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EVALUATION OF EFFICIENCY OF SOME PLANT EXTRACTS AGAINST PATHOGEN *VAIRIMORPHA(NOSEMA) CERANAE* INDIGESTIVE OF HONEY BEES

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ABSTRACT

This study aimed to evaluate the effectiveness of some plant extracts of yerba mate *Ilex paraguariensis* and *Cinnamonum cassia* against the pathogen *Vairimorpha* (*Nosema*) *ceranae* in the digestive system of workers of the global honey bee *Apis mellifera* L. at different concentrations, and showed The results of the laboratory study showed that the alcoholic extract and powders of mate and cinnamon plants at concentrations of 1, 2, and 3% were efficient concentrations and had no side effects on bees. The alcoholic extract of mate at a concentration of 3% was more efficient than the rest of the other concentrations and reached 2070, 1980, 1730, 1390,1080 and 70 x 10^3 spores / ml respectively with a reduction rate of 97%, The alcoholic cinnamon extract, at a concentration of 3%, was more efficient than the other concentrations, reaching 2600, 2350, 2260, 2190, 1750, 1390, and 1140 x 10^3 spores/ml respectively with a reduction rate of 56% after 1,3,7,14,21, and 28 days respectively. Yerba mate powder at a concentration of 3% was more efficient than the rest of the other concentrations, which reached 2470, 2240, 2080, 1750, 1460, and 1020 x 10^3 spores / ml respectively with a reduction rate of 61%, and cinnamon powder at a concentration of 3% reached 2530, 2440, 2280, 2050, 1920, and 1810 x 10^3 spores/ml respectively with a reduction of 33% after 1,3,7,14,21, and 28 days respectively.

Key words: **Mate Plant , Cinnamon plant, Bee diseases.**

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INTRODUCTION

Honey bee, *Apis mellifera* L., is one of the important economic insects around the world due to its great importance to humans, ecosystems, and the stability of environmental diversity. It is the main insect that humans can control and raise, in addition to the fact that this insect is of great importance and is responsible for 90% of pollination. The mixture of many agricultural crops that are economically important to humans through their activity in collecting nectar and pollen, because bees are natural pollinators that contribute to improving the quality and quantity of production of these crops, trees, and jungles, as well as wild plants and others (Al-Baghdadi and Sadiq,2023; Awwad and Shaher,2023).Honey bees live in high population densities and the presence of food, as well as the decrease in immune genes associated with immune function compared to solitary insects, makes them a target for many, but bees have developed their own defense methods at the individual and group levels in providing protection from pathogens and parasites, providing growth factors, and increasing immunity (Hamed et al., 2016, Najm and Al-Jassany,2023).A variety of reasons have contributed, including nutritional stress due to lack of suitable pasture, the widespread use of chemical pesticides, changes in climate conditions, and infection with various pests and pathogens. All of these conditions, whether individually or in

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combination, lead to the destruction of bee colonies and the weakening of the immune system (Dagher and Shaher,2023). Nosemosis is one of the deadly diseases that has recently spread throughout the world in apiaries, especially in cold areas with heavy rain. Due to these conditions, the bees are unable to go out in these climates, so they remain inside the hive, which helps the disease to worsen and increase its harm to the bees (23). The disease is caused by the fungus *Vairimorpha ceranae* (formerly *Nosema*), which is known as the silent killer. It is a fungus that infects bees and reproduces by spores, which enter the bees' intestines after they swallow food contaminated with the spores to invade the cells of the epithelial tissue of the middle stomach, leading to the destruction of the cells and then spreading the spores to the rest of the stomach. Bee individuals through waste, which results in the spread of infection among honey bees and leads to a shortening of the average lifespan of worker bees and a decrease in bee productivity, and affects the immune system of the bees, which leads to a decrease in brood and worker numbers and the colonies are exposed to major losses (2,23).The disease was recorded for the first time in Iraq in 2018 and was diagnosed using traditional and molecular methods, and the infection rate was 50-100% (12). Plant extracts were used to treat diseases that affect living organisms. The compounds and active substances present in these plants were identified and their mechanism of action was discovered against microorganisms that cause diseases in humans, animals and plants. The reason for the effectiveness of these compounds is that they contain natural or environmentally friendly compounds, and that essential oils do not It causes toxic and negative effects on the growth of honey bee colonies and contributes to the elimination of toxic residues in honey bee products (14,28). It can also be used effectively and safely as an alternative to chemical pesticides and manufactured antibiotics, as many of them have been tested in combating pathogens that affect bees, including the pathogen *Vairimorpha ceranae* (23). In view of the recent spread of the pathogen *Vairimorpha ceranae* in a number of governorates in Iraq and causing many deaths in honey bee colonies, and for the purpose of searching for alternatives to chemical pesticides to combat the disease that are safe for honey bees and to find an effective control method, the study aimed to: Evaluating the efficiency of *Ilex paraguariensis* yerba mate extract and powder and *Cinnamomum cassia* at different concentrations to control the pathogen *Vairimorpha ceranae* in the laboratory causes death to members of the honey bee colony.

