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Research Article

Development of Concentrated Bitter Almond Emulsions as Acaricides for *Rhipicephalus Turanicus* Ticks

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Abstract | In recent years, plant extracts have emerged as promising candidates for acaricidal applications. This study evaluates the qualitative and quantitative characteristics of bitter almond emulsions, such as shelf life, dispersed phase particle size, mechanical resistance, and temperature stability. Amygdalin, identified as the main active component, comprises 27.2% of the alcoholic extract in these emulsions. Diluting concentrated emulsions with water creates a solution suitable for acaricidal use. Dilution experiments demonstrated the emulsion's shift from W/O to O/W type with increasing dilution. By adding water to the concentrated emulsions, a milky working solution with a pH range of 7-8 was obtained, suitable for tick control. Acaricidal activity against *Rhipicephalus turanicus* ticks was observed in concentrations ranging from 0.05% to 1.0%. W/O type emulsions showed higher insecticidal efficacy, up to 75%, compared to O/W type emulsions, which have activity up to 50 percent. The concentrated emulsions exhibited stability with a shelf life of two years. Working personals and warm-blooded animals were not significantly impacted by the emulsions. Field studies further confirmed the effectiveness of the emulsions in controlling *R. turanicus* ticks in livestock settings. This research contributes to the exploration of alternative pest control strategies, addressing the limitations associated with traditional pyrethroids. Further studies and development of these emulsions can enhance their potential as an effective and sustainable solution in pest management.

Keywords | Acaricidal activity, Alcoholic extract, Concentrated emulsions, Pest control, Phase transition, *Rhipicephalus turanicus* ticks

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INTRODUCTION

Acaricides play a crucial role in combating the harmful effects of ticks and mites. The regions of Central Asia are inhabited by various tick, mites and other ectoparasite species that pose significant threats to plants, animals, and birds (Akramova *et al*., 2016; Safarov *et al*., 2023; Deak *et al*., 2022). Tick infestations are widespread among vertebrates, having a negative impact on the animals' health and productivity. While pyrethroid derivatives have been widely used as insecto-acaricides in tropical climates (Olimov and Aminova, 2011; Sajid *et al*., 2009; Sharma *et al*., 2018; Ahrorova and Muhutdinova 2020; Agwunobi *et al*., 2021; Samed *et al*., 2021), they are associated with numerous negative side effects and development of resistance in ticks (Agwunobi *et al*., 2021; Obaid *et al*., 2022). Hence, there is a need to explore alternatives that offer improved safety profiles and efficacy. Therefore, there is a growing interest in the search for safe and effective acaricides derived from plant extracts (Quadros *et al*., 2020; Pavela, 2016; Cruz *et al*., 2016; Mirzaeva *et al*., 2022).

Earlier reports have highlighted the advantages of multicomponent acaricides in the form of dust for disinfecting poultry houses on an industrial scale (Akbaev, 2017). These formulations, containing powdered permethrin, S-fenvalerate, and neopinaine at a total concentration of 0.7%, which have been found to be effective in treating infestations by red chicken mites (*Dermanyssus gallinae*) even in the presence of birds. However, the use of cypermethrin emulsions as acaricidal concentrates for bird and animal disinfection has faced challenges due to the emergence of resistant ectoparasite strains (Akbaev and Vasilevich, 2016). To address this, an emulsion has been developed with alphamethrin (0.1%), sunflower oil (70%), block copolymer MAG-540 (2.5%), and water (up to 100%) to target ticks and mites. This emulsion demonstrated a stable acaricidal effect for 4-5 months and a shelf life of 2 years (Udavliev and Panfilov, 2010).

Laboratory and field trials have also shown the effectiveness of the herbal extract formulations (20%) on *Ricinus communis L.* and oil emulsions (5% and 10%) on the mortality of *Plutella xylostella* oviposition behavior. While aqueous extracts exhibited lower toxicity, they resulted in high mortality rates (67.49 ± 1.98% and 70.86 ± 0.85%), and an effectiveness of 5-10% extract emulsions was observed (Agbeko *et al*., 2011). Another acaricidal agent, delcid, is an emulsion formulation containing 4% deltamethrin, along with excipients and fillers. This emulsion, characterized by its specific smell, miscibility with water, and stability during storage, has demonstrated enteric-contact effects. Field studies have shown the effectiveness of this emulsion against ixodid ticks and mites at a concentration of 0.05% for 6 days (Glazunov and Glazunova, 2018).

