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Influence of pollen traps on some biological activities and bee venom quantity of honeybee colonies

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Abstract

The relation between pollen trap types (Outside and inside pollen traps) and some biological activities including the weight of collected bee venom was conducted during the experimental period. Results show that colonies with outside pollen traps recorded a higher value of sealed worker brood cells, bee honey, and bee bread than those with inside pollen traps. Significant differences were recorded between inside and outside pollen traps in the amount of stored bee bread on all dates. The mean weight of captured pollen gives significant values in colonies with inside pollen traps during the treatment period. A negative correlation was recorded between the amount of bee bread and pollen weight in colonies with outside pollen traps. A positive correlation was recorded between the sealed brood area and the amount of bee bread in colonies with inside pollen traps. The highest significant amounts of bee venom were collected in colonies without pollen traps. A remarkable decrease in bee venom and bee bread amounts was observed in colonies provided with pollen traps. Colonies with inside pollen traps showed a negative correlation coefficient between pollen weight and the amount of collected bee venom.

Introduction

Honeybee products (Raw honey, royal jelly, pollen, propolis, bee venom, and bees wax) for medical aspects are known as apitherapy. Apitherapy has been processed in many cultures whereas bee venom therapy is the use of live bee stings (Or injectable venom) to treat various diseases such as multiple sclerosis, arthritis, diseases of the central and peripheral nervous system, skin diseases, heart and blood system and other diseases. Honeybee venom is a complex mixture of a variety of proteins and peptides which has strong neurotoxic and immunogenic effects (Obioma *et al*., 2016).

Pollen grains provide honeybees with vitamins, proteins, fats, and minerals. The protein content of pollen varies from 7 to 30% (By weight) with an average of about 22% (Crailsheim *et al*., 1992). Strong and energetic colonies of honeybees are highly required for successful beekeeping. Large populations of bee workers are easily achieved through queen fertility and the ability of workers to store sufficient amounts of pollen grains and honey (Brodschneider and Crailsheim, 2010). Abusabbah *et al*.

(2016) studied the effect of carbohydrate supplants and protein-rich mixtures on the quality of venom produced by *Apis cerana* L. (Hymenoptera: Apidae). They recorded that among the supplemented-carbohydrate diets to the beehives, maltose sugar was found to be the best quality of bee venom, which gave the highest concentration of melittin, phospholipase A2, and apamin. Also, alternative diets revealed that the protein-rich mixture is better than the sucrose diet.

Abou El Naga *et al.* (2008) and Hussein (1981) studied the impact of pollen traps on brood rearing. They found that colonies without pollen traps collect more pollen and rear more brood than trapped colonies. Also, colonies with pollen traps reared less brood and produced less honey than control colonies. Larval acceptance rate, and production of royal jelly, i.e. average amount per grafted cell and per colony was higher in the colonies without pollen traps than those of trapped colonies (Mohanny *et al.*, 2022). Honeybee colonies treated with a pollen grain diet produced a high amount of bee venom compared with other diets of free-fate milk, dead yeast, and sugar solution (El-Bassiony, 2007 and El-Shaarawy, 2007). Feeding honeybees with pollen substitutes affected by the venom gland parameters. From HPLC analysis of bee venom, results showed that the main components of venom were increased by feeding honeybee colonies on pollen substitute (Nowar, 2016).

The present studies aim to investigate the impact of pollen traps on some biological activities and bee venom quantity of honeybee colonies.

Materials and methods

This work was performed in a private apiary of Qualiubia Governorate, Egypt from the beginning of 21st August 2022 to 8th October 2022. In the first experiment, twenty colonies were used to compare between the outside pollen traps (Held at the hive entrance, Figure 1a) and inside pollen traps (Held at the bottom of the beehive, Figure (1b). Ten colonies headed by cariniolan queens, equally strong, were selected for each type of pollen trap. The two types of pollen traps were fixed in their hives every 4 days and removed for another 4 days interplay. Sealed worker brood, honey, bee bread areas, and weight of collected pollen in every trap were measured every 12 days intervals.