MATERIALS AND METHODS

The mate plant was obtained from local markets in the form of (leaves) packed in 500-gram carton bags, imported from the State of was carried out in the plant extracts laboratory Syria, and the cinnamon plant was obtained from local markets in the form of (bark pens) imported from the State of China, and the method of (Porrini et al.,2011) was adopted. The extraction of the Agricultural Protection Department / Ministry of Agriculture. The glassware used in the extraction process was washed with distilled water and sterilized in an electric oven at a temperature of 160°C for one hour. (100 grams) of the ground plant (yerba mate, cinnamon) were weighed each Stamp it and place it in a 1-litre glass beaker, then add 500 ml of 99% ethyl alcohol to it, and place the beaker with its contents in the mobile incubator for 24 hours at a temperature of 35°C. After completing the incubation, the contents of the beaker were placed in tubes and placed in a centrifuge at a rotation speed of 2500 rpm for 10 minutes.Then the mixture was filtered using filter paper, the liquid, leave the sediment, were takin then put in the solution. Use the Rotary Vacuum Evaporator at a temperature of 50°C and a rotation speed of 30 revolutions / minute used to evaporate the filtrate and obtain a thick liquid. For the purpose of drying the liquid, it is placed in glass containers at room temperature for 4-5 days until the liquid evaporates and turns into a soft dough. They were stored in opaque glass containers in the refrigerator at a temperature of 4°C until use (Porrini et al.,2011).

Preparing the plant extracts for laboratory experiments: The stock solution was prepared from plant extracts (yerba mate, cinnamon) by

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dissolving 2 g of the dried extract in 20 ml of ethyl alcohol. The required concentrations (1%, 2%, 3%) of yerba mate were prepared, and cinnamon.

Preparing wooden cages to conduct laboratory experiments: The wooden cages (42cages) with dimensions of 20 x 20 x 20 cm conducted. The front side of the cage is made of glass. The bees are removed through it by raising the glass to the top. The back side is made of wood containing holes 1 mm in size. The sides are made of wood and the top side is made of wood that can be closed and opened as shouwn in figure(1). It is inserted into The bees pass through it and it contains an opening for the purpose of administering solutions through it for various treatments.

Conducting artificial infection of caged bees

Artificial infection of bees confined inside wooden cages was carried out for the purpose of studying the effect of different treatments on the pathogen *Vairimorpha ceranae* and providing food contaminated with spores of the pathogen to the trapped workers. A known number of 20 x 10^6 spores/ml was used to cause infection, and to ensure that infection occurred to the workers in all cages. The study took place three days after infection occurred. A sample (5 workers) was taken from each box and examined microscopically. The experiment was carried out under laboratory conditions at a temperature of 25-35 °C and a relative humidity of 65-75%.

