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Study of Mineral Composition of Artemisia Herba-alba and its Bio Insecticidal Properties

Hayat Elwardani [1], Asmaa Oubihi [1], Sara Haida [2], Hassna Jaber [1], Abdessamad Ettouil[1], Hanaa Figuigui [1], Hefdhallah Al- Alaizari[3], Abdrrahim Benzkour [1], Mohammed Ouhssine [1]

[1]Laboratory of Natural Resources and Sustainable Development, Department of Biology, Faculty of Science, Ibn Tofail University, Kenitra Po Box 133-14000, Morocco
[2]Laboratory of Advanced Materials and Process Engineering, Department of Chemistry, Faculty of Science, Ibn Tofail University, Kenitra Po Box 133-14000, Morocco
[3]Department of Chemistry, Faculty of Education, University of Dhamar, Yemen

Abstract

Artemisia, a genus widely known for its medicinal and agricultural applications, has received attention for its potential in integrated pest management and nutritional supplementation. This study investigates the mineral composition of Artemisia Herba-Alba and evaluates its insecticidal effectiveness at various concentrations and durations during April, June, and October of 2022. The results indicated a slight increase in Aluminum (Al) over time, while Calcium (Ca), Potassium (K), and Magnesium (Mg) showed significant upward trends, with Mg reaching its peak in October. Sodium (Na) levels decreased, whereas Iron (Fe) consistently rose. Trace minerals experienced minor fluctuations; Cadmium (Cd), Cobalt (Co), and Chromium (Cr) declined, whereas Copper (Cu) and Manganese (Mn) saw notable increases. Nickel (Ni) and Lead (Pb) remained stable, with Zinc (Zn) exhibiting a gradual rise. Initially, the insecticide's efficacy was low; improving substantially 24 hours and 48 hours post-application, with effectiveness at 48 hours, increasing from 33% to 93% as the concentration rose from 1000 to 10000 PPM. The data suggest that potency escalates over time, underscoring that higher concentrations and extended exposure enhance insecticidal effectiveness. The progressive improvement over subsequent months hints at potential changes in insect behavior or susceptibility. These findings illuminate the dynamic nature of Artemisia Herba-Alba's mineral composition and its relationship with insecticide performance, underscoring the influence of concentration, exposure duration, and potential ecological adaptations.

Keywords: Artemisia Herba-alba Mineral Composition; Insecticidal Properties; Environmental Influence

Full length article **Corresponding Author*, e-mail: alaizari2@gmail.com

1. Introduction

Plants are a key source of many drugs used for treating pain (like morphine), cancer (such as vincristine), infections (e.g., penicillin), and heart diseases (e.g., warfarin) [1]. In regions with limited access to healthcare, traditional plant-based medicines are vital. Plants produce a wide range of complex chemicals, offering significant health benefits. These compounds enhance the flavor and aroma of plant-based foods and drinks, which are often utilized as "nutraceuticals" for disease prevention and treatment [2], [3]. The potential of plant extracts as innovative nutraceuticals and functional foods is increasingly recognized and explored [4]. Despite the vast potential of plants for medical use, many of the estimated 350,000 vascular plant species remain unexplored for drug discovery due to legal and logistical challenges. Furthermore, the complex and costly processes of isolating active compounds deter pharmaceutical companies and government agencies from investing in research on medicinal plants [5]. Identifying active compounds in plants involves medicinal plant examination and bioactive compound extraction, with notable advances in extraction, purification, and isolation techniques. Conventional solvent extraction is preferred for its simplicity and effectiveness, utilizing solvents of varying polarities to extract different phytochemicals. Polar solvents extract phenolics and derivatives, whereas non-polar solvents are used for fatty acids and steroids [4], [6]. Numerous studies have highlighted how the choice of solvent affects the range of secondary metabolites extracted from plants and their biological activities [7-11]. Therefore, selecting the right extraction solvents and techniques is crucial for maximizing the biological effectiveness of plant-derived compounds. Comparative studies of extracts from the same plant obtained using different solvents are instrumental in this context. About 60% of the world's population uses herbal extracts for health care, with the genus Artemisia, especially Artemisia Judaica L. (known as Artemisia or Artemisia baladi in Arabic), occupying a prominent place in traditional medicine throughout the Arab region [12-14]. The Artemisia genus, recognized for its broad spectrum of bioactive compounds, including terpenoids, phenols, and flavonoids, offers promising health benefits, particularly in cardiovascular and metabolic health. Research indicates Artemisia species possess anti-diabetic, anti-obesity, and cardioprotective properties. These are attributed to phytochemicals targeting multiple molecular pathways, making Artemisia a potential therapeutic candidate for metabolic syndrome management. Studies underscore its role in enhancing antioxidant, anti-inflammatory, and immunomodulatory activities, supporting its use as dietary supplements and functional foods. The exploration of Artemisia's health benefits, including its impact on cardiovascular well-being, highlights the need for further clinical research to validate its efficacy and safety as a natural health-promoting agent [15-17]. The study aims to analyze the mineral composition of Artemisia Plant and assess their insecticidal properties, focusing on how different minerals are concentrated within the plants and how these concentrations affect the plants' effectiveness as bioinsecticides.