The relationship between the inside pollen trap and collected bee venom was conducted through the second experiment from 2 to 23 August 2022. Eight colonies headed by cariniolan queens, equally strong, were selected for this study. Four experimental colonies were provided with inside pollen traps and apparatus for bee venom collection and the rest four colonies were left without any treatments. The device of bee venom collecting was processed by a Battery or accumulator (24 to 30 V) transformer from constant to alternating current, with an impulse frequency of 50 to 1000 Hz and an impulse duration of 3 to 6 seconds.

The collector frame consists of an electric wire net and a glass plate, covered by a thin polyethylene membrane. The collector can be mounted in the hive. The bees get in contact with the charged wire net and are stimulated to sting through the membrane and spray their venom on the glass plate. The collector frame was left in the hive for one hour only and glass plates were dried in a dark, well-ventilated room and bee venom was collected weekly by scraping it with a sharp knife. Collected bee venom is stored in a dark bottle and put in the freezer until the weight.

Statistical analysis:

Statistical analysis was carried out using SPSS program software version 18. A paired T-test was used to compare the means of treatment and conducted to test the significance of each measured parameter.

Figure (1): Types of pollen traps, outside pollen trap (a) and inside pollen trap (b).

Results and discussion

Results illustrated in Table (1) show the biological activities of tested honeybee colonies from 21st August to 20th October. The average production of sealed worker brood cells, bee honey, and bee bread was measured by square inches in colonies with inside pollen traps and colonies with outside pollen traps. Colonies with outside pollen traps recorded a higher value than those with inside pollen traps on most dates of treatment with significant differences in September and October. Results also indicated that the mean amount of bee honey increased remarkably in colonies with outside traps with no significant differences between inside and outside pollen traps. Data in Table (1) show significant differences between inside and outside pollen traps in the amount of stored bee bread on all dates. Colonies with outside traps have a higher amount of bee bread than those with inside traps. On the contrary, the mean weight of captured pollen gives significant values in colonies with inside pollen traps during the treatment period.

The obtained data in Table (2) indicated a negative correlation coefficient between the mean amount of bee honey and the amount of pollen weight in colonies with inside traps. Similarly, a negative correlation was recorded between the amount of bee bread and either the amount of sealed brood or pollen weight in colonies with outside pollen traps. A significant positive correlation was found between the amount of sealed brood and pollen weight as well as a positive significant correlation between the amount of bee honey and the amount of bee bread in colonies with inside traps. Also, a positive correlation was recorded between the sealed brood area and the amount of bee bread in colonies with inside pollen traps. Abou El Naga *et al.* (2008) studied the impact of pollen traps on brood rearing. He found that colonies without pollen traps collect more pollen and rear more brood than trapped colonies. A highly significant positive correlation was observed between the amount of collected pollen and brood rearing. Colonies with pollen traps reared less brood and produced less honey than controlled colonies (Hussein, 1981). In the other study colony activity of larval acceptance rate, production of royal jelly, i.e. average amount per grafted cell and colony was higher in the colonies without pollen traps than those of trapped colony (Mohanny *et al.*, 2022).

Results in Table (3) clearly show that colonies without any pollen trap resulted in the highest values of sealed brood cells, bee

honey, and bee bread activities in comparison with colonies supplied by inside pollen traps. The highest significant amounts of bee venom were collected in colonies without pollen traps. The highest values were observed in colonies without pollen traps on 16 and 23 August accompanied with the highest values of bee bread in the same colonies. The results of the grand mean demonstrated an increased amount of collected bee venom in colonies without pollen traps which at the same time recorded the highest area of bee bread. At the same time, a remarkable decrease in bee venom and bee bread amounts was observed in colonies provided with pollen traps (Figures 2 and 3). Colonies with inside pollen traps showed a negative correlation coefficient between pollen weight and the amount of collected bee venom (r= -0.197). The present results agree with El-Bassiony (2007) and El-Shaarawy (2007) recorded that treated honeybee colonies with a pollen grain diet gave the best results for bee venom production compared with the other treatments including free fat milk, dead yeast, and sugar solution. Fed newly emerged honeybee workers on a sufficient level of stored bee bread increased the total length of the acid gland with age and reached to the maximum length at 18^{th} days old (Omar, 2011). Studies by Badawy *et al.* (2016) clearly show that after feeding honeybee workers on pollen grains the amount of dry bee venom increased by 79.322% and 32.735% in the first and second seasons respectively. This means that the use of pollen in nutrition gave the highest significant value 1.184 mg/colony between treatments of dry bee venom in both seasons. Eshbah *et al.* (2021) observed that the greatest mean volume of acid gland sacs was shown when bees were fed on broad bean pollen (0.6419 mm^3), while the lowest mean was 0.3643 mm^3 in control. Fed honeybee workers on broad bean pollen caused the greatest mean volume of acid gland sacs (0.6419 mm^3) compared with the lowest mean 0.3643 mm^3 in control (Eshbah *et al*., 2021).