Evaluating the efficiency of different concentrations of plant extracts and powders in laboratory experiments: For the purpose of studying and evaluating the efficiency of 1, 2, and 3% concentrations of alcoholic extracts and powders of plants (yerba mate, cinnamon) to reach the best concentration in controlling the pathogen for the purpose of applying it in the field in subsequent experiments. The cages were divided into groups (each group had 3 cages representing 3 replicates of each treatment, and each cage contained 100 ± 5 workers) and were as follows:

1.Mate extract in three concentrations (1,2,3) % with sugar solution
2.Cinnamon extract in three concentrations (1,2,3)% with sugar solution.
3.Mate powder in three concentrations (1,2,3) % with sugar powder.
4.Cinnamon powder in three concentrations (1,2,3)% with diabetes powder.
5.Comparison (sugar solution).
6.Comparison (sugar powder).

The sugar solution was prepared with a ratio W/V of (1K sugar : 1L water) to be used in treating alcoholic extracts, and powdered sugar was prepared using a small home electric grinder to be used in treating plant powders in different concentrations.=

Figure1.Cages used to feed honey bees with sugar solution treated with plant extracts

Treatment using plant extracts and powders: The workers were treated with different treatments by feeding them with the treated sugar solution at different concentrations. Different concentrations (2)% of the extracts mixed with the sugar solution were given in equal quantities of the solution (50 ml/cage) through the holes at the top of the box for each treatment, where a 10 ml syringe was placed and inserted.There is a thread in it

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to deliver sugar solutions with extracts to the bees inside the cages. As for the powders, they were mixed with powdered sugar (50 ml /cage) and placed in Petri dishes and provided to the bees inside the cages in different concentrations and in equal quantities for all dishes. For the purpose of evaluating the efficiency of the different treatments in reducing the number of spores of the pathogen, the number of spores was counted before the treatment and calculated after of treatment 1, 3, 7, 14, 21, and 28 days by taking 5 workers from each replicate, and the numbers of dead workers in the cages were calculated during different time periods and for different treatments.

Statistical analysis

Laboratory experiments were designed using a completely randomized design (CRD), and the results were compared using the Least Significant Difference (LSD) test at the 5% level (3), and the results were analyzed using the statistical program Genstat 12.1.

RESULTS AND DISCUSSION

The efficiency of plant extracts to suppression of the pathogen *Vairimorpha ceranae:* The results of laboratory evaluation of plant extracts at different concentrations showed an effective effect in killing the spores of the pathogen *V.ceranae* and gradually reducing the numbers of spores as the treatment time progressed compared to the increasing numbers of spores in the comparison treatment.Statistical analysis demonstrated the presence of significant differences between the numbers of spores in infected workers. It is clear from Table (1) that the yerba mate extract (*Ilex paraguareinsis*) was significantly superior to the cinnamon extract (*Cinnamonum cassia*) at a concentration of 3% and to the rest of the other concentrations and led to a reduction in the number of spores of the pathogen in infected workers as it reached (2070, 1980, 1730, 1390, 1080, 70) × 10^3 spores / ml, with a reduction rate of 97% after 28 days, and the two concentrations (1%) and (2%), reaching (2580, 2360, 2140, 1790, 1580, 130) and (2360, 2150, 2060, 1440, 1370, 120) x 10^3 spores / ml respectively after 1,3,7,14,21 and 28 days after treatment, with a reduction rate of 95% and 95%. When treated with the extract of the students, statistical analysis showed significant differences between the numbers of spores at concentrations of (1%), (2%), and 3%, as they reached (2670, 2550, 2430,2360,2290,2200) and (2580, 2500, 2270 ,1850, 1770,1500) and (2350,2260,1390,1140, 1750, 2190) x 10^3 spores/ml after 1,3,7, 14,21 and 28 days after treatment, and the reduction percentage reached 20%, 44% and 56%, respectively. Based on the results of the plant extracts, the mate extract 3% and the cinnamon extract 3% were filtered and used in field experiments because they are efficient concentrations in controlling the number of spores of the pathogen and did not kill all worker bees in laboratory experiments. The leaves of the yerba mate plant contain high concentrations of phenolic compounds, tannins, flavonoids, phenolic acids, caffeine, and caffeoylquinic acids, Caffeine, theobromine, and theophylline are alkaloids present.In the leaves of the yerba mate plant, the amount of Caffeine is 1-2% and the percentage of theobromine is 0.9-0.3 (7). indicated that mate extract at a concentration of 1% led to a reduction in the severity of the pathogen *Vairimorpha ceranae*, as it was safe for bees and led to the survival of the workers after 15 days of treatment(20). Caffeine found in some plants in small concentrations reduces the severity of infection with the pathogen *Vairimorpha* (*Nosema*) *ceranae*. The yerba mate plant contains biologically active compounds against parasites and bacteria harmful to human health, including Salmonella Spp. (9, 30).Cinnamon extract has an effective role on the pathogen *Vairimorpha cearnae* and leads to reducing its numbers in the digestive system of honey bee workers. The compound cinnamaldehyde, which has a high percentage in cinnamon, plays a more effective role than other existing compounds and has led to a reduction in the number of spores of the pathogen *V.ceranae*, reaching 16.2 × 10^6 When infection was carried out with 10,000,000 spores and the reduction rate reached 24.4%, the death rate of worker bees was 7.64% (4,13,18,17,22). A study showed that when cinnamon was used at a concentration of 6 grams to combat