Active ingredients from raw tobacco leaves (*Nicotiana tabacum* Linn., Solanaceae) have been successfully transferred into concentrated emulsions in the presence of tweens and spans. These palm oil-based concentrated emulsions have demonstrated effectiveness against plant pests (Jindaporn *et al*., 2013). Another plant extract, *Melia azedarach*, has been utilized as a repellent to deter cabbage aphids (*Brevicoryne brassicae*) (Bina *et al*., 2017). Plant extracts, when used in conjunction with 1% commercial liquid soap, have shown efficacy against *Rhipicephalus (Boophilus) decoloratus* cattle ticks, with improved effectiveness observed (Nyahangare *et al*., 2019). Aqueous extracts of *Tephrosia vogelii* and *Hyptis suaveolens*, along with *Azadirachta indica* and *Jatropha curcas* oils, and the pesticide Furadan 5G, have been employed against the corn borer *Mussidia nigrivenella* Ragonot. Laboratory and field trials have demonstrated that oil emulsions of these extracts, at concentrations ranging from 3% to 25.5%, reduce *Jatropha curcas* egg hatch (Agboka *et al*., 2009).

Safe acaricides targeting the camel tick *Hyalomma dromedarii* have been developed based on the essential oils of *Artemisia herba-alba* and *Melia azedarach*. The emulsions' main characteristics were studied using electron microscopy and Fourier transform infrared spectroscopy. The nanoemulsion capsule size was found to be approximately 62-69 nm for *Artemisia herba-alba* and 52-91 nm for *Melia azedarach*. The LC50 values of the nanoemulsions saturated with *A. herba-alba* and *M. azedarach* oils on embryonated eggs, larvae, engorged females, and starving adults were as follows: 0.3% &1.1%, 0.7% & 1.7%, 0.3% & 0.4%, and 4.4% and 22.2%, respectively (Abdel-Ghany *et al*., 2021).

Essential oils derived from three species of *Eucalyptus* (*E. citriodora, E. globulus*, and *E. staigeriana*) have been utilized to develop an environmentally friendly acaricide. Emulsions of essential oils at various concentrations have shown effectiveness against larvae and engorged females of *Rhipicephalus microplus*, demonstrating efficacy against mites (Chagas et al., 2002). Stable nanoemulsions of vitamin E (alpha-tocopherol acetate) have been achieved by incorporating highly dispersed mineral particles into the emulsions, resulting in stable oil-in-water emulsions (Nagdalyan *et al*., 2022; Grechishcheva *et al*., 2023).

The objective of this study is to assess the potential of an emulsion-based alcoholic extract derived from bitter almonds (Zagrobelny and Lindberg, 2011) as an environmentally friendly and effective acaricide. Bitter almonds are naturally rich in amygdalin, a cyanogenic glycoside that exhibits insecticidal properties by releasing hydrogen cyanide through hydrolysis (Tukhtaev *et al*., 2022). By leveraging the presence of amygdalin in bitter almonds and their extracts, this research aims to explore the development of a sustainable solution for pest control (Khamidov *et al*., 2021;

Lutfullina and Fatkhutdinova 2022; Soeung *et al*., 2022). Through comprehensive analysis and evaluation, this study seeks to investigate the acaricidal activity and safety of concentrated emulsions formulated with the alcoholic extract, providing valuable insights for the potential integration of bitter almond-based formulations into pest management strategies.

MATERIALS AND METHODS

Extraction and Analysis of Amygdalin in Bitter Almond Seeds

Bitter almond seeds obtained from the Bostanlik district of the Tashkent region in Uzbekistan (collected in 2020) were used as the subject of the study. The oil was extracted by cold pressing after removing the seed shells. The remaining residue was dried, ground, and subjected to extraction using 96% ethanol by percolation. The yield of the alcohol extract was determined to be 10.5±0.25%. HPLC-mass spectrometry analysis was employed to determine the amygdalin content in the extracts. Positive ionization mass spectra revealed the molecular fragment of amygdalin $[M+H]^+$=458. The retention time for a sample with 0.27 mg (100%) amygdalin was 9.056 min. Amygdalin was detected in the alcohol extract powder at a retention time of 8.879 min, with a content of 27.86%.

