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Phytochemical profile and acaricidal efficacy of *Syzygium cordatum* bark extracts against the tick *Rhipicephalus evertsi* in Tanzania

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Abstract

Tick infestations significantly hinder livestock productivity, especially in small-scale practices across various agro-ecological zones. The primary control method, through application of synthetic acaricides faces challenges such as growing resistance, scarcity, environmental impact, and high costs, particularly for low-income farmers. One of the promising alternatives by livestock keepers is the use of botanical pesticides, derived from herbal plants, in recent times researchers explore these plants for their potential to control tick populations. This study explored the potential of *Syzygium cordatum* a herbal plant, specifically evaluating its phytochemical profile and the acaricidal effectiveness of hexane, methanol, and water extracts of *S. cordatum* bark against larval and adult *Rhipicephalus evertsi* ticks in Tanzania. Extracts were screened for its phytochemical properties by standard laboratory procedures using Gas Chromatography- Mass Spectrometry and tested at 3.13, 6.25, 12.5, 25, 50, 100, and 200 mg/ml concentrations using an immersion technique. The bark extracts contained alkaloids, saponins, tannins, steroids, triterpenes, and phenolic compounds and all extracts achieved nearly 100% mortality at 200mg/ml within 24 hours, except for the negative control. The hexane, methanol, and water extracts caused 100% larval mortality at 25, 50, and 100, and 200 mg/ml concentrations, and adult mortality at 50, 100, and 200 mg/ml concentrations. Hexane extract was the most effective, with an LC50 of approximately 10.23 and 17.38 mg/ml and an LC99 of around 35.48 and 48.92 mg/ml for larvae and adults, respectively. These findings suggest that different extraction solvents selectively capture distinct classes of phytochemicals from *S.cordatum* barks, potentially offering diverse bioactive compounds for *R. evertsi* management. Field-based trials are recommended to validate the efficacy of *S.cordatum* bark extracts under real-world livestock management conditions for tick control.

Keywords: *Syzygium cordatum; Phytochemicals; Rhipicephalus evertsi; Acaricidal activity*

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Introduction

Ticks are the most prevalent arthropods of economic significance to the livestock sector and public health (Eskezia and Bekalu, 2016). These arthropods are the most significant carriers of major livestock and human disease causing pathogens (Pages *et al*., 2014). Globally, ticks significantly reduce the value of livestock and have negative impact on animal and human health (Perveen *et al*., 2021). With severe tick infestations, livestock lose weight about 1.37 ± 0.25g bodyweight for each engorged tick in *Bos taurus* cattle (Jonsson, 2006). In addition, ticks bites cause visible damage to hides through scarring, irritation, and infections, leading to reduced hide quality and market value, ultimately impacting livestock productivity and profitability (Amde, 2017). Numerous dangerous diseases that impact humans, animals, and livestock are spread by ticks. They cause serious health problems and raise important public health and economic issues by spreading rickettsial, viral, and protozoal infections in livestock (Rahman *et al*., 2022). The major diseases transmitted by ticks in livestock include babesiosis, anaplasmosis, theileriosis, heartwater, and East Coast fever (Rajput *et al*., 2006).

In humans; ticks transmit several diseases including viral diseases such as tick-borne encephalitis and Crimean-Congo hemorrhagic fever, bacterial diseases namely Coxiellosis, Lyme borreliosis, Mediterranean spotted fever, Tick-borne African fever, Tick-borne lymphadenopathy (TIBOLA), Tularemia and Human granulocytic anaplasmosis and Parasitic diseases, one of them being Babesiosis (Boulanger *et al*., 2019). The wild animals have also been reported to harbor pathogens belonging to the genera Anaplasma, Babesia, Hepatozoon, and Theileria (Ledwaba *et al*., 2022).

Tick control is crucial, particularly in regions with extensive livestock farming and high agricultural production, where the unchecked distribution and spread of ticks, along with the diseases they transmit, can result in massive economic losses. These losses stem not only from the direct health impacts on livestock, such as reduced weight gain, reduced milk production, and increased veterinary costs, but also from the deterioration of livestock hides and the decreased quality of meat, all of which affect the profitability of farmers. Additionally, the prevalence of tick-borne diseases in both animals and humans can lead to increased healthcare expenses, decreased labor productivity, and a reduction in the overall value of agricultural outputs, further stressing the need for effective tick management strategies (Jongejan, 1999). In 2006, annual loss attributed to tick-borne diseases (TBDs) in Tanzania was estimated at 364 million US Dollars. Such loss was due to theileriosis (68%), anaplasmosis 13%s, babesiosis13%, and cowdriosis 6% each accounted for the loss (Kivaria, 2006).