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Vairimorpha cearnae, the reduction rate reached 55%, compared to wormwood at a concentration of 4 grams, where the reduction rate reached 50%. Likewise, when used with the antibiotics Flagyl at a concentration of 6 ml and Septazol at a concentration of 3 and 6 ml, the reduction rate reached 50 and 32 and 39%, respectively, and in a laboratory study conducted by Hadi and Al-Jassany (12) using alcoholic extract and nettle powder in low concentrations, which leads to reducing the severity of infection by the pathogen *Vairimorpha ceranae* and was safe for worker bees during Transaction period.

Table 1.The reduction in numbers of spores of the pathogen *Vairimorpha ceranae* when treated with different concentrations of plant extracts after successive time periods of treating honeybee workers under laboratory conditions

Treatments	Before treatment	Number of spores x 10^3 (spores/ml) after treatment						Reduction percentage %
		day 1	3 day	7 day	14 day	21 day	28 day	
Extract mate 1%	2650	2580	2360	2140	1790	1580	130	95
Extract mate 2%	2700	2360	2150	2060	1440	1370	120	95
Extract mate 3%	2680	2070	1980	1730	1390	1080	70	97
Extract cinnamon 1%	2760	2670	2550	2430	2360	2290	2200	20
Extract cinnamon 2%	2680	2580	2500	2270	1850	1770	1500	44
Extract cinnamon 3%	2600	2350	2260	2190	1750	1390	1140	56
Control	2700	2800	3450	4070	4540	5080	5630	
Mean of days	2681	2481	2476	2400	2116	1993	1543	
l.s.d.05 of days	117.9							
Mean of treatments	1776	2108	4039					
l.s.d.05 of treatments	96.2							
l.s.d.05 Interaction	180.0							

The efficiency of plant powders to suppression of the pathogen *Vairimorpha ceranae:* The results of the laboratory evaluation of plant extracts at different concentrations showed an effective effect in killing the spores of the pathogen *V.ceranae* and gradually reducing the number of spores as the treatment time progressed compared to the increasing numbers of spores in the control treatment. It is clear from Table (2) that Ilex paraguareinsis yerba mate powder at a concentration of 3% was significantly superior to Cinnamon powder and the other concentrations led to a reduction in the numbers of spores of the pathogen as they reached (2470, 2240, 2080, 1750, 1460, 1020) x 10^3 spores/ml, with a reduction rate of 61% after 28 days, and the two concentrations (1%) and (2%) (2680, 2550, 2340, 2030, 1860, 1350) and (2620, 2380, 2170, 1960, 1730, 1340) × 10^3 spores / ml, respectively, with a reduction rate of 50 and 50% after 1, 3, 7, 14, 21, and 28 days of treatment, respectively. When treated with cinnamon extract at concentrations of (1%), (2%), and 3%, the numbers of spores reached (2680, 2570, 2460, 2350, 2230, 2140) and (2620, 2530, 2300, 2160, 2070, 1980). (2530, 2440, 2280, 2050, 1920, 1810) × 10^3 spores / ml after 1, 3, 7, 14, 21 and 28 days after treatment, and the reduction percentage reached 20%, 44% and 56%, respectively. Based on the results of the plant powders, 3% yerba mate powder and 3% mate powder were filtered and used in field experiments because they are efficient concentrations in controlling the number of spores of the pathogen and did not kill all worker bees in laboratory experiments. Panek (19) mentioned that caffeine is a chemical defense against biological agents, and that caffeine positively affects the defense function of bees by increasing antioxidant activity by using low concentrations of caffeine at 25% when workers are infected with the pathogen *Vairimorpha* Spp. Honey bee workers live longer, up to 32 days ,Folly et al. (11) reported that caffeine reduces the severity of *Vairimorpha bombi* infection, which affects bumblebees Bombus terrestris, as the number of worker bees fed with a sugar solution containing caffeine was 272 fewer workers, and in the comparison treatment it amounted to 438 workers. A study indicated the use of cinnamon at concentrations of 333 and 666

