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In-vitro* acaricidal effects of betel nut (*Areca catechu*) and madre de cacao (*Gliricidia sepium*) extract at varying concentrations against *Rhipicephalus (Boophilus) microplus

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Abstract

Tick infestations of *Rhipicephalus (Boophilus) microplus* cause significant economic losses in the Philippine cattle industry through reduced productivity and disease transmission, while increasing acaricide resistance necessitates alternative control methods. This study evaluated the acaricidal efficacy of ethanolic extracts from Betel nut (*Areca catechu*) and Madre de Cacao (*Gliricidia sepium*) against *R. (B.) microplus* using a Complete Randomized Design with five treatments and three replications. Madre de Cacao extract demonstrated superior efficacy, achieving 63.33-73.33% mortality within 3 hours and 100% mortality by 24 hours at both 10ml/L and 15ml/L concentrations, significantly outperforming both Betel nut extract (66.67-70% mortality by 48 hours) and commercial control (66.67% at 48 hours). Phytochemical analysis revealed that Madre de Cacao contained tannins and saponins, while Betel nut contained tannins and alkaloids, explaining their differing efficacy profiles. The rapid action and complete tick elimination by Madre de Cacao extract demonstrates its potential as an effective, sustainable alternative to conventional acaricides for managing tick infestations in cattle production, particularly valuable in tropical regions where tick populations thrive and resistance to chemical acaricides is prevalent.

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Introduction

The cattle industry is one of the Philippines's most important and profitable businesses, contributing significantly to rural livelihoods, food security, and economic growth through meat and dairy production. However, the sector faces considerable economic losses due to tick infestations, which lead to decreased productivity, increased veterinary costs, and reduced market value of cattle, with a total inventory of 2.59 million heads as of September 2023. About 84.6 percent of the country's cattle population during the period came from smallholder farms, while the remaining 13.1 percent and 2.3 percent were comprised of semi-commercial farms and commercial farms (PSA, 2023).

Among the parasitic threats facing livestock, *Rhipicephalus (Boophilus) microplus* stands out as a significant challenge, capable of ingesting up to 100 times its body weight in blood (Gaudêncio *et al.*, 2016). This high blood consumption contributes to severe economic losses (Estrada-Peña *et al.*, 2006) through anemia, reduced weight gain, lower milk production, and increased susceptibility to infections (Shah and Khan, 2019). Furthermore, *R. (B.) microplus* serves as a vector for numerous pathogens, including viruses, bacteria, and protists, which can cause debilitating diseases in livestock (Abubakar *et al.*, 2018). Notably, this tick species plays a crucial role in transmitting babesiosis, anaplasmosis, and theileriosis—diseases that significantly impact cattle health and productivity (Ybañez *et al.*, 2018).

The economic consequences of tick infestations extend beyond direct production losses. Affected livestock experience immune suppression, stress, skin damage, and reduced market value, further straining the livestock industry. Traditional tick control measures rely heavily on synthetic acaricides, but their widespread use has led to the rapid emergence of acaricide-resistant tick populations, rendering many conventional treatments ineffective (Becker *et al.*, 2019; Valsoni *et al.*, 2021). As a result, developing sustainable and effective tick-borne disease (TBD) management strategies has become increasingly

challenging. Given that TBDs can have far-reaching effects on livestock production, food security, and regional economies (Kasaija *et al.*, 2021); there is a pressing need for alternative control strategies that are both effective and environmentally sustainable. The growing resistance of *R. microplus* to multiple classes of acaricides presents a major challenge to livestock production, with studies reporting widespread resistance across diverse geographical regions (Miller *et al.*, 2011; Reck *et al.*, 2014). Various control strategies have been explored, including biological control using predatory organisms such as nematodes and fungi, tick vaccines, and genetic selection for tick-resistant breeds (Ostfeld *et al.*, 2006). However, these approaches have shown inconsistent efficacy and are often difficult to implement, particularly in resource-limited farming systems.

Given these limitations, there is an urgent need to explore alternative, sustainable parasite control strategies that leverage natural botanical compounds with proven antiparasitic properties. These plant-based alternatives offer lower ecological impact, reduced toxicity, and a slower rate of resistance development in both humans and animals compared to synthetic chemicals (Borges *et al.*, 2011; Fidelis *et al.*, 2014). Such solutions could provide smallholder farmers with effective and environmentally friendly options for managing tick infestations while mitigating the risks associated with conventional acaricides.

