Areca catechu Extract Against Haemonchus contortus in a Tropical Setting

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ABSTRACT Gastrointestinal nematode infections, particularly Haemonchus contortus, pose a significant challenge to goat production in the Philippines, leading to reduced productivity and economic losses among smallholder farmers. This study evaluated the in vitro anthelmintic efficacy of Areca catechu (betel nut) extract against H. contortus. A Completely Randomized Design (CRD) was employed with four treatments: distilled water (control) and three concentrations of betel nut extract (3 ml, 4 ml, and 5 ml), each replicated three times. A total of 240 adult worms were collected from the abomasum of a naturally infected goat and exposed to the treatments. Mortality was assessed at 15-minute intervals, and the median lethal dose (LD_{50}) was determined using probit analysis. Results showed that all extract concentrations achieved 100% mortality within 15 minutes, while no mortality was observed in the control group. The estimated LD_{50} was 1.54 ml, indicating high efficacy even at low concentrations. The findings demonstrate the strong anthelmintic potential of A. catechu, attributed to its bioactive compounds such as arecoline. This study highlights the potential of betel nut as a cost-effective and locally available alternative to synthetic dewormers; however, further in vivo studies and safety evaluations are recommended to support field application.

Keywords: bioactive compounds, Completely Randomized Design, LD_{50}, mortality rate, probit analysis, smallholder farming systems

INTRODUCTION

Goat production has long been an integral component of smallholder farming systems, contributing to food security, income generation, and livelihood sustainability in developing countries. However, its productivity has historically been constrained by parasitic infections, particularly gastrointestinal nematodes such as Haemonchus contortus, commonly known as the barber pole worm. This parasite resides in the abomasum of goats, feeding on blood and causing anemia, weight loss, and mortality (Dwyer, 2021; Villaroel, 2003). Early control strategies primarily relied on synthetic anthelmintics, which were initially effective in managing parasite burdens. Over time, however, extensive and repeated use of these drugs led to the emergence of anthelmintic resistance, reducing their long-term efficacy and prompting the exploration of alternative control approaches (Kaplan, 2021).

At present, gastrointestinal nematode infections remain a major constraint to goat production in tropical countries such as the Philippines, where warm and humid environmental conditions favor rapid parasite development and transmission (Cabaret et al., 2002; Getachew et al., 2007). The high prevalence of H. contortus significantly affects animal health and productivity, resulting in economic losses among smallholder farmers. The growing challenge of anthelmintic resistance, coupled with increasing costs and concerns about drug residues in animal products, has intensified the search for sustainable and locally available alternatives (Lecová et al., 2014; Ahuir-Baraja et al., 2021). Medicinal plants such

as Areca catechu (betel nut) have gained attention due to their accessibility and bioactive compounds, particularly arecoline, which is known to disrupt parasite neuromuscular activity (Balqis et al., 2017; Badar et al., 2021). Previous studies have reported that betel nut exhibits antiparasitic activity against a range of helminths, suggesting its potential as a natural anthelmintic agent (Yusuf et al., 2023).

Despite growing interest in plant-based anthelmintics, there remains limited empirical evidence specifically evaluating the efficacy of Areca catechu against Haemonchus contortus in goats under controlled conditions. Many existing studies focus on other parasite species or different host animals, limiting their direct applicability to goat production systems (Iqbal et al., 2021; Mansur et al., 2021). Furthermore, variations in extraction methods, concentrations, and experimental designs have resulted in inconsistent findings across studies (Hamid et al., 2023). There is also a lack of standardized data on lethal dose (LD_{50}), mortality rate, and exposure time, which are critical parameters for practical field application. In the Philippine context, research on ethnoveterinary anthelmintics remains underdeveloped, highlighting the need for localized validation of plant-based treatments suited to tropical production systems (Jato et al., 2022).

Given these gaps, there is a need for systematic and controlled evaluation of betel nut extract to establish its efficacy, optimal dosage, and potential as a sustainable alternative to synthetic anthelmintics. This study addresses this need by assessing the in vitro anthelmintic activity of Areca catechu extract against Haemonchus contortus, focusing on mortality rate and lethal dose determination. The results aim to contribute to the development of affordable, locally sourced parasite control strategies aligned with sustainable livestock production and integrated parasite management approaches (Ademola, 2016; Hamid et al., 2023). Furthermore, the findings will serve as baseline data for future in vivo studies, toxicity evaluation, and formulation development, supporting evidence-based recommendations for smallholder goat farmers in the Philippines.