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mg/kg to treat the pathogen *V.ceranae*. The survival rate of the workers was 7.243 and 9.886 days, respectively, when using volatile oils of some plant compounds and studying the survival of the worker bees and the period of development of the pathogen *Vairimorpha ceranae* (21), extracts of thyme, basil, mint, rosemary, and cinnamon were used to feed the bees and led to improving the health of the bees while increasing honey production. Cinnamon was used to feed the bee colonies in the fall, which led to a decrease in the number of pathogens in the bees' intestines. By 32.54%, 29.95% in mint, and 25.43% in thyme (15).

Table 2. Numbers of spores of the pathogen *Vairimorpha* (*Nosema*) *ceranae* when treated with different concentrations of plant powders after successive time periods of treating honeybee workers under laboratory conditions

Treatments	Before treatment	Number of spores x 10^3 after treatment (spores/ml) 1 day	3 day	7 day	day 14	day 21	28 day	Reduction percentage %
Powder mate 1%	2750	2680	2550	2340	2030	1860	1350	50
Powder mate 2%	2700	2620	2380	2170	1960	1730	1340	50
Powder mate 3%	2630	2470	2240	2080	1750	1460	1020	61
Powder cinnamon 1%	2720	2680	2570	2460	2350	2230	2140	21
Powder cinnamon 2%	2700	2620	2530	2300	2160	2070	1980	26
Powder cinnamon 3%	2710	2530	2440	2280	2050	1920	1810	33
Control	2750	2890	3540	4160	4670	5190	5720	
Mean of days	2708.6	2641.4	2602.9	2574.3	2410.0	2238.6	2010.0	
l.s.d.05 of days	71.90							
Mean of treatments	2110.0	2241.4	4131.4					
l.s.d.05 of treatments	95.60							
l.s.d.05 Interaction	155.32							

The effect of plant extracts on honey bee workers: The results of the laboratory evaluation of plant extracts with different concentrations showed that there is an effect of the different treatments in causing death to the workers. The statistical analysis showed that there are significant differences between the numbers of dead workers from the different concentrations of the different plant extracts. It is clear from Table (3) that the concentration is 1%, 2%, and 3%. In yerba mate extract, it was safer and caused the death of small numbers of workers, which amounted to (1,2,2,3,3,4), (2,3,3,3,4,5), and (2,3,3,4,4,5) respectively, while the students' summary was (1,2,3,2,4,4), (2,2,3,4,5,5), and (2,3,4,4,5, 6) workers in a row. In comparison by treatment, the results control without treatments were 3,4,7,10, 12, and 17 female workers in a row, after 1, 3, 7,14, 21, and 28 days respectively. Therefore, it can be concluded after extracting the reduction of death that the 1% concentration is the best in the mate extract treatment, as the percentage of live honey bee workers reached 75%, while the percentage of live workers decreased to 79% at a concentration of 3%. Likewise, the percentage of mortality reduction in the cinnamon extract treatment at a concentration of 1% reached 84%, and the percentage of live workers at a concentration of 3% reached 76%, based on the results of the plant extract mate and cinnamon of concentration 3% were nominated for use in field experiments because they are efficient concentrations in controlling the spore numbers of the pathogen and did not kill all worker bees in laboratory experiments. Panek (2021) reported that the number of worker bees surviving when using caffeine at a concentration of 0.125 mg was 146/294 workers compared to the comparison treatment, which amounted to 149/294 workers over a period of 25 days after the experiment was conducted . A study showed