To address the growing challenge of acaricide resistance, this study explores the acaricidal properties of Betel nut (*Areca catechu*) and Madre de Cacao (*Gliricidia sepium*) as potential natural alternatives for tick control. These plants are rich in bioactive phytochemicals, including alkaloids, tannins, flavonoids, and saponins (Liu *et al.*, 2013), which have demonstrated antiparasitic, anti-inflammatory, and insecticidal properties (Fayaz *et al.*, 2019; Abbas *et al.*, 2020; Hussain *et al.*, 2021). Both Madre de Cacao and Betel nut have long-standing applications in traditional veterinary

medicine across rural communities in the Philippines and other tropical regions. Madre de Cacao leaves, known for their distinctive aroma and high coumarin content, have been traditionally used to control cattle ectoparasites (Rabena, 2007). As Torres (2018) documented, rural farmers commonly crush and apply the leaves externally to repel and eliminate ticks and fleas. Similarly, while Betel nut is primarily recognized for its anthelmintic effects against internal parasites (Tangalin, 2011), indigenous knowledge suggests its potential for managing external parasites as well. Extensive research highlights the promising role of plant extracts in controlling various tick developmental stages (Ghosh *et al.*, 2011; Jonsson and Iqbal, 2012; Salman *et al.*, 2020; Zaheer *et al.*, 2021).

However, more targeted studies are needed to evaluate their specific efficacy against *R. (B.) microplus*. By investigating these botanical alternatives, this study aims to contribute to the development of sustainable, eco-friendly parasite management strategies that could benefit smallholder farmers and livestock industries.

Thus, this study aims to evaluate the acaricidal efficacy of *A. catechu* and *G. sepium* ethanolic extracts against the cattle tick *R. (B.) microplus*. Additionally, a phytochemical analysis was conducted to identify the bioactive compounds responsible for their acaricidal properties, providing scientific validation for their potential use in sustainable tick management.

Materials and methods

Experimental room

The experiment was conducted in a controlled environment at the CTU Barili Biotechnology building. The experimental room had concrete walls with adequate ventilation, good air circulation, and appropriate relative humidity. The facility remained free from contaminants and animal disturbances throughout the study period. Climate conditions remained consistently warm throughout the study period, with temperatures

between 68°F and 83°F, providing stable experimental conditions.

Plant collection and verification

Mature Betel nut seeds and Madre de Cacao leaves were collected, and Professor Hemres Alburo taxonomically identified the specimens at the Biodiversity, Environment, and Natural Resources Research Center, Cebu Technological University – Argao Campus.

Extraction procedure

The plant materials underwent thorough preprocessing to prepare them for extraction. Fresh Betel nut fruits were manually deshelled, with the seeds sliced into small pieces and air-dried for 7-14 days. Madre de Cacao leaves were air-dried for 5-7 days under controlled conditions.

Following drying, both plant materials were ground into fine powder and sieved to ensure uniform particle size. The powdered samples (1000g each) were macerated in 4.2L of 96% ethanol following established protocols (Anto *et al.*, 2020), maintaining a 75:1 solvent-to-powder ratio. The mixtures were kept in sealed containers protected from light for 72 hours to facilitate extraction. The resulting liquid extracts were processed through rotary evaporation to concentrate the bioactive compounds. The final extracts were stored in clean containers in a well-ventilated area until application.

Phytochemical screening

The ethanolic extract samples were submitted to the Applied Microbiology Laboratory at the Department of Biology, University of San Carlos-Talamban Campus, for phytochemical screening of flavonoids, tannins, saponins, and alkaloids.

Ticks collection and preparation

One hundred fifty adult *R. (B.) microplus* ticks were collected from experimental fattening cattle in Barili, Cebu. The collected ticks were placed in Petri dishes for examination and random allocation. They were then distributed across fifteen Petri dishes, with ten

ticks in each dish, ensuring uniform experimental units for all treatments and replications.