General Objective

To determine the anthelmintic effect of Areca catechu nut extract against Haemonchus contortus.

Specific Objectives

1. To determine the mortality rate of Haemonchus contortus exposed to varying concentrations of betel nut extract.
2. To estimate the lethal dose (LD_{50}) of betel nut extract against H. contortus.

MATERIALS AND METHODS

Research Design

The study was conducted using a Completely Randomized Design (CRD) consisting of four treatment groups, each replicated three times to ensure reliability and minimize experimental error. The treatments involved varying concentrations of Areca catechu (betel nut) extract, including a control group for baseline comparison. The treatment groups were defined as follows:

- T_1 (Control): Distilled water (0 ml extract)
- T_2: 3 ml betel nut extract
- T_3: 4 ml betel nut extract
- T_4: 5 ml betel nut extract

Each experimental unit was randomly assigned to one of the four treatments to eliminate bias and ensure homogeneity across groups. The design allowed for the evaluation of the dose-dependent anthelmintic effect of betel nut extract on Haemonchus contortus under controlled laboratory conditions.

Preparation of Betel Nut Extract

Mature fruits of Areca catechu were collected and manually dehulled to obtain the seeds. The seeds were air-dried under ambient conditions for 5–7 days until a constant weight was achieved. Dried samples were then pulverized into a fine powder using a mortar and pestle.

A total of 500 g of powdered material was subjected to maceration in 1 L of 70% ethanol for 48 hours at room temperature to facilitate extraction of bioactive compounds. The resulting mixture was filtered sequentially using muslin cloth followed by Whatman No. 1 filter paper to obtain a clear extract. The filtrate was then stored in sterile, airtight containers at 4°C until further use.

Collection of Parasites

A goat exhibiting clinical signs consistent with gastrointestinal parasitism (e.g., anemia, weight loss, and abdominal distension) was selected for sample collection. The animal was humanely slaughtered following standard ethical and sanitary procedures. Subsequently, the abomasum was carefully dissected, and Haemonchus contortus specimens were recovered through manual extraction. A total of 240 viable adult worms were collected and immediately transferred to appropriate laboratory conditions for use in the experimental treatments.

Data Collection and Analysis

Mortality of Haemonchus contortus was assessed at 15-minute intervals following exposure to the different treatments. Worms were considered dead when no observable movement was detected, even after gentle mechanical stimulation, and this was confirmed under microscopic examination.

Mortality data were summarized using descriptive statistics (e.g., percentage mortality and mean values). Probit analysis was employed to estimate the median lethal dose (LD_{50}) of Areca catechu extract. All statistical analyses were conducted at a 95% confidence level to determine the effectiveness of the treatments.

Limitations of the Study

This study was limited to an in vitro experimental design, which may not fully represent the complex physiological conditions present in live animals. The responses of Haemonchus contortus to Areca catechu extract under laboratory conditions may differ from in vivo environments where factors such as metabolism, immune response, and digestive processes influence efficacy.

The study utilized worms collected from a single host animal, which may limit the generalizability of the findings across different goat populations and varying levels of parasite burden. Additionally, the sample size, although sufficient for preliminary evaluation, may not capture the full variability in parasite susceptibility.

Variations in extraction procedures and phytochemical composition of betel nut were not extensively analyzed, which could influence the consistency and reproducibility of the results. The study also did not include phytochemical profiling or quantification of active compounds such as arecoline, which are critical in understanding the mechanism of action.

Furthermore, the study focused primarily on mortality rate and lethal dose (LD_{50}) without assessing sublethal effects such as inhibition of egg production, larval development, or long-term parasite viability. Toxicity and safety evaluation of the extract in live goats were also not conducted, limiting its immediate applicability for field use.

Lastly, no comparison with standard commercial anthelmintics was performed, which could have provided a benchmark for evaluating the relative efficacy of A. catechu extract.

RESULTS AND DISCUSSION

Mortality Rate

The results demonstrated that all concentrations of Areca catechu extract (3–5 ml) achieved 100% mortality of Haemonchus contortus within 15 minutes of exposure, whereas the control group (distilled water) showed no observable mortality. This indicates a rapid and concentration-independent lethal effect within the tested range. The absence of mortality in the control confirms that the observed effects were attributable solely to the bioactive components of the betel nut extract rather than external factors or handling conditions.