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the use of *Cinnamomun cassia* extract at concentrations of 333 and 6666 mg/kg when treating bees infected with the pathogen *N.ceranae* at a concentration of $2.32x10^4$ and reached workers survival period was 18 and 10 days, respectively, after the treatment, while the experimental period was 20 days (Porrini et al.,2017).

Table 3. Numbers of dead honey bee workers treated with different plant extracts during successive time periods in laboratory experiments

Treatments	Before treatment	Number of dead workers after (day) 1 day	3 day	7 day	14 day	21 day	28 day	Reduction of Death%	Mean of treatments
Extract mate 1%	100	1	2	2	3	3	4	75	
Extract mate 2%	100	2	3	3	3	4	5	80	3.11
Extract mate 3%	100	2	3	3	4	4	5	79	
Extract cinnamon 1%	100	1	2	2	3	4	4	84	3.38
Extract cinnamon 2%	100	2	2	3	4	5	5	79	
Extract cinnamon 3%	100	2	3	4	4	5	6	76	
Control	100	3	4	7	10	12	17	47	8.83
Mean of days		1.85	2.71	3.42	4.42	5.28	6.57		
l.s.d.05 of days	0.33								
l.s.d.05 of treatments	0.20								
l.s.d.05 Interaction	1.21								

The effect of plant powders on honey bee workers: The results of Table (4) showed the effect of different concentrations of plant powders, as yerba mate powder at a concentration of 1%, 2%, and 3% caused the death of small numbers of workers amounting to (2,3,4,4,5 ,5) and (2,3,4,5,6,6) and (3,4,5,6,6,7) worked respectively, and in the study powder they reached (2,4,5,5,5,6) and (3,4,5,5,6,7) and (3,5,6,6,7,7) workers, respectively. In the comparison treatment, it amounted to 4,6,9,12,15,19 female workers, respectively, after 1,3,7,14. 21.28 days in a row, and the reason is due to the high number of dead workers in the comparison treatment and a significant difference from the different concentrations in the plant extracts and powders, where the cells were left infected with the pathogen *Vairimorpha* (*Nosema*) *ceranae* and were not exposed to remedial procedures, which caused death in the number of workers during Successive time periods in a laboratory experiment. Therefore, it can be concluded after extracting the reduction of death that the 1% concentration is the best in the mate powder treatment, as the percentage of live honey bee workers reached 77%, while the percentage of live workers decreased to 69% at a concentration of 3%. Likewise, the percentage reduction of death in the cinnamon powder treatment at a concentration of 1% reached 73%, and the percentage of live workers at a concentration of 3% reached 66%, based on the results of the plant powder mate and cinnamon of concentration 3% were nominated for use in field experiments because they are efficient concentrations in controlling the spore numbers of the pathogen and did not kill all worker bees in laboratory experiments. Bernklau et al. (2019) showed that when honey bees were infected with the pathogen Nosema ceranae at a concentration of $1x10^5$ When treated with Caffeine, Gallic acid, Kempferol, and P- Coumaric acid, at a concentration of 25 ppm, 250 ppm, and 2500 ppm respectively, Caffeine was the most efficient in keeping worker bees alive, reaching 58, 43 and 27 days respectively, compared to the control treatment, which reached 23 days,As for the longevity of the workers, caffeine was more effective than the other compounds at concentrations, reaching 40, 30 and 19 days respectively. In a study on the infection of bees with the pathogen *V.ceranae* at a concentration of 5×10^4, 40 bees were placed in a cage with dimensions (13.0 x 9.5 x 15 cm), and when treated with the compound cinnamaldehyde at a

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concentration of µl/ml4 and a 50% sugar solution, it reduced the pathogen to a concentration of 16.2 × 10^3, and the reduction rate was 24.4%, and the number of surviving workers was 32 for a period of 16 days after the treatment(Ferreira et al.,2021). The plant extracts of mint, chamomile, and cinnamon have a more positive effect and have less effect on bees when using these extracts when feeding honey bees, as the death of worker bees reached 6/25 bees, and cinnamon extract reached 13/100 bees when using cinnamon to treat bees infected with *Varroa*, which indicates no effect.Cinnamon extract on honey bees (Pasca et al.,2021).