2. Materials and Methods

2.1. Artemisia Herba-alba

Artemisia Herba-alba specimens tested were harvested from Morocco's Taliouine region in April (4), June(6), and October(10) of 2022.The aerial parts of the plant of Artemisia Herba-alba were dried in a shaded, dry area and aired out at a room temperature of 25°C for two weeks. The dried plant material was then ground into a powder using a Waring type electric grinder a commercial blender designed to pulverize the plant material. This powder was sifted through a 0.5 mm mesh sieve to achieve a fine, uniform granule size. The resulting powder was stored in airtight glass jars in a location protected from light and moisture.

2.2. Inductively Coupled Plasma ICP-OES

The mineral content of Artemisia Herba-alba was determined using ICP-OES. A 500 mg powdered sample was mixed with 3 mL of 65% nitric acid and 3 mL of 37% hydrochloric acid, agitated for 90 minutes, and then heated to 105 °C until it liquefied. The solution was diluted with 50 mL of distilled water, settled, and homogenized. The supernatant was analyzed in triplicate via ICP-OES to identify the mineral composition [18-21].

2.3. Aphid insect

The rearing of aphid insects was carried out under laboratory conditions, a temperature of 25 ± 2 °C, a relative humidity of 75% and a photoperiod of 14/10 h light/dark. The selection principle consists of infesting bean plants of the sensitive Defes variety at a less advanced vegetative stage (fourth node stage), in entomological breeding cages.

2.4. Insecticidal Activity

The methodology outlined by Rashedi et al. was utilized for conducting this experiment. Black aphids (Aphis fabae) were cultured in a regulated lab setting, maintaining specific environmental conditions. The contact toxicity assessment was performed in a laboratory environment set to a temperature of 25 ± 2 °C, with a relative humidity of 75%, and a light/dark cycle of 14/10 hours. Five concentrations of each oil (0.01%, 0.02%, 0.03%, 0.05%, and 0.10%) were applied directly using a 30 ml spray bottle. Larvicidal trials were conducted on the first three larval stages: Month 4, Month 6, and Month 10 .A fully randomized design with five replicates was implemented, including a control group treated with water and 0.01% Triton X-100, an emulsifier used to mix distilled water with oil. Mortality rates were calculated after exposure times of 1, 2, 3, 4, 24, and 48 hours. Each concentration was tested in four replicates. The mortality percentage for each replicate, for both control and treated larvae, was calculated using the following formula: Mortality rate (%) = (Number of deaths / Total number of individuals) × 100. The observed mortalities were then corrected using Abbot's formula (1925), taking into account the natural mortality observed in the control lots, according to the equation: $Mc = ((M2 - M1) / (1 - M1))$, where M1 is the percentage of mortality in the control lot, M2 is the percentage of mortality in the treated lot, and Mc is the corrected mortality percentage [22].