The rapid mortality observed suggests that A. catechu extract possesses potent anthelmintic properties, likely mediated by its bioactive alkaloid, arecoline. Arecoline is known to act on the neuromuscular system of helminths, causing spastic paralysis that leads to detachment and eventual death of the parasite (Balqis et al., 2017; Badar et al., 2021). In addition, other phytochemicals present in betel nut, such as tannins and flavonoids, may contribute synergistically by disrupting the parasite's cuticle and interfering with metabolic processes (Yusuf et al., 2023). Similar findings have been reported in studies where plant-derived extracts exhibited rapid immobilization and mortality of gastrointestinal nematodes, including H. contortus, under in vitro conditions (Iqbal et al., 2021; Mansur et al., 2021).

These findings highlight the potential of A. catechu as an effective plant-based anthelmintic, offering a promising alternative to synthetic dewormers, particularly in smallholder goat production systems. The rapid efficacy observed suggests that lower doses and shorter exposure times may be sufficient for parasite control, which could reduce treatment costs and minimize risks of toxicity. Moreover, the use of locally available botanical resources aligns with sustainable livestock management and may help mitigate the growing problem of anthelmintic resistance (Ademola, 2016; Hamid et al., 2023). However, further in vivo validation, dose optimization, and safety assessment are necessary before recommending its widespread application in field conditions.

Lethal Dose

The estimated median lethal dose (LD_{50}) of Areca catechu extract was 1.54 ml, indicating that relatively low concentrations are sufficient to achieve substantial mortality of Haemonchus contortus. This result reflects the high biological potency of the extract and suggests a strong dose–response relationship even at minimal exposure levels. The effectiveness at low concentrations may be attributed to the presence of bioactive compounds such as arecoline, tannins, and flavonoids, which are known to interfere with the neuromuscular activity and structural integrity of helminths, ultimately leading to paralysis and death (Balqis et al., 2017; Badar et al., 2021; Yusuf et al., 2023). From a practical standpoint, the low LD_{50} value implies that smaller quantities of the extract could be utilized to achieve effective parasite control, thereby reducing input costs and improving accessibility for smallholder farmers. Moreover, the use of plant-based anthelmintics with high efficacy at low doses may help mitigate the development of anthelmintic resistance associated with frequent use of synthetic drugs (Ademola, 2016; Hamid et al., 2023).

These findings support the potential integration of A. catechu into sustainable parasite management programs; however, further in vivo studies and toxicity assessments are necessary to establish safe dosage thresholds and validate its applicability under field conditions.

CONCLUSION

This study demonstrated that Areca catechu (betel nut) extract possesses strong in vitro anthelmintic activity against Haemonchus contortus, a major gastrointestinal parasite affecting goats. All tested concentrations (3–5 ml) resulted in 100% mortality within 15 minutes, indicating rapid and effective antiparasitic action. Furthermore, the estimated median lethal dose (LD_{50}) of 1.54 ml highlights the potency of the extract even at relatively low concentrations. These findings suggest that the bioactive compounds present in betel nut, particularly arecoline and other phytochemicals, play a significant role in disrupting parasite viability. The study underscores the potential of A. catechu as a cost-effective, locally available, and sustainable alternative to synthetic anthelmintics, especially for smallholder goat production systems in the Philippines. However, given the limitations of in vitro experimentation, further in vivo studies, toxicity assessments, and formulation standardization are necessary to validate its safety, efficacy, and practical applicability under field conditions.

RECOMMENDATION

The study established that Areca catechu (betel nut) extract exhibits potent in vitro anthelmintic activity against Haemonchus contortus, a key gastrointestinal parasite of goats. All tested concentrations (3–5 ml) produced complete mortality within 15 minutes, while the computed LD_{50} of 1.54 ml indicates high efficacy even at low doses. These findings confirm the strong antiparasitic potential of betel nut, likely attributable to its bioactive constituents such as arecoline and other phytochemicals. The results highlight its promise as an affordable, locally available, and sustainable alternative to conventional synthetic dewormers, particularly for smallholder production systems in the Philippines. Nonetheless, further in vivo validation, safety evaluation, and dosage standardization are essential to support its practical application and integration into evidence-based parasite management strategies.

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