Preparation and Characterization of Bitter Almond Extract Emulsion

An emulsion was prepared using an alcoholic extract of bitter almonds, sunflower oil, T-2 emulsifier, and sodium salt of distilled fatty acids. The emulsion was obtained by melting the bitter almond extract with the T-2 emulsifier, followed by the gradual addition of sunflower oil. The mixture was then dispersed with the addition of sodium salt of fatty acids. The resulting emulsion was diluted with water to create a working emulsion. The particle size of the dispersed phase was determined using turbidimetry and mechanical stability was assessed using centrifugation (temperature 25°C and environmental humidity 80%). Higher humidity conditions were taken because the low humidity will very literally dry out ticks, causing them to die naturally. Concentrated emulsions had a shelf life of 2 years.

Evaluation of Acaricidal Activity of Bitter Almond Extract Emulsion

The acaricidal action of the bitter almond extract emulsion was assessed by diluting it with water to different concentrations and testing its efficacy against *Rhipicephalus turanicus* ticks. Ticks were collected from small and large cattle in the Nizhne-Chirchik district of the Tashkent region at various stages of orthogenesis. Twenty tick specimens were placed on filter paper in glass dishes in 42 Petri dishes, divided into five separate groups. The experiments were conducted with five repetitions under laboratory conditions of 81% relative humidity and a temperature of 26°C. For comparison, the acaricide cypermethrin (0.1/100 ml) and distilled water (control group) were used.

RESULTS AND DISCUSSION

Concentrated Emulsion Formation

A concentrated emulsion was successfully prepared using 10 g of an alcoholic extract of bitter almonds, 100 g of sunflower oil, 10 g of emulsifier T-2, and 1 g of sodium salt of distilled fatty acids. The concentration of amygdalin in the alcoholic extract was found to be 27.2%. The concentrated emulsion does not contain water and therefore it can be stored for quite a long time and an insectoacaricidal form can be prepared on its basis in various quantities per package.

Emulsion Type and Stability

Dilution experiments revealed the emulsion type and its stability. Dilution in a 1:1 ratio maintained a Type II (W/O) emulsion, as confirmed by the dyeing method with methylene blue and the dilution method. The emulsion type remained stable even at a dilution ratio of 1:10. However, further dilution at a ratio of 1:20 resulted in a phase reversal, forming a Type I (O/W) emulsion. Dilution at a ratio of 1:30 led to an increase in the particle size of the dispersed phase, while the emulsion type remained unchanged. Without the addition of water, the concentrated emulsion can be stored for up to 2 years without any changes.

Particle Size Determinations

Turbidimetric analysis of the emulsion system (Table 1) indicated that when diluted at a ratio of 1:1, the particle size of the dispersed phase was measured at 36 nm. Dilution at a ratio of 1:10 resulted in an increase in particle size to 39 nm. Further dilution to a ratio of 1:30 increased the particle size to 43 nm. Dilution to a ratio of 1:100 further increased the particle size to 69 nm.

Table 1: Change in the particle size of the dispersed phase upon dilution of concentrated emulsions of bitter almond alcoholic extract.

Emulsion system	The particle size of the dispersed phase (r, nm) based on turbidity						
	r	r	r	r	r	r	r
Emulsion concentrate*	36	39	43	48	52	56	69
Added amount of water	1	10	20	30	40	50	100
emulsion type	w/o	w/o	o/w	o/w	o/w	o/w	o/w

*As part of a concentrated emulsion: alcohol extract of bitter almonds: emulsifier T-2: Na salt of distilled fatty acids: sunflower oil at a ratio of 1:1:0.1:10.

Emulsion Stability and Characteristics

Diluted emulsions exhibited a milky color, and the pH of the aqueous extract ranged from 7 to 8. With dilution, there was an increase in the particle size of the dispersed phase. The resistance to centrifugation of the emulsions was investigated at 1500 rpm (Table 2). The data revealed that at a dilution ratio of 1:1, the emulsions remained stable for 30 minutes during centrifugation. At a ratio of 1:10, stability decreased to 25 minutes, and further dilution to 1:20 maintained stability for 15 minutes without significant changes. The thermal stability of the emulsions at 50 °C ranged from 20 to 35 minutes. Centrifugation of the emulsions was carried out at a temperature (25°C) with an environmental humidity of 80%. The stability of the emulsion was studied at a temperature of 50°C and a relative humidity of 80% until separation. Turbidimetry was carried out at a temperature of 25°C and a relative humidity of 80%. pH measurements were carried out at temperature of 25°C (using a silver chloride electrode as a standard one).