The most popular approach to tick management in livestock production is the routine use of synthetic chemicals known as acaricides (Rahman *et al*., 2022; Waldman, 2023). However, the continued use of synthetic acaricides leads to acaricide resistance in ticks as well as high cost on small-scale farmers. Additionally, their widespread use poses risks to the environment (Rodríguez-Mallon, 2016). One of the promising alternatives is the use of botanical pesticides, derived from plant-based compounds, which are being explored for their potential to control tick populations. Many plants produce natural chemicals with insecticidal properties that can be combined to develop eco-friendly, biodegradable pesticides. Botanical pesticides offer a multitude of advantages over synthetic alternatives such as natural compounds exhibit diverse mechanisms of action, making them effective against a wide range of livestock pests (Ayilara *et al*., 2023).

Additionally, botanical pesticides are not only affordable and easily biodegradable, but they also offer a sustainable alternative to chemical pesticides by breaking down quickly in the environment, reducing long-term ecological impact, and posing minimal risk to beneficial non-target organisms such as pollinators, wildlife, and beneficial insects, making them a safer option for integrated pest management (Lengai *et al*., 2020). *Syzygium cordatum* is one such botanical plant that has garnered attention for its acaricidal properties (Pavela *et al*., 2016; Wanzala *et al*., 2012).

Previous studies show that *S. cordatum*

contains phytochemical compounds such as alkaloids, anthocyanidins, essential oils, flavonoids, leucoanthocyanidins, phenols, phytosterols, saponins, simple sugars, terpenoids, and triterpenoids (Maliehe *et al*., 2017; Maroyi, 2018). Some of these phytochemicals specifically terpenoids, flavonoids, steroids, tannins, and saponins are also found in *Tephrosia vogelii*, which has been shown to possess acaricidal activity (Mlozi *et al*., 2022). Other studies have found that terpenes and terpenoids in *S. cardatum* which can be used as potential botanical acaricides as well as a safe insect repellant (Abbas *et al*., 2017). In addition, phytosterols extract were reported to be effective against *Rhipicephalus annulatus* ticks infesting cattle (Moawad *et al*., 2017). The investigations on the presence of phytochemicals in *S. cordatum* were carried out in South Africa (Maliehe *et al*., 2015) but no similar study has been carried out in Tanzania to investigate the phytochemical profile and its acaricidal effect of *S. cordatum* despite its abundance in the southern Tanzania.

Materials and Methods

Plants material

The *S. cordatum* barks were collected at the Kipela River, located in Matwebe ward in Rungwe district of the Mbeya region in Tanzania. The area is rich in these plants, which are traditionally used for fishing purposes.

Study Design

This study employed an experimental research design to evaluate the acaricidal efficacy of Syzygium cordatum bark extracts against larval and adult stages of the tick Rhipicephalus evertsi. The larval immersion test (LIT) and adult immersion test (AIT) were conducted under controlled laboratory conditions. In the LIT, tick larvae were exposed to varying concentrations of the plant extract, and mortality was assessed after 24 hours of exposure. In the AIT, adult ticks were immersed in the extract solutions, and mortality was recorded to determine efficacy after 24 hours of exposure.

Collection and identification of plant materials

The barks from *S.cordatum* were collected from a matured plant during the rainy season. About 4kg of *S. cordatum* bark was peeled using a bush knife and placed in a cool box then transported to the Tanzania Plant Health and Pesticide Authority (TPHPA) in Arusha.
The collected plant specimens were identified by an experienced botanist affiliated with the TPHPA in Arusha-Tanzania. The plant specimen was assigned a voucher specimen number (JEK 001) and subsequently deposited in the National Herbarium of Tanzania at TPHPA, ensuring proper documentation and preservation for future reference and research purposes.