Table 4. Numbers of dead honey bee workers treated with different plant powders during successive time periods in laboratory experiments

Treatments	Before treatment	Number of dead workers after (day) 1 day	3 day	7 day	14 day	21 day	28 day	Reduction of Death%	Mean of treatments
Powder mate 1%	100	2	3	4	4	5	5	77	
Powder mate 2%	100	2	3	4	5	6	6	74	4.44
Powder mate 3%	100	3	4	5	6	6	7	69	
Powder cinnamon 1%	100	2	4	5	5	5	6	73	5.05
Powder cinnamon 2%	100	3	4	5	5	6	7	70	
Powder cinnamon 3%	100	3	5	6	6	7	7	66	
Control	100	4	6	9	12	15	19	35	10.83
Mean of days		2.71	4.14	5.42	6.14	7.14	8.14		
l.s.d.05 of days	0.35								
l.s.d.05 of treatments	0.22								
l.s.d.05 Interaction	1.25								

CONCLUSION

The results of the laboratory study showed that the alcoholic extract and powders of yerba mate and cinnamon at concentrations of 1%, 2%, and 3% were effective and had no side effects on bees, with the 3% alcoholic extract of yerba mate being the most effective of the other concentrations.

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CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

AUTHOR/S DECLARATION

We confirm that all Figures and Tables in the manuscript are original to us. Additionally, any Figures and images that do not belong to us have been incorporated with the required permissions for re-publication, which are included with the manuscript.

Author/s signature on Ethical Approval Statement.

Ethical Clearance and Animal welfare

Funds:

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تقييم كفاءة بعض المستخلصات النباتية المتة و القرفة ضد المسبب المرضي *Vairimorpha ceranae* في الجهاز الهضمي لشغالات نحل العسل .

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المستخلص

هدفت الدراسة الحالية الى تقييم كفاءة بعض المستخلصات النباتية المتة *Ilex paraguariensis* و القرفة *Cinnamonum cassia* ضد المسبب المرضي *Vairimorpha ceranae* في الجهاز الهضمي لشغالات نحل العسل العالمي *Apis mellifera* L. وبتراكيز مختلفة،وأظهرت نتائج الدراسة المختبرية أن المستخلص الكحولي والمساحيق لنباتي المته والقرفة بتركيز 1 و 2 و 3% كانت تراكيز كفوءة و ليس لها آثار جانبية على النحل حيث كان المستخلص الكحولي للمته بتركيز 3% أكثر كفاءة من باقي التراكيز الأخرى وبلغت 2070 ،1980، 1730،1390،1080،70 ×10^3 بوغ / مل على التوالي وبنسبة تخفيض 97%، ومستخلص القرفة الكحولي بتركيز 3% أكثر كفاءة من باقي التراكيز الأخرى وبلغت 2350،2600، 2190،2260 ،1750،1390،1140×10^3 بوغ / مل على التوالي وبنسبة تخفيض 56% بعد 1 و3 و 7 و 14 و21 و 28 يوماً على التوالي . ومسحوق المته بتركيز3% أكثر كفاءة من باقي التراكيز الأخرى بلغت 2470،2240،2080،1750،1460،1020 ×10^3 بوغ / مل على التوالي وبنسبة تخفيض 61% ومسحوق القرفة بتركيز3% بلغت 2530،2440،2280،2050 ،1920، 1810×10^3 بوغ / مل على التوالي وبنسبة تخفيض 33% بعد 1 و3 و 7 و 14 و21 و 28 يوماً على التوالي .

الكلمات المفتاحية: نبات المتة، نبات القرفة، امراض النحل