Table (1): Impact of two pollen trap types on some biological activities of honeybee colonies.

Time	Mean amount of sealed brood (inch²)			Mean amount of bee honey(inch²)			Mean amount of bee bread(inch²)			Mean weight (gm.) of captured pollen.		
	Outside pollen trap	Inside pollen trap	t-value	Outside pollen trap	Inside pollen trap	t-value	Outside pollen trap	Inside pollen trap	t-value	Outside pollen trap	Inside pollen trap	t-value
21st August	386.2±18	363±16.6	0.82	208.7±15.2	196.9±18.6	0.43	55.7±2.8	25.3±3.3	5.76*	57.3±6.9	116±13.7	3.70*
2nd September	416.2±14	363±16.6	2.88*	210±15.8	173±20.7	1.15	57.6±2.3	25.3±1.6	10.56*	49.7±7.3	85.5±11.2	2.49*
14th September	384.2±17	362±16.3	0.82	274.5±29.8	295.5±21.7	0.54	55±3	28±1.3	7.52*	54.50±7	110.2±15	2.73*
26th September	400±5.7	387±14.7	0.77	320±1.4	299±19.9	0.34	56.5±2.2	28.3±1.4	13.25*	60.1±7.4	127.7±17	3.17*
8th October	394±6.8	382±14.8	0.71	298.5±19.9	261.5±31.2	0.93	57.9±1.9	29.5±1.5	13.46*	44±8.02	89.9±16.7	2.75*
20th October	302.8±19	363±16.6	2.55*	278.5±28.1	235.5±35.9	0.98	72±12	27.3±2.6	3.89*	35.5±5.5	81±11.2	4.08*
Grand mean	380.56	370	---	265.03	243.56	---	59.11	27.28	---	50.18	101.71	---

t value 2.26 (o.o5 of probability)

Table (2): Correlation coefficient within some biological activities in honeybee colonies treated with outside and inside pollen traps.

Measurements		Mean amount of sealed Brood		Mean amount of bee honey		Mean amount of pollen Weight		Mean amount of bee bread	
		Outside pollen trap	Inside pollen trap	Outside pollen trap	Inside pollen trap	Outside pollen trap	Inside pollen trap	Outside pollen trap	Inside pollen trap
Mean amount of Sealed Brood	Outside pollen trap	1	…….	---	……	---	…….	----	……..
	Inside pollen trap	……..	1	….	---	…..	---	……..	----
Mean amount of honey	Outside pollen trap	0.047	……	1	…….	---	……	----	…….
	Inside pollen trap	……..	0.117	…..	1	……	----	…….	----
Mean amount of pollen Weight	Outside pollen trap	0.076	…….	0.122	…….	1	…….	----	……
	Inside pollen trap	…….	0.352*	….	-0.096	……	1	……	---
Mean amount of bee bread	Outside pollen trap	- 0.072	……	0.044	…….	- 0.058	……	1	……..
	Inside pollen trap	……..	0.167	…..	0.328*	…….	0.118	…….	1

r = 0.273 at 0.05 of probability

Table (3): Effect of inside pollen traps on some biological activities and the amount of collected bee venom.