Crude extraction

The bark was washed with tap water, rinsed with distilled water to remove any debris, and allowed to dry in the shade for six weeks. Approximately 2 kg of the dried bark was ground into a powder using a heavy-duty Pinetech blender. The pounded bark powder was macerated using hexane, methanol and water to obtain respective crude extracts as per solvent used as described by (Kemal *et al*., 2020) with slight modifications. Briefly, 100 g of the bark powder was macerated in 400 ml of each solvent (hexane, methanol, and water) separately for 72 hours, with agitation every 12 hours. Thereafter, the mixtures were first filtered using muslin cloth to remove large debris, followed by filtration through Whatman filter paper No. 1. The hexane and methanol extracts were evaporated to dryness using a rotary evaporator (Büchi Rotavapor R-100) under reduced pressure. The aqueous (water) extract was separated by freeze-drying (LABCONCO^{R}) for 24 hours. The obtained extracts were then stored at 4 °C until used.

Phytochemical screening

The extracts were screened by using standard procedures as described by Akpor et al. (2021). Alkaloids, Saponins, Steroids, Terpenoids, Anthraquinone, Flavonoids, Phlobatannins and Phenols were tested.

Alkaloids Test

Dissolving 2ml of the crude extract in 1ml of 1% HCl followed by the addition of Wagner's reagent. The formation of a cream or brown precipitate served as an indicator of alkaloid presence.

Saponins Test

Mixing 0.5ml of the bark extract with 5ml of distilled water and vigorously shaking the

solution revealed the presence of saponins through persistent foaming.

Steroids Test
Adding 1ml of chloroform to 2ml of the extract, followed by the careful addition of strong sulfuric acid down the side of the test tube, led to the observation of a cream or red upper layer, confirming the presence of steroids.

Terpenoids Test
Combining 2ml of chloroform and a few drops of concentrated sulfuric acid with 5ml of crude extract resulted in the formation of a grey color, indicating the presence of terpenoids.

Anthraquinone Test
Introducing 1ml of 10% ammonia to 2ml of the bark extract revealed the presence of anthraquinone through a noticeable change in color to red, violet, or pink.

Flavonoids Test
Mixing 1ml of diluted NaOH with 0.5ml of the bark extract in a test tube enabled the detection of flavonoids by the production of yellow precipitates, which were soluble in dilute mineral acids.

Phlobatannins Test
Adding a few drops of 1% diluted hydrochloric acid to a test tube containing 2ml of the bark crude extract, followed by boiling, resulted in the appearance of red precipitates, confirming the presence of phlobatannins.

Phenols Test
Combining 1ml of the bark crude extract with 1ml of 5% ferric chloride in a test tube revealed the presence of phenols through the formation of a blue color.

GC-MS for organic constituents of Syzygium cordatum bark extract
The Sub-groups of Terpenoids, phytosterol, and phenolic compounds were analyzed by using Triple Quad System. Agilent GC-MS-7890B/7000D Series equipped with analytical column: J&W DB-5ms UI 30 m × 0.25 mm × 0.25 µm and mass selective detector (Agilent 7000D Series) with performance turbo pump. Helium was the carries gas at flow rate of 2.3mL /min. The oven temperature was programmed as follows; 70 °C (0.5 min), 25 °C/min to 180 °C (1 min), 6 °C/min to 280 °C (8 min). The MS operating parameters TIC (Total Ion Current) 70 Ev scat. The compounds were identified based on comparison of their mass spectra with those of NIST 2020 and Willey Libraries. The analysis was carried out at the Government Chemist Laboratory in Dar es Salaam, Tanzania.

Tick collection
Fifty engorged female *Rhipicephalus evertsi* ticks were randomly collected from cattle in Mgeta Ward, Morogoro Region. Ticks were gently removed from cattle and placed in petri dishes and transported to the Tanzania Plant Hearth and Pesticide Authority bio-efficacy laboratory in Arusha Tanzania. Once in the laboratory, they were identified by tick expert at TPHPA and kept for oviposition for up to a month in a tick rearing room to lay eggs at 28°C and 80% relative humidity. The eggs were kept in 2.5 cm diameter x 8 cm long test tubes, sealed with cotton wool and gauze plugs and left to hatch into larvae in the same environment (Shyma *et al.,* 2014). Larvae of 10-14 days were used for the experiment, the remaining larvae were fed into adulthood using rabbits. The adult ticks were obtained after 6 weeks.

