THE EFFECT OF COMMERCIAL PROPOLIS PRODUCTION ON HIVE PROFITABILITY

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Abstract

This study was conducted to determine the effect of increased propolis production on overall hive profitability and productivity. The study took place near George situated in the Southern Cape region of South Africa. Standard Langstroth hives were used (n=12) containing honeybee colonies of equal strength from the species Apis mellifera capensis. *Propolis production in colonies equipped with commercial propolis traps (n=6) was compared to propolis production in control colonies (n=6). The strength of the hives was determined by calculating the area of worker brood cells and the number of frames containing bees. Propolis production, honey production, brood area, resin percentage, frames containing bees and income generated were measured on a monthly basis with the removal of the traps for an nine month period. There was no significant difference in honey production (24.66±0.1 kg and 26.53±0.1 kg) and frames containing bees (18±0.22 frames and 18.7±0.20 frames) between the two groups for the nine-month period. However, brood area was significant ($p<0.05$) with the control hives producing substantially more brood area than the trapped hives (3511.24±3.96 cm^2 vs 2554.17±3.90 cm^2). Propolis quality and production was significantly higher ($p<0.01$) in hives with the traps producing 75.6±1.5% resin and 361.87±0.18 g propolis compared to 64±1.25% resin and 36.1±0.18 g propolis in the control group. Hives containing propolis traps were significantly ($p<0.01$) more profitable than the control group when honey and propolis income were pooled (385.09±0.40 Rand vs 324.04±0.42 Rand). Therefore the increased propolis production improved profitability of the hive without affecting overall hive productivity.*

Key words: *Propolis production / Honey production / Brood area / Income generated.*

Introduction

There has been a decline in South African beekeeping. The primary reasons for this is the destruction of habitat and forage necessary to sustain honeybees, increased human populations and urbanization and the effect of pesticides and pollutants (BEGG, 2001). Most beekeepers reside in urban areas and may keep bees hundreds of kilometres away, frequently moving with their hives in search of flowering plants or suitable bee forage. Beekeepers face with further problems such as theft and vandalism, the *capensis* problem, the recent arrival and rapid spread of *Varroa destructor*, reduced nectar flows and other pests and diseases such as Argentine ant, Banded Bee Pirate, Honey badgers and European Foulbrood. These problems have led to huge colony losses, loss of income and made beekeeping in general more expensive.

The South African beekeeper is generally unaware of the number of alternative products produced by bees, besides the normal functions associated with honey production and pollination services as a means of generating additional income from beekeeping. One of these relatively unknown products produced in the honeybee colony, is propolis. Propolis is a mixture of various amounts of beeswax and resins collected by the honeybee from plants, particularly from flowers and leaf buds. The worker bees use propolis to line the inside of the hive cavities and brood combs, repair combs, seal small cracks in the hive, reduce the size of the entrance and to mix small quantities of propolis with wax to seal brood cells.

Propolis production can be a viable option to derive an additional income for the South African beekeeper. It involves a low capital and minimum labour input, which make it a low risk enterprise in a beekeeping system. With the world food and medicine trends to natural products, the natural antibiotics and medicinal substances in propolis can be of great value to the pharmaceutical and beekeeping industry.

Materials and methods

The collection of propolis took place in the George area, southern Cape region, South Africa (33.9 latitude south, 22.5 longitude east). The climate in this area is classified as Mediterranean. The average maximum and minimum temperatures for the George area are 19.2 and 9.4 degrees Celsius for the winter and 23.9 and 16.1 degrees Celsius for the summer with an annual rainfall of 715 mm. The area receives 60% of the rainfall in the summer months (September to February) and 40% during the winter months (March to August). However, during the collection period drought conditions were experienced with the area receiving 67% of the normal annual rainfall. The plant growth in the George area consists predominantly of indigenous forests, mountain fynbos and pine plantations.

The study was conducted over a nine-month period from the beginning of July to the end of March. Standard Langstroth (n=12) hives containing 10-frames of honeybees from the species *Apis mellifera capensis* were used. The hives were placed 400 mm from the ground with the opening of the hive being positioned in a northeast direction in order to protect the hive from the prevailing wind and rain.

The strength of the swarms was determined by calculating the worker brood area, with the aid of a calibrated frame consisting of blocks with an area of 6.25 cm^2 (1 square inch). The number of frames containing bees in the hives were calculated and served as a further indication of swarm strength. Swarms,

considered of equal strength were then divided between the control and treatment groups. Hives (n=6) were equipped with a commercial available propolis trap and compared to the propolis production from hives (n=6) without traps, which served as the control group. The propolis traps were removed from the hives and replaced with clean traps at monthly intervals. The traps containing propolis were placed in a freezer overnight and cooled to –4 degrees Celsius. At this low temperature propolis becomes brittle, making it easy to remove from the propolis traps. Propolis from the control group was harvested at 3 monthly intervals by scraping it from the frames and entrance of the hive. The propolis was weighed, sealed and a representative sample from the control and trapped groups analysed to determine the resin percentage. The resin percentage of the propolis was determined by extracting propolis by using a 25% ethanol solution as described by SOSNOWSKI (1984). Total average propolis production, honey production, brood area, frames containing bees, resin % and income generated between the control and treatment group at the end of the collection period were recorded.

In order to determine whether the increased propolis production has an effect on the normal productivity of the hives, honey production, brood production, and frames containing bees were measured in both control and treatment groups. This was done with the removal of the propolis traps on a monthly basis.

Income generated was determined by yield in honey and quality of propolis produced, fixed to current market prices.