Table 2: Mechanical resistance to centrifugation and temperature of dilute emulsions (the composition of the concentrated emulsion emulsifier T-2: alcohol extract of bitter almonds: sunflower oil: sodium salt of distilled fatty acids at a ratio of 10:10:100:1).

The amount of water in the emulsion, g	emulsion type	Appearance of the emulsion	Rotation time in centrifuge*, min.	Temperature resistance**, min
1	W/O	milky	30	35
10	W/O	milky	25	35
20	O/W	milky	20	30
30	O/W	milky	15	35
50	O/W	milky	15	35
100	O/W	milky	15	20

* 1500 rotation/min; ** 50 °C.

Acaricidal Activity on Rhipicephalus Turanicus Ticks

To study the acaricidal effect, working emulsions of different dilutions were prepared from concentrated solutions. Initially, the acaricidal activity of emulsions was studied by diluting the concentrated emulsion and water at a ratio of 1:1 (Table 3). This ratio corresponds to reverse emulsion (W/O). It should be emphasized that the emulsion contains 1% of the active substance amygdalin at a 1:1 ratio. In laboratory conditions, after one day of treatment with the emulsion at a 1:1 ratio, the death of ticks of the Rhipicephalus turanicus type is 70 ± 2%, and on the second day after treatment the acaricidal activity remains at the same level. On the third and fourth days after treatment, the acaricidal activity of the emulsion increases to 75%. This is due to the fact that the duration of contact of the emulsion with ticks allows the hydrolysis reaction of the active substance amygdalin to occur, which causes an increase in the acaricidal activity of the drug. Emulsions with dilutions of 1:100 and 1:200 are classified as O/W emulsions. The acaricidal activity of the emulsion turned out to be lower than that of W/O type emulsions. An emulsion with a dilution of 1:10 (the content of the active component amygdalin is 0.1%) has a maximum acaricidal activity of up to 60%. Emulsions with a dilution of 1:200 (amygdalin content 0.05%) have acaricidal activity of up to 55%. These data show that a decrease in the active component in the emulsion leads to a decrease in the acaricidal activity of the emulsion. In all cases, it is observed that the acaricidal activity of the emulsions is greater than that of the well-known acaricide cypermethrin.

Table 3: Acaricidal activity of dilute emulsions of bitter almond alcoholic extract (I=5).

Concentration * of amygdalin in emulsion (%)	Mortality rate of Rhipicephalus turanicus ticks (%)			
	1 day	2 day	3 day	4 day
1.0	70 ± 2	70 ± 3	75 ± 2	75 ± 3
0.10	60 ± 2	70 ± 2	60 ± 2	60 ± 2
0.05	55 ± 2	60 ± 2	55 ± 2	55 ± 2
0.1% solution of cypermethrin	20 ± 2	40 ± 2	50 ± 2	50 ± 2
Distilled water	0	0	0	0

*Dilution of the concentrated emulsion 1:1(1.0%), 1:100(0.1%) and 1:200(0.05%).

In light of the findings presented in this study, several key points emerge regarding the formation and potential applications of the concentrated emulsion. Firstly, the successful preparation of the emulsion using bitter almond extract, sunflower oil, emulsifier T-2, and sodium salt of distilled fatty acids highlight its viability as a delivery system for insecticidal compounds (Patent No. IAP 07357 RUz, (Tukhtaev *et al*., 2023; Mirzaeva et al., 2022). The high concentration of amygdalin in the alcoholic extract may play a role in the emulsion's acaricidal effects, warranting further investigation into its mechanism of action (Khamidov *et al*., 2021). The concentrated emulsion, with bitter almond extract as a carrier, offers a practical and efficient means of delivering these active ingredients for tick destruction. This formulation presents advantages in terms of stability and controlled release, which are crucial factors for effective pest control strategies (Sánchez-Pérez *et al*., 2012). Furthermore, the long-term stability of the concentrated emulsion without the addition of water is a promising characteristic for its practical applications in pest control. The absence of the need for water addition enhances its shelf life and convenience, making it a reliable option for storage and field use (Tukhtayev et al., 2021).