Preparation of crude extract
A concentration of 200mg/ml of hexane, methanol and water crude extract and 1% of Taifa washing soap (used as sticking agent (Siame *et al.,* 2019) were respectively prepared. Each was serially diluted to obtain other concentrations (3.13, 6.25, 12.5, 25, 50, 100 and 200mg/ml). Plain solvent (hexane, methanol and water) with 1% of washing soap (1g mixed with solvent to make a total volume 100ml) as the negative control while synthetic acaricide (Amitraz 125mg/ml) was used as positive control. The positive control was diluted in water according to the manufacturer's recommendation (1: 500) for experiment (Kemal *et al.,* 2020).

In vitro acaricidal test
Larval and Adult Immersion tests was employed as per guidelines (FAO, 2004). Larvae of 14 days old, were removed from their holding tube by means of paint brush. The number of larvae per test was approximately 80. On the other hand, the number of adults were 80. Each concentrate was tested in triplicate. Whatman Filter papers were chopped into circular shape about equal

to the inner diameter of petri dishes. 3ml of crude extract was poured into petri dish followed by filter paper, and then ticks were distributed on it. Another 4 ml of crude extract was flooded on top of ticks followed by another filter paper and finally 3ml of crude extract was poured on top of filter paper. The filter-papers sandwich containing the ticks were thus saturated with a total of 10 ml solution of crude extract. The immersion period was 10 minutes. Then, the filter papers with ticks were removed from petri dish and placed on a soft tissue and allowed to dry. Finally, the ticks were removed from filter papers by the aid of paint brush and placed into another folded filter paper clipped with bulldog clips and stored in tick rearing room at 28^0C and 80% relative humidity. After 24 hours, tick's mortality was recorded. Tick that remained motionless and exhibited no movements in response to stimulation were considered dead. The results were used to determine the percentage of mortality, and probit regression analysis was performed to estimate the lethal concentrations of the crude extract.

Results

By standard laboratory procedures, the hexane, methanol, and water extracts all contained alkaloids, saponins, steroids, terpenoids, and phenols as shown in Table 1. Anthraquinones were present in both the methanol and water extracts, while phlobatannins were detected only in the hexane extract. None of the three extracts contained flavonoids.

Table 1

Phytochemical Screening of Syzygium cordatum bark extracts

Test for	Hexane extract	Methanol extract	Water extract
Alkaloids	+	+	+
Saponins	+	+	+
Steroids	+	+	+
Terpenoids	+	+	+
Anthraquinone	_	+	+
Flavonoid	_	_	_
Phlobatannins	+	_	_
Phenols	+	+	+

KEY; '+' and '-' shows present and absent respectively

GC-MS analysis of *S. cordatum* bark extracts revealed distinct compound profiles across different solvents (Table 2). The hexane extract contained predominantly lipophilic compounds, including phytol, β-bisabolene, and γ-murolene. In contrast, the methanol extract yielded polar constituents such as 2,4-di-tert-butylphenol, butyl citrate, and campesterol. The aqueous extract was rich in hydrophilic compounds, notably 1,2,3-benzenetriol, phenolic 3,4,5-trimethoxy, tributyl acetyl citrate, and 13-docosenamide

Table 2

GC-MS analysis of Bark extract from Syzygium cordatum

Sample Name	Extracting Solvent	Compounds identified
Bark extract of *Syzygium cordatum* tree	Water	1,2,3 Benzenetriol 2,4-Di-tert-butylphenol Phenolic, 3,4,5-trimrthoxy Butyl citrate Tributyl acetyl citrate 13-Docosenamide, (Z)
	Methanol	2,4-Di-tert-butylphenol Butyl citrate Campesterol
	Hexane	Phytol β-Bisabolene γ-Murolene

The findings illustrate that mortality generally increased with increases in concentration level of hexane, methanol and water crude extracts, indicating a cumulative effect of the crude extract on tick mortality (Table 3).