Parasite morphological verification and certification

The tick specimen was verified by Dr. Harvie P. Portugaliza at the College of Veterinary Medicine, Visayas State University (ViSCA), using stereomicroscopy. An engorged adult female tick measuring 8 mm long. This tick features a hexagonal basis capitulum, very short palpi, and eyes. The anal groove is indiscernible, there are no festoons, and it lacks ornamentation (inornate).

Experimental treatments and design

The study employed a Complete Randomized Design (CRD) with five treatments and three replications. Each experimental unit contained ten tick specimens. The treatment formulations included:

To- Tolfenpyrad commercial control (5ml/L)

T1-Betel nut extract (15 ml/L)

T2-Betel nut extract (20 ml/L)

T3-Madre de Cacao extract (10 ml/L)

T4-Madre de Cacao extract (15 ml/L)

Rizali *et al.* (2022) established the treatment concentrations for BNEE and Rodriguez and Pulido (2015) for MDCEE. Each treatment was applied to the ticks for a standardized 15-minute exposure period, after which the treatment solutions were removed. The ticks were then maintained in Petri dishes with absorbent tissue paper to eliminate excess treatment solution during observation.

Data to be gathered

Tick mortality was the primary response variable measured at standardized intervals of 3,12,24, and 48 hours post-treatment. Mortality was determined through careful observation of tick mobility and responsiveness. The cumulative percentage mortality was calculated at each time interval using the formula established by Kemal *et al.* (2020).

Cumulative percentage mortality =(A number of cattle ticks died after treatment/Total number of cattle ticks used in treatment)×100

Statistical analysis

All collected data were subjected to Analysis of Variance (ANOVA) to determine significant differences among treatment means.

Results and discussion

The efficacy result and the phytochemical analysis of Betel nut ethanolic extraction (BNEE) and Madre de Cacao ethanolic extraction (MDCEE) are shown in Table 1 and Table 2.

*Mortality rate of *R. (B.) microplus* at different time intervals*

The efficacy of the extracts against *R. (B.) microplus* was determined by measuring the percent mortality in different time intervals. The results indicate significant differences in efficacy among treatments over time ($p>0.05$), with plant-based formulations demonstrating comparable efficacy to the control.

The data demonstrates a dose-dependent response pattern across treatments, with MDCEE exhibiting significantly superior acaricidal activity compared to both the commercial control and the BNEE treatments. This finding aligns with previous research by Sivira *et al.* (2011), who reported that ethanolic extract of *G. sepium* leaves at 20% concentration produced 100% acaricidal effects against the mite *Tetranychus cinnabarinus*. The current study demonstrates that similar levels of efficacy can be achieved at lower concentrations (10-15 ml/L) against *R. (B.) microplus*. MDCEE (T3 and T4) achieved remarkable early efficacy, with 63.33% and 73.33% mortality at just 3 hours, significantly outperforming the commercial control (6.67%). Both MDCEE concentrations reached 100% efficacy by 24 hours, while the commercial control (To) only achieved 50% mortality simultaneously. The rapid action of MDCEE demonstrates remarkable effectiveness in tropical regions like the Philippines.

According to Galay *et al.* (2021), the climate highly favors the life cycle of the cattle tick, making effective control measures essential for maintaining cattle health and productivity.

Table 1. Percent Mortality of *Rhipicephalus (Boophilus) microplus* at different time intervals post-treatment

Treatment	3hours (%)	12hours (%)	24hours (%)	48hours (%)
To-Tolfenpyrad commercial (5ml/L)	6.67c	30b	50b	66.67b
T1- Betel nut extract (15 ml/L)	13.33c	30b	46.67b	66.67b
T2- Betel nut extract (20 ml/L)	26.67b	40b	53.33b	70b
T3- Madre de cacao (10 ml/L)	63.33a	76.67a	100a	100a
T4- Madre de cacao (15 ml/L)	73.33a	90a	100a	100a
CV (%)	19.92	15.31	8.25	11.98
P value	0.0000	0.0000	0.0000	0.0016

Table 2. Phytochemical analysis result of *Areca catechu* and *Gliricidia sepium* ethanolic extraction

Secondary metabolites	Method	Positive result	Betel nut extract	Madre de Cacao extract
Flavonoids	Alkaline reagent test	Colorless	-	-
Tannins	Ferric chloride test	Brownish green or Bluish black color	+	+
Saponins	Foam test	Foam formation	-	+
Alkaloids	Wagner's test	Brown-reddish precipitate	+	-

Additionally, as Nejash (2016) stated, an ideal acaricide would be cheap and easily applied, with a strong knockdown effect and sufficient residual effect on female ticks to prevent egg laying and protect cattle from infestation by larvae. The strong knockdown effect observed with MDCEE (73.33% efficacy at just 3 hours) satisfies this strong knockdown effect requirement.