2.5. Statistical Analysis

The significance of the effects from various treatments was evaluated using an analysis of variance, performed with Minitab 22 software.

3. Results and discussion

3.1. Mineral Analysis

Table 1 presents a detailed summary of the mineral element concentrations in Artemisia Herba-Alba, quantified at varied dosages across several time within months 4, 6, and 10. The data reflects an increasing trend in element concentrations corresponding to higher doses and extended time frames, highlighting the dynamic accumulation of minerals over the observed period. Figure 1 shows the concentration of minral metals over three months: month 4, 6, and 10,, Artemisia Herba-alba exhibited varying mineral concentration trends. Aluminum (Al) rate slightly by 0.85%. Calcium (Ca) saw a notable increase of 29.12%, with most gains in the first two months. Potassium (K) surged by an impressive 120.15%, primarily between Months 4 and 6. Magnesium (Mg) increased significantly by 78.27%, while Iron (Fe) grew steadily by 14.42%. In contrast, Sodium (Na) decreased by 21.19%, with the most significant drop early on. These trends indicate that while most mineral concentrations tend to increase, sodium uniquely diminished, perhaps due to environmental or developmental factors influencing the plant's nutrient assimilation. Potassium's remarkable ascent points to a robust uptake mechanism or external supply spike, and the minimal fluctuation in aluminum suggests a relatively consistent availability or uptake rate of this element within the plant system. Figure 2 shows the concentration of heavy metals over three months: month 4, 6, and 10, Artemisia Herba-alba showed distinct trends in metal concentration. Concentrations of cadmium (Cd) and cobalt (Co) decreased by 8.33% and 13.27%, respectively, with cobalt having the greatest decrease. Chromium (Cr) also saw a marginal decline of 3.80%. Conversely, copper rose 24.59%, with strong gains initially and smaller gains later. Manganese (Mn) had the most pronounced increase of 92.75%, doubling its concentration by the sixth month. Nickel (Ni) decreased by 9.37%, indicating steady declines. Lead (Pb) achieved overall growth of 12.83%, with a notable increase between months 4 and 6. Zinc (Zn) also increased by 24.39%, with steady growth over the months. These changes reflect a pattern in which some minerals accumulate while others are depleted, perhaps due to plant developmental stages or environmental factors that influence absorption and storage. Research conducted by Korablova et al. (2023) for Artemisia annua L., A. ludoviciana Nutt., and A. austriaca L., which reveals the macro- and microelements present in these plants, showing great variation influenced by their ability to absorb and accumulate elements from the soil. This variability is consistent with the statistical analysis presented, where elements such as calcium (Ca), potassium (K), and magnesium (Mg) showed a wide range of concentrations across different Artemisia species, suggesting a complex interaction with environmental conditions and genetic factors influencing mineral absorption and accumulation [23]. Moreover, the research by Wei Ji-qing (2008) into the mineral content of Artemisia annua L. leaves supports the statistical analysis, highlighting the abundance of macro elements such as P, K, Ca, and Mg, and microelements such as Fe, Mn, and Mg. Zinc. This study also indicates low levels of heavy metal elements, which is consistent with what was reported in this study indicating relatively narrow ranges for potentially toxic elements such as cadmium (Cd) and lead (Pb), confirming the ability of the species to regulate the absorption of harmful substances [24]. Minerals like Calcium (Ca) show narrow concentration ranges, indicating a consistent uptake across species, unlike Potassium (K) which varies widely due to environmental factors. Low mean concentrations of Cadmium (Cd) and Lead (Pb) highlight their trace presence, whereas higher averages of Calcium (Ca) and Potassium (K) underscore their essential roles. The variability in elements like Potassium (K) suggests adaptability to environmental conditions. Conversely, stable concentrations of certain elements imply a basic physiological need. The presence of trace elements such as Cadmium (Cd) and Lead (Pb) poses ecological and health concerns, especially for medicinal use, underscoring the interaction between genetic traits and environmental influences in Artemisia species.