Table 3

Larval mortality effect of Hexane, methanol and water crude extract after 24 hours

Concentration (mg/ml)	**No, of ticks exposed**	**Mortality for Hexane (%)**	**Mortality for Methanol (%)**	**Mortality for Water (%)**
3.13	80	0	0	0
6.25	80	24.7	0	0
12.5	80	72.0	45.2	17.2
25	80	100	75.6	33.3
50	80	100	100	91.9
100	80	100	100	100
200	80	100	100	100
Negative Control	80	0	0	0
Positive control	80	100	100	100

Table 4 indicates the relationship between concentration and mortality of ticks after treatment with the methanolic crude extract. No mortality observed at 3.13 and 6.25mg/ml concentrations. Mortality was first observed at concentrations above 6.25 mg/ml and gradually increased with increasing concentration. Complete (100%) mortality was recorded at 50, 100, and 200 mg/ml, as well as in the positive control, while no mortality was observed in the negative control.

Table 4

Adult mortality effect of Hexane, methanol and water crude extract after 24 hours

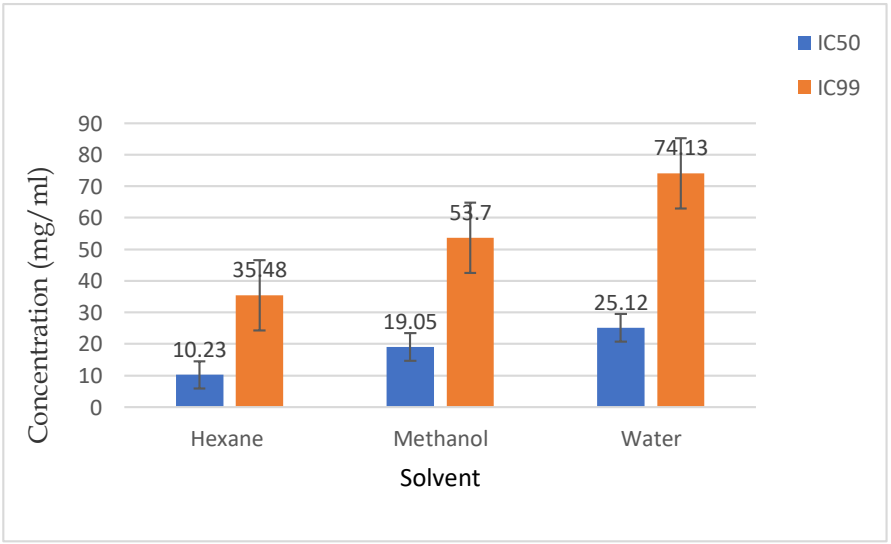
Concentration (mg/ml)	No, of ticks exposed	Mortality for Hexane (%)	Mortality for Methanol (%)	Mortality for Water (%)
3.13	80	0	0	0
6.25	80	0	0	0
12.5	80	66.7	16.6	16.7
25	80	92.0	25.0	41.7
50	80	100	58.3	58.3
100	80	100	100	83.3
200	80	100	100	100
Negative Control	80	0	0	0
Positive control	80	100	100	100

Lethal concentration of the extracts

The Figure 1 shows the concentration of crude extract needed to kill 50% (LC50) and 99% (LC99) of larval ticks within 24 hours. Hexane's LC50 value was approximately 10.23 mg/ml, and its LC99 value was around 35.48 mg/ml. Methanol, while effective, required higher concentrations than Hexane, with an LC50 value of about 19.05 mg/ml and an LC99 value of approximately 53.7 mg/ml. Water, once again, was least effective, with highest LC50 value of around 25.12 mg/ml and an LC99 value of approximately 74.13 mg/ml.

Figure 1

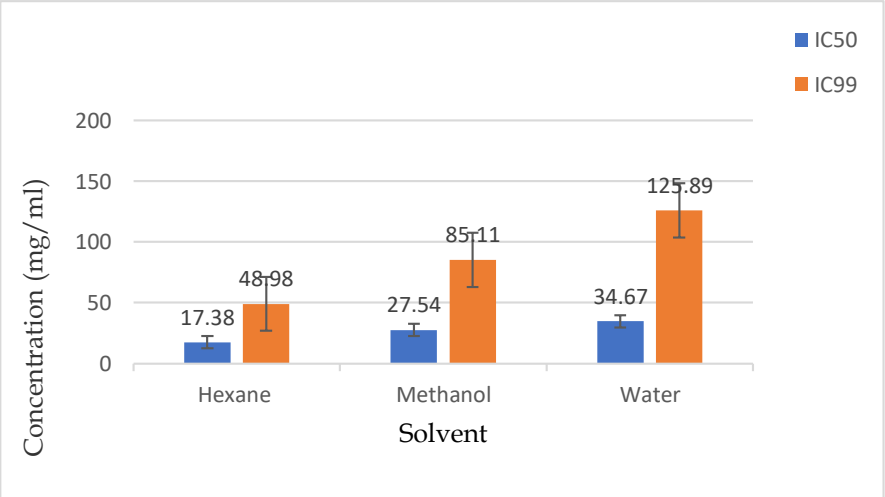
Lethal concentration (LC50 and LC99) of S. cordatum extracts against Rhipicephalus evertsi larvae after 24 hours exposure