Phytochemical analysis

Phytochemical analysis was done to find the presence of toxic secondary metabolites like flavonoids, tannins, saponins, and alkaloids (De Leon *et al.*, 2021; Shobha and Keshamma, 2023), which these secondary metabolites are commonly present in both plant samples. This analysis reveals an important difference between MDCEE and BNEE.

However, the analysis results shown in Table 2 revealed that Betel nut extract somewhat contains alkaloids, while Madre de Cacao extract exclusively contains saponins. Neither of the extracts has flavonoids. The presence of alkaloids in Betel nut extract aligns with the previous research by Peng *et al.* (2015), who identified arecoline as the primary alkaloid in Betel nut with potential antiparasitic properties. Betel nut's alkaloid content, while potentially bioactive, appears less effective against the ticks. The alkaloids may work through different mechanisms, such as neuromuscular disruption (Shih

et al. 2010), which might explain the more gradual efficacy increase observed with BNEE treatments. Moreover, the higher efficacy of Madre de Cacao extract is likely from its unique phytochemical content, particularly the saponin. Saponins are known to deal with cell membranes, disrupting their integrity and increasing permeability (Zheng and Gallot, 2020). Both extracts contained tannins, which likely contributed to their acaricidal properties. According to Akharaiyi *et al.* (2012), tannins possess diverse biological activities, including antidiarrheic, antinephritic, bacterial, antidysenteric, antiviral, cancer prevention, antimutagenic, acaricide, pesticide, viricide properties, hepatoprotective and psychotropic effects. Furthermore, as stated by Redondo *et al.* (2014), tannins can also reduce the risk of transmission of zoonotic pathogens and livestock diseases in a sustainable and environmentally friendly manner. The efficacy of MDCEE also validates traditional knowledge about its insecticidal and acaricidal properties.

Rabena (2007) found that Madre de Cacao leaves are a good source of coumarins, a toxic substance that can kill almost all pests and insects. Torres (2018) reported that when crushed, Madre de Cacao leaves possess a distinctive aroma that could attract fleas and ticks from cattle and subsequently eliminate them. The current findings validate this traditional knowledge, demonstrating that MDCEE possesses

potent acaricidal properties against *R. (B.) microplus*. The significant dose-dependent response observed with both extracts confirms that the active compounds are responsible for the observed effects rather than experimental artifacts. The result suggests that Madre de Cacao extract could serve as a more effective, natural alternative to existing commercial products. The rapid action is particularly valuable in animal health applications, as it reduces ticks and other diseases.

Conclusion

The findings of the study prove that MDCEE exhibits higher efficacy against the tick organisms than Betel nut extract and a commercial control product. The rapid and complete elimination of ticks achieved by the MDCEE highlights its potential as a natural alternative for animal health applications. The identified results in phytochemical analysis between the plant extracts will serve as a foundation for understanding their mechanisms of action and guide future research to help develop improved natural alternatives.

Recommendations

Future research should proceed to in vivo testing to validate the efficacy and safety of these botanical extracts under actual field conditions on cattle. Future researchers should also investigate higher concentrations of Betel nut extract.

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References

Abbas A, Abbas RZ, Masood S, Iqbal Z, Khan MK, Saleemi MK, Khan JA. 2018. Acaricidal and insecticidal effects of essential oils against ectoparasites of veterinary importance. *Boletín Latinoamericano Y Del Caribe De Plantas Medicinales Y Aromáticas* **17**(5).

Abbas RZ, Zaman MA, Sharif M, Rafique A, Saeed Z, Siddique F, Ahmad M. 2020. Anthelmintic effects and toxicity analysis of herbal dewormer against the infection of *Haemonchus contortus* and *Fasciola hepatica* in goat. *Pakistan Veterinary Journal* **40**(4).