The findings of this study contribute to our understanding of the emulsion's behaviour and efficacy (Khamidov *et al*., 2020). The determination of emulsion type and stability through dilution experiments provides valuable insights into its performance under different conditions. The maintained stability of a Type II (W/O) emulsion at a dilution ratio of 1:1 indicates its robustness in preserving the desired properties (Tukhtaev *et al*., 2023). However, the observed phase reversal and formation of a Type I (O/W) emulsion at a dilution ratio of 1:20 highlight the importance of appropriate dilution ratio to maintain the desired emulsion type (Tukhtaev *et al*., 2020). It is worth noting that the increase in particle size of the dispersed phase with dilution, while the emulsion type remains unchanged, suggests the influence of dilution on the physical properties of the emulsion (Tukhtaev *et al*., 2021). This information is important for optimizing the formulation's efficacy and shelf life, as particle size can affect factors such as bioavailability, dispersibility, and overall performance of the emulsion.

The determination of emulsion type and stability through dilution experiments provides valuable insights into the behaviour of the formulation under different conditions. Dilution experiments allow us to explore the effects of varying concentrations on the emulsion's physical properties and stability. The maintenance of a stable Type II (W/O) emulsion at a dilution ratio of 1:1 (Figure 1) indicates the robustness of the formulation in preserving its desired characteristics (Wangcai *et al*., 2022). This suggests that the emulsion can maintain its structure and integrity even when diluted, making it suitable for practical applications where dilution may occur.

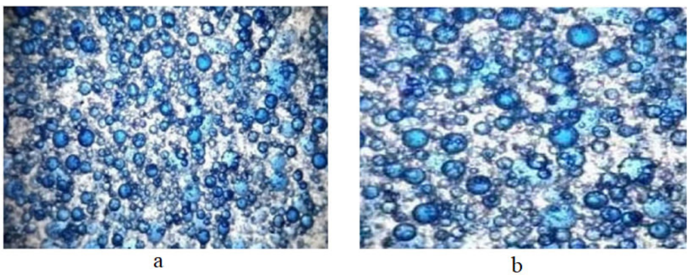

Figure 1: Water-in-oil (W/O) emulsion formed by diluting the concentrated solution obtained from the alcoholic extract of bitter almond at ratios of 1:1 (a) and 1:10 (b).

The phase reversal observed at a dilution ratio of 1:20, forming a Type I (O/W) emulsion (Figure 2), highlights the importance of proper dilution ratios to maintain the desired emulsion type (Iyer *et al*., 2015). This phenomenon indicates that beyond a certain dilution threshold, the emulsion undergoes a transition from water-in-oil to oil-in-water, which can affect its stability and performance. Understanding the specific dilution ratios that lead to phase reversal is crucial for optimizing the formulation and ensuring its consistency and efficacy in different dilution scenarios.

The milky colour and observed pH range in the diluted emulsions provide additional clues about the properties of the formulation. The presence of dispersed particles, indicated by the milky appearance, suggests the maintenance of a stable emulsion system even after dilution. Furthermore, the neutral to slightly alkaline pH range indicates the formulation's ability to maintain a suitable environment for its intended applications (Jianming *et al*., 2024; Xingjuan et al., 2023). These findings contribute to our understanding of the emulsion's dynamic nature and the need to consider its stability under different dilution conditions.

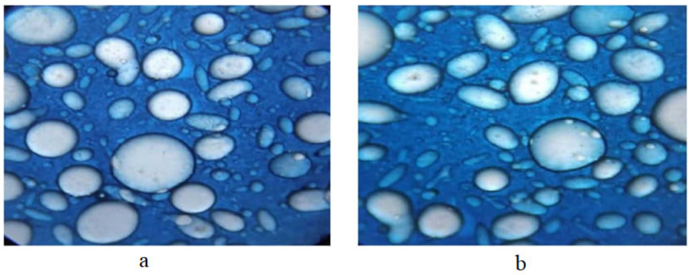

Figure 2: Formation of type I (O/W) emulsion occurs when the concentrated emulsion is subjected to dilution with bitter almond alcohol extract. When the concentrated emulsion is diluted at ratios of 1:20 (a) and 1:30 (b) the phase in the W/O emulsion changes to (O/W).