3.2. Insecticidal Activity

Table 2 shows the insecticidal activity of a substance at different concentrations (1000, 2000, 3000, 5000, and 10000) of Artemisia Herba-alba extract over different time periods (1 hour, 2 hours, 3 hours, 1 hour, 2 hours, 3 hours, 24 hours and 48 hours) and three months (4,6, and 10). The effectiveness of an insecticide across three different months (4, 6, and 10). The various concentrations and time intervals reveal of increasing insecticide effectiveness with time across all concentrations and months. In all cases, the effectiveness at 1h and 2h is generally low, often 0%, with a significant increase by 24h and 48h.In month 4, we observe a gradual increase in effectiveness from 33% at 1000 PPM to 80% at 10000 PPM over 48 hours. Month 6 shows a similar pattern, with effectiveness rising from 47% at 1000 PPM to 80% at 10000 PPM by 48h. Month 10 continues this trend, demonstrating increased effectiveness ranging from 53% at the lowest concentration to 93% at the highest concentration by 48h.When comparing the same dose and time interval across the three months, there are notable differences in insecticide performance. For instance, at 3000 PPM and 48h, the effectiveness is 33% in month 4, 60% in month 6, and 80% in month 10. This indicates that the insecticide's effectiveness is increasing with subsequent months. At the 1h, 2h, and even at 3h mark, the insecticide shows little to no effectiveness across all months and doses, with few exceptions. By 24h and 48h, the effectiveness has increased significantly in all months, with month 10 showing the highest effectiveness at the 48h mark across all concentrations (Figure 3:a, b, and c). The effectiveness of the insecticide at the specified concentration and time. For example, at a concentration of 1000, the insecticide has no effect in the first 3 hours, but shows 13% activity after 24 hours during the month of four and sixteen, while the mortality rate increases to 53% after 48 hours. This trend of increasing mortality efficacy over time and with higher concentrations is consistent throughout the scale, peaking at 93% efficacy at the highest concentration of 10,000 after 48 hours in month 10. Comparing the insecticidal efficacy of Artemisia Herba-alba extract against aphids across different studies, we observe a consistent trend confirming the powerful insecticidal properties of Artemisia extracts. Ahmed et al. (2020) demonstrated that Artemisia argyi extract exhibited significant toxicity to Brevicoryne brassicae, an aphid species, with increasing mortality rates corresponding to higher concentrations and prolonged exposure times[25]. This aligns with the described trend of increasing efficacy with higher concentrations and over time. Specifically, A. Argy extract showed a maximum mortality of 55.50% at a concentration of 20 mg/L after 72 hours of exposure, indicating a dose-dependent and time-dependent insecticidal activity, similar to the results presented in the initial query about Artemisia plant extract's efficacy against aphids over time. Furthermore, the study by Zibaee and Bandani (2010) on Artemisia annua extracts against sunn pests also highlighted a dose-dependent mortality rate, underscoring the broad spectrum of Artemisia extracts' insecticidal potential across different aphid species and insect pests. The extracts were found to be more lethal in combinations than singly, suggesting a synergistic effect that could be leveraged for pest control purposes [26].

Table 1. Concentrations of Mineral Elements in Artemisia Herba-Alba across Different Months (4, 6 and 10).