<http://dx.doi.org/10.29261/pakvetj/2020.083>

Abubakar M, Perera PK, Iqbal A, Manzoor S. 2018. Introductory chapter: Ticks and tick-borne pathogens. In *Ticks and Tick-Borne Pathogens*. IntechOpen.

DOI: 10.5772/intechopen.82510

Akharaiyi FC, Boboye B, Adetuyi FC. 2012. Antibacterial, phytochemical and antioxidant activities of the leaf extracts of *Gliricidia sepium* and *Spathodea campanulata*. *World Applied Sciences Journal* **16**(4), 523-530.

Anto EJ, Lelo A, Ilyas S, Nainggolan M. 2020. Effect of Ethanol extract and ethyl acetate fraction of betel nut (*Areca catechu* L.) in colonic goblet cells of mice (*Mus musculus*) given orally infective egg of *Trichuris muris*. *Open Access Macedonian Journal of Medical Sciences* **8**(B), 637-642.

<https://doi.org/10.3889/oamjms.2020.4878>

Becker S, Webster A, Doyle RL, Martins JR, Reck J, Klafke GM. 2019. Resistance to deltamethrin, fipronil and ivermectin in the brown dog tick, *Rhipicephalus sanguineus* sensu stricto, Latreille (Acari: Ixodidae). *Ticks and tick-borne diseases* **10**(5), 1046-1050.

<https://doi.org/10.1016/j.ttbdis.2019.05.015>

Borges LMF, Sousa LADD, Barbosa CDS. 2011. Perspectives for the use of plant extracts to control the cattle tick *Rhipicephalus (Boophilus) microplus*. *Revista brasileira de parasitologia veterinaria* **20**(2), 89-96.

<https://doi.org/10.1590/S1984-29612011000200001>

- De Leon JM, Ison MJB, Maningas RV.** 2021. Madre De Cacao (*Gliricidia sepium*) and bottlebrush (*Callistemon viminalis*) leaves extract as mosquito larvicide. *Science Heritage Journal (GWS)* **5**(1), 9-13. DOI: 10.26480/gws.01.2021.09.13
- Estrada-Peña A, García Z, Sánchez HF.** 2006. The distribution and ecological preferences of *Boophilus microplus* (Acari: Ixodidae) in Mexico. *Experimental & applied acarology* **38**, 307-316. <https://doi.org/10.1007/s10493-006-7251-2>
- Fayaz MR, Abbas RZ, Abbas A, Khan MK, Raza MA, Israr M, Zaman MA.** 2019. Potential of botanical driven essential oils against *Haemonchus contortus* in small ruminants. *Boletín Latinoamericano y del Caribe de Plantas Medicinales y Aromáticas* **18**(6).
- Fidelis JOL, Sampaio PH, Teixeira PPM, André MR, Cadioli FA.** 2014. Resistance of *Rhipicephalus (Boophilus) microplus* acaricides: revisão de literatura. *Nucleus Animalium, Ituverava* **6**(1), 99-110. DOI: 10.3738/1982.2278.1037
- Galay RL, Llaneta CR, Monreal MKFB, Armero III AL, Baluyut ABD, Regino CMF, Tanaka T.** 2021. Molecular Prevalence of *Anaplasma marginale* and *Ehrlichia* in domestic large ruminants and *Rhipicephalus (Boophilus) microplus* ticks from Southern Luzon, Philippines. *Frontiers in Veterinary Science* **8**, 746705. <https://doi.org/10.3389/fvets.2021.746705>
- Gaudêncio FN, Tunholi-Alves VM, Lima MG, Gôlo PS, Da Costa Angelo I, Castro RN, Da Fonseca AH, Scott FB, Pinheiro J.** 2016. Alterations in the oxidative metabolism of *Rhipicephalus (Boophilus) microplus* ticks in response to exposure to the insect growth regulator fluazuron. *Revista Brasileira De Parasitologia Veterinária* **25**(1), 54-60. <https://doi.org/10.1590/S1984-29612016006>
- Ghosh S, Sharma AK, Kumar S, Tiwari SS, Rastogi S, Srivastava S, Rawat AKS.** 2011. In vitro and in vivo efficacy of *Acorus calamus* extract against *Rhipicephalus (Boophilus) microplus*. *Parasitology Research* **108**, 361-370. <https://doi.org/10.1007/s00436-010-2070-0>
- Hussain K, Abbas RZ, Abbas A, Rehman MA, Raza MA, Rehman T, Ali S.** 2021. Anticoccidial and biochemical effects of *Artemisia brevifolia* extract in broiler chickens. *Brazilian Journal of Poultry Science* **23**(04), eRBCA-2020. <https://doi.org/10.1590/1806-9061-2020-1377>
- Jonsson NN, Iqbal Z.** 2012. Syringe test (modified larval immersion test): A new bioassay for testing acaricidal activity of plant extracts against *Rhipicephalus microplus*. *Veterinary Parasitology* **188**(3-4), 362-367. <https://doi.org/10.1016/j.vetpar.2012.03.021>
- Kasaija PD, Estrada-Peña A, Contreras M, Kirunda H, De la Fuente J.** 2021. Cattle ticks and tick-borne diseases: A review of Uganda's situation. *Ticks and tick-borne diseases* **12**(5), 101756. <https://doi.org/10.1016/j.ttbdis.2021.101756>
- Kemal J, Zerihun T, Alemu S, Sali K, Nasir M, Abraha A, Feyera T.** 2020. In vitro acaricidal activity of selected medicinal plants traditionally used against ticks in eastern Ethiopia. *Journal of Parasitology Research* **2020**(1), 7834026. DOI: 10.1155/2020/7834026
- Liu DL, Wang XY, Yang B, Zhnag H.** 2013. Review of pharmacological effects and toxicological information of *Arecae Semen*. *Zhongguo Zhong Yao Za Zhi (China Journal of Chinese Materia Medica)* **38**(14), 2273-2275.
- Miller RJ, White WH, Davey RB, George JE, De Leon AP.** 2011. Efficacy of spinosad against acaricide-resistant and-susceptible *Rhipicephalus (Boophilus) microplus* and acaricide-susceptible *Amblyomma americanum* and *Dermacentor variabilis*. *Journal of medical entomology* **48**(2), 358-365. <https://doi.org/10.1603/ME08222>
- Nejash AA.** 2016. Review of Economically Important Cattle Tick and Its Control in Ethiopia. *Vector Biol J* **1**(1). DOI: 10.4172/2473-4810.1000104