Measurements	2nd August			9th August			16th August			23rd August		
	With inside pollen trap	Without any pollen trap	t-value	With inside pollen trap	Without any pollen trap	t-value	With inside pollen trap	Without any pollen trap	t-value	With inside pollen trap	Without any pollen trap	t-value
Mean amount of sealed brood	430±9.1	450±12	1.12	…….	……	…..	422.5±11	457.5±8.5	2.11	…..	…….	…..
Mean amount of bee honey	173±32.6	198.7±28	0.48	174.5±32	197.5±27	0.44	172.5±31.7	197.5±27	0.48	173.7±31	202.7±27	0.56
Mean amount of bee bread	33.7±2.3	40±2	2.61	37.5±1.4	42.5±3.2	1.41	36.2±1.2	43.7±2.3	2.32	36.2±1.2	43.7±2.3	2.32
Mean amount of bee venom (gm)	0.91±0.0	0.97±0.0	10.7*	0.91±0.0	0.97±0.0	8.33*	0.91±0.0	0.98±0.0	8.49*	0.91±0.0	0.98±0.0	17.5*

t value 3.18 (0.05 of probability)

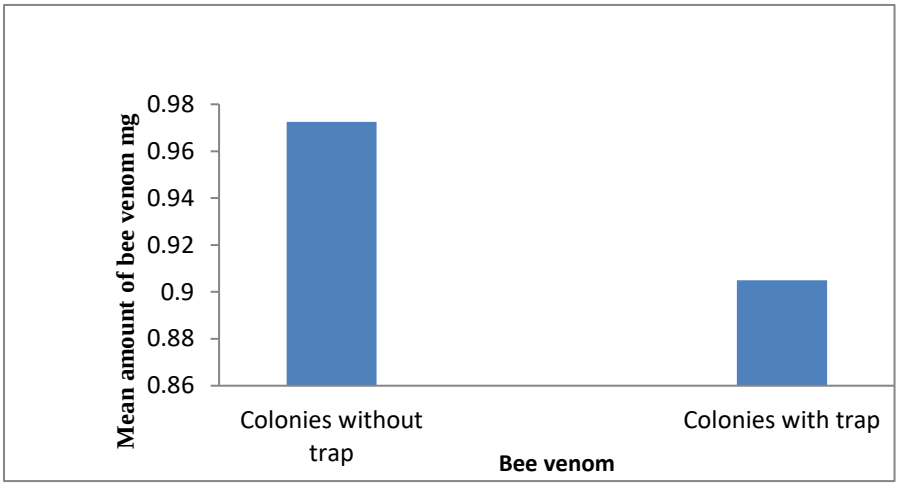

Figure (2): Impact of pollen trap on the amount of bee venom (mg).

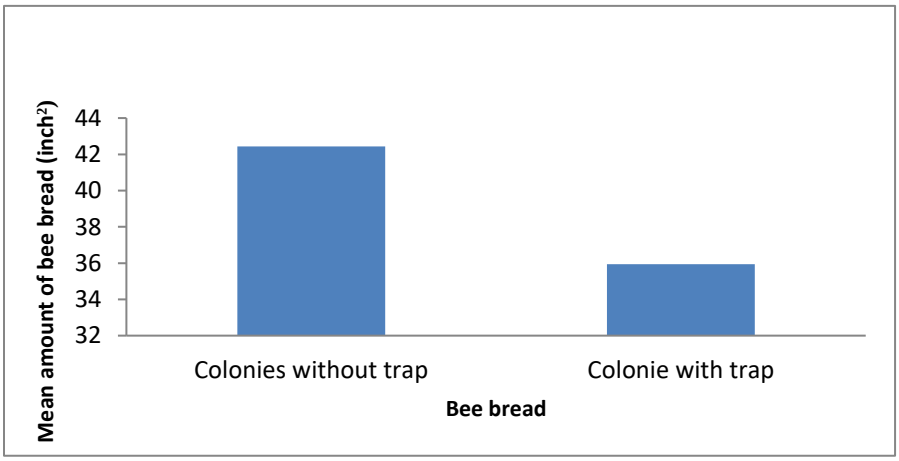

Figure (3): Impact of pollen trap on the amount of bee bread (inch²).

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