Variable	Month 4	Month 6	month 10
Al	76,17	76,54	76 ,82
Ca	755,9	923,6	976
K	617,3	1339	1359
Mg	84,48	103,5	150,6
Na	550,3	436,8	
Fe	33,22	35,08	38,01
Cd	0,12	0,113	0,11
Co	0,113	0,11	0,098
Cr	0,79	0,779	0,76
Cu	1,704	2,066	2,123
Mn	2,357	4,211	4,543
Ni	0,331	0,302	0,3
Pb	0,265	0,298	0,299
Zn	1,525	1,776	1,897

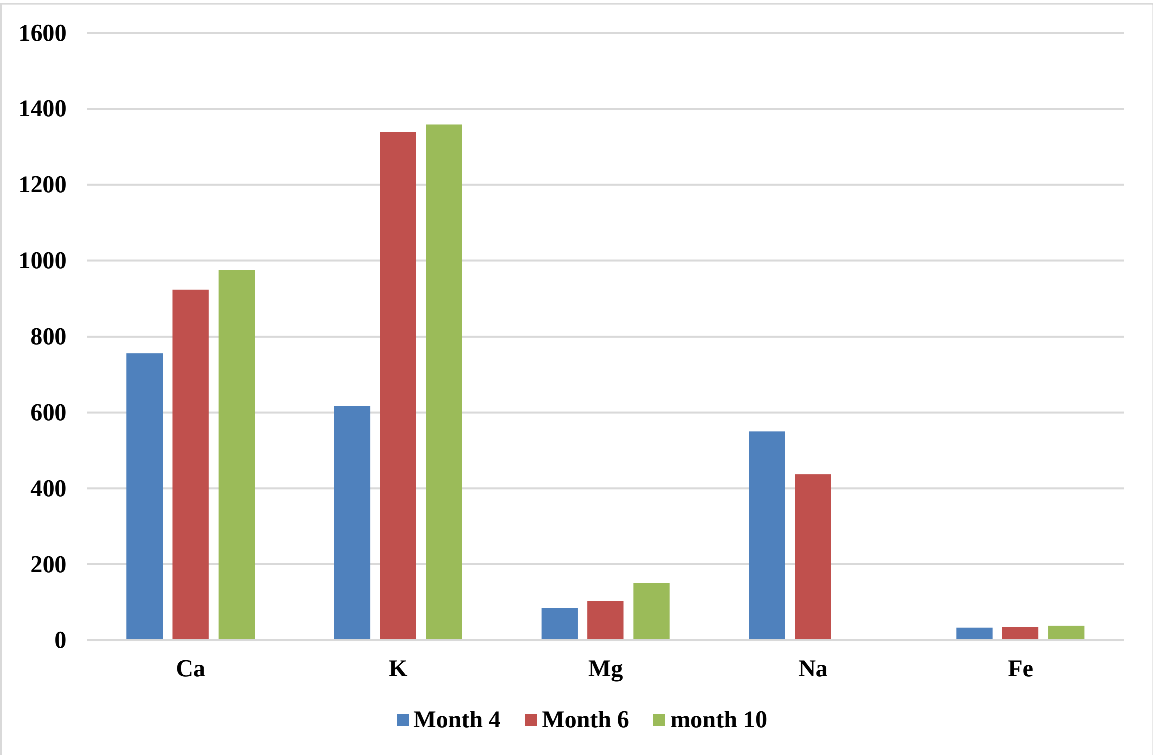

Figure 1. Concentration of minerals of Artemisia Herba-alba

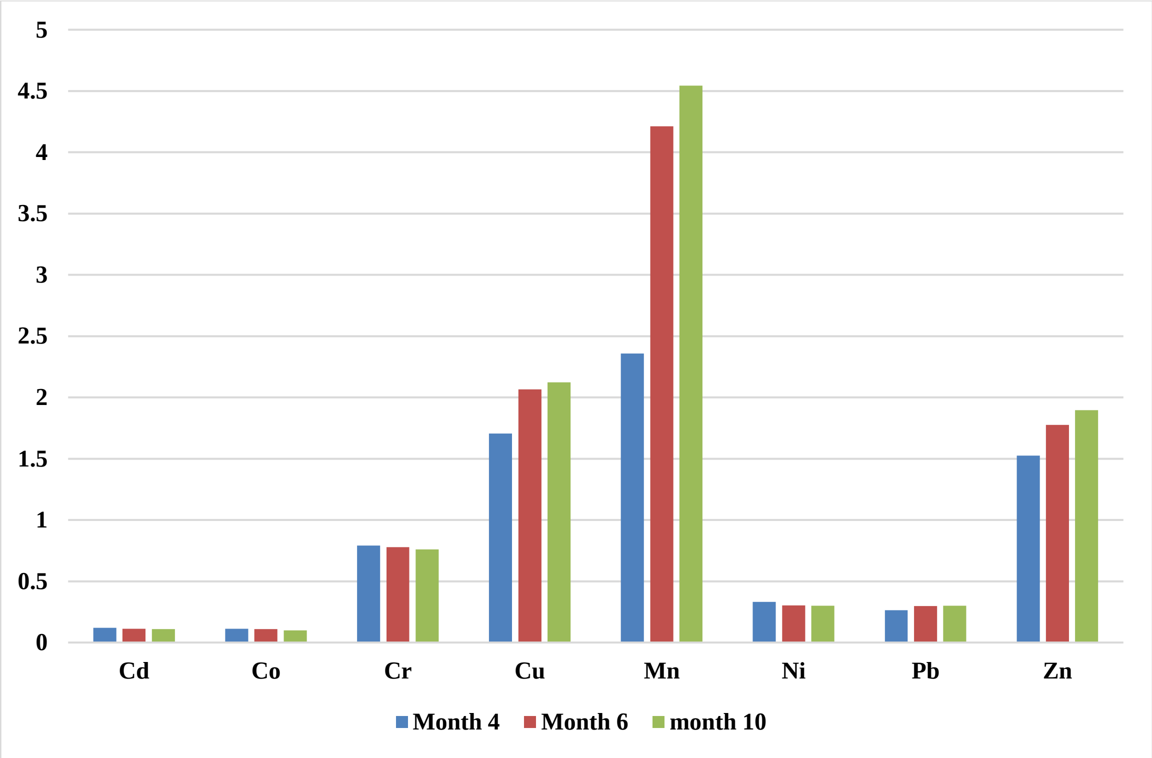

Figure 2. Concentration of heavy metals of Artemisia Herba-alba

Table 2. The effectiveness of an insecticide across three different months (4, 6, and 10)

Time	1h	2h	3h	24h	48h
Dose (PPM)		**Month 4**			
1000	0%	0%	0%	0%	33%
2000	0%	0%	0%	13%	20%
3000	0%	7%	7%	20%	33%
5000	0%	7%	7%	7%	20%
10000	0%	13%	20%	33%	33%
Dose (PPM)		**Month 6**			
1000	0%	0%	0%	7%	47%
2000	0%	0%	0%	7%	53%
3000	0%	0%	0%	20%	60%
5000	0%	0%	7%	20%	73%
10000	0%	0%	7%	40%	80%
Dose (PPM)		**Month 10**			
1000	0%	0%	0%	13%	53%
2000	0%	0%	0%	27%	73%
3000	0%	0%	0%	33%	80%
5000	0%	7%	7%	47%	87%
10000	0%	7%	13%	60%	93%