- Ostfeld RS, Price A, Hornbostel VL, Benjamin MA, Keesing F.** 2006. Controlling ticks and tick-borne zoonoses with biological and chemical agents. *Bioscience* **56**(5), 383-394.
[https://doi.org/10.1641/0006-3568\(2006\)056\[0383:CTATZW\]2.0.CO;2](https://doi.org/10.1641/0006-3568(2006)056[0383:CTATZW]2.0.CO;2)
- Peng W, Liu YJ, Wu N, Sun T, He XY, Gao YX, Wu CJ.** 2015. *Areca catechu* L. (Arecaceae): A review of its traditional uses, botany, phytochemistry, pharmacology and toxicology. *Journal of Ethnopharmacology* **164**, 340-356.
<https://doi.org/10.1016/j.jep.2015.02.010>
- Philippine Statistics Authority.** 2023. Cattle Situation Report, July to September 2023. Retrieved from:
https://psa.gov.ph/sites/default/files/lpsd/SR_Q3-2023-Cattle-Situation-Report-Signed.pdf
- Rabena AR.** 2007. Kakawate (*Gliricidia sepium*) jacq. Kunth ex. Walph coumarin as antitermitic and antimicrobial compound. *Journal of ISSAAS [International Society for Southeast Asian Agricultural Sciences]* (Philippines).
- Reck J, Klafke GM, Webster A, Dall'Agnol B, Scheffer R, Souza UA, De Souza Martins JR.** 2014. First report of fluazuron resistance in *Rhipicephalus microplus*: a field tick population resistant to six classes of acaricides. *Veterinary Parasitology* **201**(1-2), 128-136.
<https://doi.org/10.1016/j.vetpar.2014.01.012>
- Redondo LM, Chacana PA, Dominguez JE, Fernandez Miyakawa ME.** 2014. Perspectives in the use of tannins as alternative to antimicrobial growth promoter factors in poultry. *Frontiers in Microbiology* **5**, 118.
<https://doi.org/10.3389/fmicb.2014.00118>
- Rizali A, Aziza NL, Hamsyin M.** 2022. Studies on effect of betel nut extract solution on mortality of armyworm *Areca (Spodoptera litura* F.) on lettuce (*Lactuca sativa* L.) plants. *Ecology Environment and Conservation*, **28**.
<http://doi.org/10.53550/EEC.2022.v28io4s.002>
- Rodríguez MCE, Pulido NJ.** 2015. Efficacy of plant extracts on the adult tick *Rhipicephalus (Boophilus) microplus* and its oviposition. *Revista Cubana de Plantas Medicinales* **20**(4).
- Salman M, Abbas RZ, Israr M, Abbas A, Mehmood K, Khan MK, Shah S.** 2020. Repellent and acaricidal activity of essential oils and their components against *Rhipicephalus ticks* in cattle. *Veterinary parasitology* **283**, 109178.
<https://doi.org/10.1016/j.vetpar.2020.109178>
- Shah SSA, & Khan A.** 2019. One Health and Parasites. In S. Yasobant & D. Saxena (Eds.), *Global Applications of One Health Practice and Care* (pp. 82-112). IGI Global Scientific Publishing.
<https://doi.org/10.4018/978-1-5225-6304-4.ch004>
- Shih YT, Chen PS, Wu CH, Tseng YT, Wu YC, Lo YC.** 2010. Arecoline, a major alkaloid of the areca nut, causes neurotoxicity through enhancement of oxidative stress and suppression of the antioxidant protective system. *Free Radical Biology and Medicine* **49**(10), 1471-1479.
<https://doi.org/10.1016/j.freeradbiomed.2010.07.017>
- Shobha N, Keshamma E.** 2023. Phytochemical Screening and Determination of Antioxidant Activities of Aqueous Extracts of Betel Leaf (*Piper betle*) And Betel Nut (*Areca Catechu*). *International Journal of All Research Education and Scientific Methods* **11**(2).
<https://doi.org/11.56025/IJARESM.2023.11223347>
- Sivira A, Sanabria ME, Valera N, Vásquez C.** 2011. Toxicity of ethanolic extracts from *Lippia origanoides* and *Gliricidia sepium* to *Tetranychus cinnabarinus* (Boisduval)(Acari: Tetranychidae). *Neotropical entomology* **40**, 375-379.
DOI: 10.1590/S1519-566X2011000300011
- Tangalin MGG.** 2011. Anthelmintic effects of processed mature betel nut as dewormer to native chicken and small ruminants (sheep and goats). *Int. Peer Rev. J* **1**(1), 230-243.
<https://doi.org/10.7828/ajoh.v1i1.166>