Similarly, for adult ticks (Figure 2), hexane crude extract had an LC50 value of approximately 17 mg/ml and an LC99 value of approximately 48 mg/ml. With LC50 value of around 28 mg/ml and the LC99 value of approximately 85 mg/ml, methanol required higher concentrations than hexane. Water extract required the highest concentrations to cause mortality of ticks, with an LC50 value of approximately 35 mg/ml and an LC99 value of around 126 mg/ml.

Figure 2

Lethal concentration (LC50 and LC99) of S. cordatum extracts against adult Rhipicephalus evertsi after 24 hours exposure



Discussion

Ticks are ectoparasites affecting livestock in tropical and subtropical regions, causing significant economic losses through both their direct blood-sucking impact and their role as vectors for pathogens. There is growing interest among smallholder livestock farmers in using herbs to control ticks by using their indigenous knowledge. Plants contain a variety of chemically active compounds that can affect all biological processes of organisms, disrupting their life cycle and spread (Dias *et al.*, 2021).

This study aimed to evaluate both the phytochemical composition and the efficacy of *S. cordatum* bark extract in causing mortality of *R. evertsi* ticks under laboratory condition. The phytochemicals composition identified qualitatively in stem bark extracts were Alkaloids, Saponins, tannins, steroids, triterpenes and phenolic compounds in all three extracts (Table 1) aligned with other studies however flavonoids was not detected (Maroyi, 2018). The phytochemicals identified are among of the class of compounds known for their diverse biological activities, including insecticidal properties (Kemal *et al.*, 2020; Pavela et al., 2016) The detection of phytosterols, specifically campesterol, in the methanol extract by GC-MS analysis (Table 2) is consistent with findings reported in previous studies on *S. cordatum* as part of the bioactive constituents in various parts of *S. cordatum*, including the bark and leaves (Maliehe *et al.*, 2017; Maroyi, 2018). Phytosterols extract were tested its efficacy and found effective against *Rhipicephalus annulatus* ticks infesting cattle (Moawad *et al.*, 2017). Terpenes (β-Bisabolene and γ-Murolene) is a non-polar compound that found present in hexane crude extract and reported as a promising compound for tick control (Fouche *et al.*, 2017; Cardoso *et al.*, 2020).

This study also demonstrated the acaricidal effect of *S.cordatum*, findings show that mortality generally increased with increases in concentration level of the crude extract, indicating a cumulative effect of the crude extract on tick mortality. Other studies have reported a similar phenomenon during acaricidal testing, where tick mortality

increased not only with prolonged exposure but also with higher concentrations of the tested compounds (Kemal *et al*., 2020). This temporal progression of mortality suggests that the crude extract might exert its effects gradually, possibly through mechanisms such as systemic absorption or prolonged exposure to the active compounds (Slikker *et al*., 2004). The absence of mortality in the negative control group further indicates the inference that the observed mortality in the treated groups was attributable to the effect of *S. cordatum* bark extract being tested rather than external factors.

The findings further showed that the higher extract concentrations were clearly associated with higher tick mortality. No tick mortality was observed at lowest concentration (3.13mg/ml) for hexane crude extract, while all larvae died (100% mortality) at 25mg/ml concentration (Table 3). Other studies observed that tick mortality became significantly high at higher concentrations (Temba *et al*., 2018).