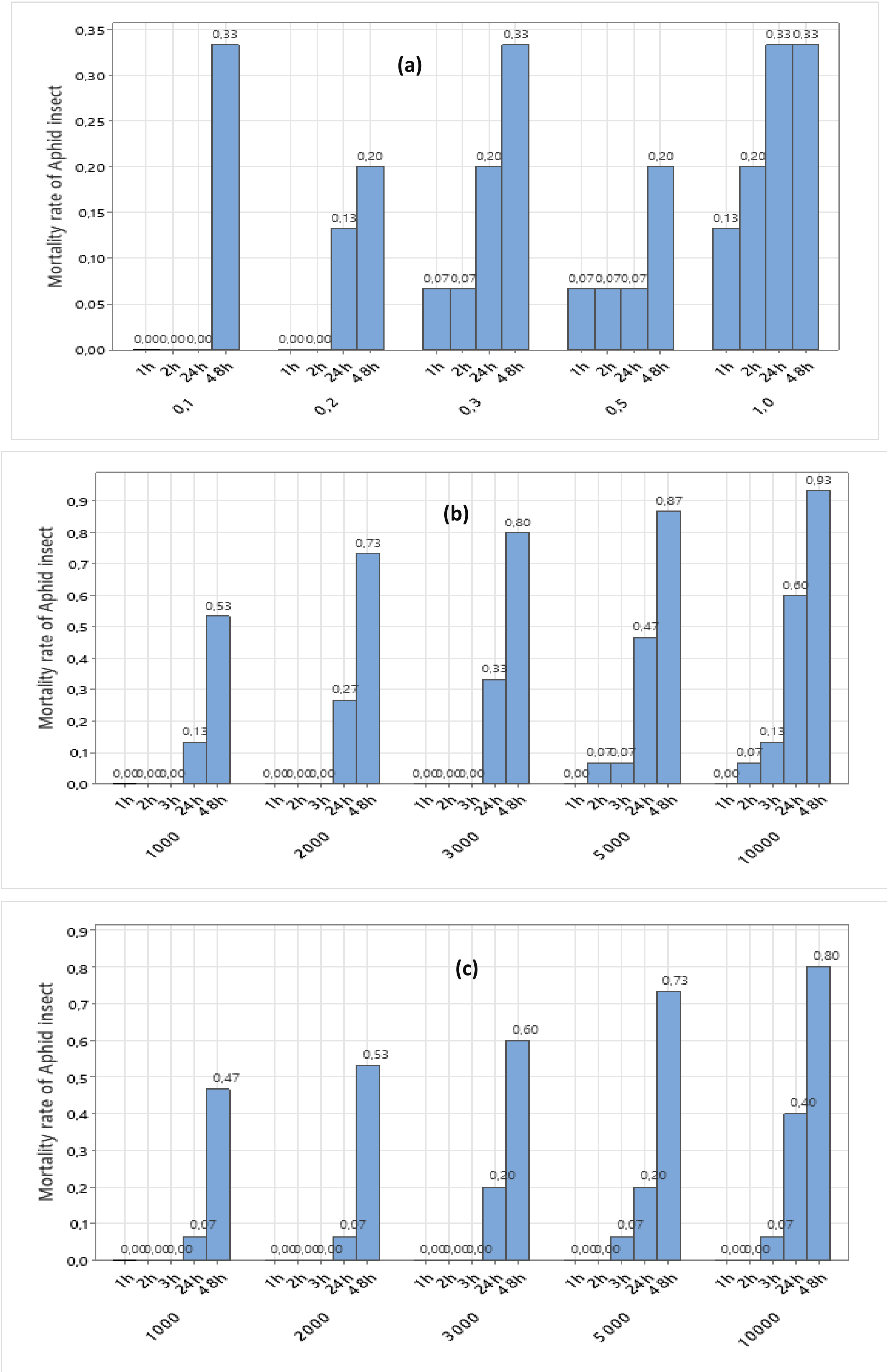

Figure 3. Mortality rate of Aphid insect through (a) month 4, (b) month 6 and (c) month 10

The effectiveness of the insecticide depends on times and concentrations, with much higher effectiveness observed at higher concentrations and over longer exposure periods. There is clearly no noticeable insecticidal activity in the first hour at any concentration, and very limited or no activity during the first three hours for lower concentrations.

4. Conclusions

Study of Mineral Composition of Artemisia Herba-alba and its Bio Insecticidal Properties between 4, 6 and 10 months. The study revealed that the Artemisia Herba-alba contains essential nutrients such as calcium and potassium in high concentrations, which indicates their importance in plant structure and metabolic functions, with differences in the levels of iron and magnesium in addition to heavy metals indicating environmental influences. The insecticidal activity of wormwood extract has been shown to be concentration and time dependent, with maximum efficacy at higher concentrations and longer exposure times. This indicates the potential of Artemisia Herba-alba as an effective bio-insecticide, with time varying.

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