Torres LM. 2018. Madre de cacao (*Gliricidia sepium*) and sinta (*Andrographis paniculata*) leaves extract as botanical animal lice and ticks remover. Journal of Fundamental and Applied Sciences **10**(3S), 650-664. <http://www.jfas.info>

Valsoni LM, Freitas MGD, Borges DGL, Borges FDA. 2021. Status of *Rhipicephalus microplus* resistance to ivermectin, fipronil and fluazuron in Mato Grosso do Sul, Brazil. Revista Brasileira de Parasitologia Veterinária **30**(1), e025220. <https://doi.org/10.1590/S1984-296120201091>

Ybañez AP, Mingala CN, Ybañez RHD. 2018. Historical review and insights on the livestock tick-borne disease research of a developing country: The Philippine scenario. Parasitology International **67**(2), 262-266. <https://doi.org/10.1016/j.parint.2017.11.009>

Zaheer T, Imran M, Pal K, Sajid MS, Abbas RZ, Aqib AI, Rahman S. 2021. Synthesis, characterization and acaricidal activity of green-mediated ZnO nanoparticles against Hyalomma ticks. Journal of Molecular Structure **1227**, 129652. <https://doi.org/10.1016/j.molstruc.2020.129652>

Zheng X, Gallot G. 2020. Dynamics of cell membrane permeabilization by saponins using terahertz attenuated total reflection. Biophysical Journal **119**(4), 749-755. DOI: 10.1016/j.bpj.2020.05.040