The results of centrifugation and thermal stability further offer important information regarding the formulation's resistance to external forces and temperature changes, which are relevant to its practical applications (Obaid *et al*., 2022). Centrifugation tests assess the emulsion's ability to withstand mechanical stress, simulating real-world conditions where the formulation may be subjected to agitation or mixing. Thermal stability tests, on the other hand, evaluate the formulation's ability to maintain its properties and stability under varying temperature conditions. Understanding the emulsion's response to these external forces and temperature fluctuations is crucial for ensuring its effectiveness and reliability in practical settings.

The evaluation of the diluted emulsions' acaricidal activity against *R. turanicus* ticks demonstrates their potential as acaricidal agents. The emulsion's ability to effectively combat ticks was evident through the significant acaricidal effects observed at a concentration of 0.05% (dilution 1:200) (Gupta *et al*., 2021). This highlights the efficacy of the emulsion in effectively destroying mites and controlling their populations.

The stability of the activity for four days suggests the formulation's prolonged effectiveness, indicating its potential for sustained control of mite infestations (Khamidov *et al*., 2019). This is a significant advantage, as long-lasting control measures are crucial in preventing mite re-infestations and reducing the risk of associated diseases.

Furthermore, the superior activity of the diluted emulsion compared to the conventional acaricide cypermethrin supports its potential as an alternative or complementary treatment option. The emulsion's effectiveness in combating ticks without the drawbacks associated with traditional chemical acaricides, such as toxicity and side effects, is a notable advantage (Patent "Insectoacaricidal composition", No. FAP 01611 RUz (Khamidov *et al.*, 2021). Additionally, the convenient dosage form of the emulsion makes it user-friendly and practical for application in various settings.

Field-based experimental investigations were carried out in the Kibray district of the Tashkent region throughout the month of May. The ambient temperature during these investigations ranged from 25 to 30 degrees Celsius. Emulsions with amygdalin concentrations varying from 0.05% to 1.00% were employed in the field experiments to eradicate cattle ticks. A total of five cattle specimens were utilized in the experimental procedures. Initially, the affected regions of the animals' integument were meticulously identified. Subsequently, the sites of tick accumulation were treated using a pulverizer for the emulsion application. After a period of one day, the integument of the animals was closely examined. Throughout the span of one week, the animals underwent daily examinations. Following this evaluation period, the effectiveness of the treatment was assessed. The data obtained indicated that under field conditions, the efficacy on the first day reached up to 50%, while subsequent days witnessed tick mortality rates escalating to 80%. This study was repeated twice and did not produce a single case of reinfestation. In addition, no changes in the physiological condition of the animals were recorded throughout the study. In addition, no cases of skin toxicity were reported in the subjects. A wide application of the drug in agricultural enterprises is currently planned.

The results of field studies conducted on the concentrated emulsion after dilution further validate its effectiveness against *Argas* ticks in real-world conditions (Alwan *et al.*, 2023). These studies provide valuable insights into the emulsion's performance and applicability in practical pest control scenarios. The successful translation of laboratory findings to field settings strengthens the evidence supporting the emulsion's potential as a viable solution for tick and mite control.

Overall, the advantages offered by the emulsion, including its low toxicity, absence of side effects, convenient dosage form, and demonstrated efficacy against mites, make it a promising candidate for tick and mite control. The pursuit of natural and environmentally friendly solutions for pest management is of growing importance, and the results of this study contribute to the expanding body of research in this field (Barakat *et al.*, 2022).

Tick saliva contains the enzyme, that hydrolysis of amygdalin in emulsion. It is assumed that prunasin is formed first, followed by benzaldehyde and cyanic acid, resulting in tick poisoning (Barakat *et al.*, 2022). This poisoning mechanism of ticks requires more detailed experimental confirmation. Looking ahead, future studies should aim to explore the mode of action of the emulsion, unravelling the specific mechanisms by which it exerts its acaricidal effects. Understanding the underlying processes will provide valuable insights for further optimization and refinement of the formulation. Additionally, investigating the emulsion's potential applications in larger-scale pest control efforts will be crucial for assessing its feasibility, scalability, and overall impact in the field (Gago-López *et al.*, 2021).