In this study the acaricidal effects of hexane, methanol, and water crude extracts on adult ticks at various concentrations were compared. Initially, at lower concentrations of 3.13 and 6.25 mg/ml, no discernible mortality was observed within all crude extracts (Table 4). However, as the concentration of the extract increased to 12.5 mg/ml and beyond, a corresponding rise in mortality became evident. Hexane extract induced 66.7% tick mortality at 12.5 mg/ml concentration. A corresponding increase in mortality was observed with higher concentrations up to 92% at 25 mg/ml. All adult ticks perished at 50, 100 and 200mg/ml highest concentrations, demonstrating a mortality rate of 100%. Conversely, the negative control group, which was treated with diluent exhibited no mortality while positive control with amitraz caused 100% mortality at of 0.25% concentration. These findings show a dose-dependent relationship between the concentration of crude extracts and its efficacy in inducing mortality of adult *R. evertsi*, suggesting its potential for controlling tick populations. Comparing mortality rates between treated adult ticks and those in the negative control group emphasize the specificity of the observed mortality in the treated groups.

The comparison between mortality of larvae and adult stages of *R. evertsi* ticks shows slight differences in the effectiveness of hexane, methanol, and water extracts. Generally larval stage of tick was more susceptible than adult stage. Hexane extracts exhibit the highest potency, with complete mortality achieved at 25 mg/ml for larvae and 50 mg/ml for adults. Methanol extracts, while moderately effective, required higher concentrations to achieve similar mortality rates as hexane. There was significant mortality in larvae at 12.5 mg/ml of methanol extract, with 100% mortality at 50 mg/ml; 100% mortality of adult ticks was observed at 100 mg/ml. Water extracts were the least effective, requiring the highest concentrations to achieve complete mortality. Larval ticks showed increased mortality with concentration, achieving 100% mortality at 100 mg/ml, while adult ticks required up to 200 mg/ml for 100% mortality.

Statistical analysis at a 95% confidence interval revealed significant differences in efficacy among the extracts, with p-values of 0.011 for larvae and 0.0249 for adult mortality. The observed mortality indicates that the extracts have a contact effect, with higher concentrations resulting in immediate effects, while lower concentrations took longer to manifest (Temba *et al*., 2018).

In both stages, larval and adult *R. evertsi* tick, hexane extract showed a marked increase in tick mortality. Moreover, Baz and colleagues noted that hexane extracts consistently performed better than, methanol extracts across multiple hematophagous arthropods. This supports the effectiveness of hexane as a solvent for isolating potent fat-soluble bioactive compounds (Baz *et al*., 2024). Other showed that hexane extracts are more potent due to their ability to dissolve lipophilic compounds, enhancing penetration through the tick's cuticle (Théophile *et al*., 2022). Methanol extracts, although requiring higher concentrations compared to hexane, were also effective, likely due to their ability to extract both polar and non-polar compounds (Sultana *et al*., 2009). Water extracts generally showed lower efficacy because many bioactive compounds are not water-soluble, resulting in less concentrated and effective extracts (Lajoie *et al*., 2022).

Hexane extract exhibited the lowest LC50 and LC99 compared to methanol and water extract (Figure 1 and figure 2). This aligns with recent studies that have explored the use of organic solvents in pest control has shown that hexane extracts from certain plants exhibited strong acaricidal activity against ticks (Torres-Santos *et al.,* 2021). The lower concentrations of Hexane required for tick mortality suggest potential cost savings and resource efficiency. This is particularly relevant in large-scale tick control programs where the cost of chemicals can be significant. Théophile *et al.* (2022) highlighted the economic benefits of using highly effective solvents in pest management. Water, although the least effective, is the safest option in terms of environmental and health considerations (Borges *et al.,* 2020).

Study limitations

The study was conducted solely under laboratory conditions using only one species of ticks. The investigation did not depict other parts of the plant such as leaves, fruits, and roots extracts. It is strongly recommended to conduct field trials and to explore the use of extracts from various parts of the *S. cordatum* plant to test on different species of ticks.

Conclusion

This study confirms the presence of alkaloids, saponins, tannins, steroids, triterpenes, and phenolic compounds in *S. cordatum* bark extract, which are among the class of compounds known for their diverse biological activities, including insecticidal properties. The in vitro adulticidal and larvicidal efficacy of *S.cordatum* bark against *R. evertsi* was more pronounced in hexane bark extracts, followed by methanol, and the least was water extract.

Recommendations

This study was conducted using *Rhipicephalus evertsi* under laboratory conditions and not in the field, further studies are recommended to validate its efficacy on the wider perspectives.

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