In the context of bitter almonds, the mean concentration of amygdalin is quantified at 40060.34 ± 7855.26 mg/kg (Lee *et al.*, 2013). The maximum concentration of amygdalin was recorded in Tangut almonds, exhibiting a range of 5.45-9.73 g/100 g (Wang *et al.*, 2022). Amygdalin functions as a down-regulator of oncogenesis within a specified dosage and plays a pivotal role in the attenuation of various malignancies in humans. Moreover, both in vitro and in vivo evaluations of amygdalin may prove to be instrumental in substantiating its pharmacological properties (Ayaz *et al.*, 2020; Shi et al., 2019). Analytical data indicate that amygdalin possesses pharmacological activities including antitumor, antifibrotic, anti-inflammatory, analgesic, immunomodulatory, and anti-atherosclerotic effects, while also enhancing the digestive and reproductive systems, ameliorating neurodegeneration and myocardial hypertrophy, and lowering blood glucose levels. Furthermore, research has demonstrated that the toxicity associated with amygdalin is attributable to its deleterious metabolic byproducts, benzaldehyde and hydrogen cyanide, following oral administration; notably, the toxicity associated with intravenous injection is substantially lower than that resulting from oral ingestion, which can be mitigated by an oral dosage of 0.6 to 1 g per day (He *et al.*, 2020). An incident of poisoning has been documented wherein the consumption of 40 bitter almond pits led to toxic manifestations. The consumption of significant quantities of bitter almond fruit results in severe adverse consequences (Arabizadeh *et al.*, 2024). Additionally, an instance of poisoning among children due to the ingestion of bitter almond fruit has also been recorded (Nader *et al.*, 2010). The above examples refer to the ingestion of bitter almond orally. However, treatment of animal skin surface with 0.05-1.0% emulsions based on alcoholic extracts of bitter almond is a safe means. Whereas known pyrethroids used for this purpose are toxic to both animals and the environment. Pyrethroid-based compounds are toxic poisons that disrupt the transmission of nerve impulses, resulting in paralysis and death of the insect. Large quantities of pyrethroids are released into the environment and also cause poisoning of service personnel. (Kurdyl et al., 2015).

CONCLUSIONS AND RECOMMENDATIONS

A concentrated emulsion based on an alcoholic extract of bitter almonds, emulsifier T-2, sodium salt of distilled fatty acids and sunflower oil is proposed as a promising insectoacaricide against ticks. For emulsions, qualitative and quantitative indicators have been determined (type of emulsion, particle size of the dispersed phase, resistance to mechanical stress and temperature). It has been established that diluted W/O emulsions have the best acaricidal properties against R. turanicus ticks (efficacy up to 75%). Highly diluted O/W emulsions have a lower acaricidal effect (up to 50%).

The emulsion demonstrated significant acaricidal effects, particularly at a dilution ratio of 1:200, effectively controlling *R. turanicus* ticks. The formulation exhibited stability over a four-day period, indicating its potential for sustained tick control. Compared to conventional acaricides, the emulsion offers advantages such as low toxicity, absence of side effects, and a convenient dosage form. Field studies further validated the emulsion's efficacy in real-world conditions against *Argas mites*. These findings contribute to the growing body of research on natural and environmentally friendly solutions for pest management. Further exploration of the emulsion's mode of action and scalability in larger-scale pest control efforts will pave the way for its wider application in tick and mite control strategies.

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NOVELTY STATEMENTS

Concentrated emulsions obtained from the alcoholic extract of bitter almonds represent a promising and environmentally sustainable acaricidal preparation, which serves as a real alternative to traditional pyrethroids in tick control. In this study, amygdalin was presented as the main active component of bitter almond emulsions, its dispersed phase, qualitative and quantitative characteristics were determined. In our study W/O type emulsions showed high insecticidal efficacy up to 75%.

AUTHOR'S CONTRIBUTIONS

Khakim Tukhtaev, Adolat Mirzaeva and Angela Ionică: Conceptualization, Writing- Original draft preparation, Supervision.
Firuza Akramova, Orifjon Khamidov, Ruziboy Shapaotov and Javokhir Esonboev Shoira Saidova: Methodology, Visualization, Investigation.
Adolat Mirzaeva: Data curation, Software, Validation.
Adolat Mirzaeva and Angela Ionică: Writing- Reviewing and Editing.
Kakali Bhadra: Writing and editing.

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Data Availability

All relevant data is enclosed within the manuscript.

Code Availability

Not applicable.

Ethics Approval and Consent to Participate

Not applicable.

Consent for Publication

Not applicable.

Conflict of Interest

The authors declare no competing interests.

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