The average propolis, honey, brood area, frames containing bees, resin % produced and income generated at 90,180 and 270 days for the control and treatment groups were fitted to a fixed effects model. Data were analysed by least squares ANOVA using the GLM procedure of SAS (1988), and are reported as least square means and standard errors (±SE). All possible two-way interactions were analysed. However, some main effects and two-way interactions were dropped because of lack of significance.

Results

The lease square means (LSM) and standard errors (SE) for the effect of propolis production on honey production, brood area, number of frames containing bees, resin %, groups and income between hives with propolis traps and hives not fitted with propolis traps at 90, 180 and 270 days are represented in table I.

Table I

The lease square means (SE) for propolis production on the production of honey, worker brood area, frames containing bees, resin %, group and income generated at 90, 180, 270 days and total production

	90 days	180 days	270 days	Total/hive
Honey (kg)	**No specified**	**No specified**	**No specified**	**No specified**
Control	2.54 (0.15)	8.1 (0.12)	14.03 (0.15)	24.66 (0.1)
Treatment	2.28 (0.15)	7.95 (0.10)	16.3 (0.15)	26.53 (0.1)
Brood (cm^2)	**No specified**	**No specified**	*	*
Control	499.58 (4.44)	1861.61 (4.93)	1150.05 (3.76)	3511.24 (3.96)
Treatment	510.75 (4.40)	1944.11 (4.80)	99.31 (3,74)	2554.17 (3.90)
Frames (each)	**No specified**	**No specified**	**No specified**	**No specified**
Control	5.4 (0.36)	9.9 (0.28)	2.7 (0.20)	18 (0.22)
Treatment	2.1 (0.24)	12.2 (0.20)	4.4 (0.20)	18.7 (0.20)
Group (g)	**	**	**	**
Control	10.2 (0.30)	12.5 (0.22)	13.4 (0.20)	36.1 (0.18)
Treatment	59.1 (0.28)	109.8 (0.25)	192.8 (0.22)	361.87 (0.18)
Resin (%)	*	*	*	**
Control	66 (2.12)	65 (1.88)	62 (1.79)	64 (1.25)
Treatment	79.2 (1.65)	76.8 (1.88)	71 (1.05)	75.6 (1.5)
Income (rand)	*	**	**	**
Control	34.03 (0.40)	106.52 (0.53)	183.48 (0.61)	324.04 (0.42)
Treatment	36.66 (0.40)	116 (0.38)	232.43 (0.55)	385.09 (0.40)

*Level of significance; * ($p<0.05$); ** ($p<0.001$)*

There was no significant difference in honey production, and frames containing bees between the hives with traps and hives without traps over the nine-month period. However, propolis production, resin percentage and worker brood area was significantly influenced by the propolis traps, with the hives containing traps producing on average 348.9 g, and 11% more propolis and resin than the control group. However the control group produced 957.07 cm^2 more brood area than the treatment group over the nine-month period.

Discussion

Honey production was not influenced by the inclusion of propolis traps into the hives. Although not significant the hives containing traps produced 8% more honey than hives without propolis traps. Literature

regarding the influence of propolis production on honey production is scarce. The findings of this study are contradictory to the results obtained by ROOT (1942) who found that very little propolis is produced in hives during honey production. MC ADDAM (2000) and MANN LAKE INT (2000) observed a positive correlation between honey production and propolis production. Propolis production was found to increase during times of honey production when collected by means of a propolis trap. These observation supports the results from this study as maximum propolis (13.4 g and 192.8 g) and honey production (14.03 g and 16.3 kg) were obtained at 270 days for both control and treatment groups, which corresponds to the summer months when the nectar flow is at its peak. These findings can be ascribed to the increased activity of the bees during the warmer summer months due to an increase in day light length and the availability of bee forage. KRELL (1996) recommends the collection of propolis should be done after the major nectar flow, as quality of propolis tends to improve towards the end of the nectar flow. This may be true in temperate climates where the bees have to over-winter and therefore collect more propolis to protect them from the extreme winter element. This tendency was not observed in the results of this study. A possible reason for the difference in results could be the small difference in temperature between summer and winter experienced in the Southern Cape.

Propolis production has a significant influence on the worker brood area at 270 days and total brood area. The number of frames containing bees was not influenced. However propolis and honey production increased as worker brood area increased during the summer months. A positive correlation (r=0.83) was found to exist between the number of frames containing bees and the worker brood area. Worker brood area increased on average from 499.58 cm^2 and 510.75 cm^2 at 90 days to reach a total production of 3511.24 cm^2 and 2554.17 cm^2 for the control and treatment group respectively. From the results obtained in this study it is evident that the major honey flow takes place during the summer months which explains the increase in brood area for both control and treatment groups. ROOT (1942) found that it takes a cell of honey to produce a cell of brood and the egg laying activity of the queen decrease after the major nectar flow. However, ROOT (1942) also found that there is a negative correlation between colony population and the amount of sealed brood present. ANDERSON et al. (1993) found that colony size increases from the winter (off season) to the summer or honey flow season. Flowering is the impetus for colony renewal and provides the intense flow of fresh pollen that drives brood production in the ascended phase of the colony cycle. Thereafter flowering intensity declines and both adult and worker populations gradually diminish throughout the summer to reach ebb in the winter (ALLSOPP and HEPBURN, 1997). The control group produced significantly more worker brood at 270 days, compared to the treatment group (1150.05 cm^2 ± (3.76) vs 99.31 cm^2 ± (3.71)). The difference in brood area between the groups can be ascribed to the two queen cells that developed in the control hives causing supersedure and swarming. The result was a drastic increase in worker brood area preceding the swarming process. However, this process did not affect the number of frames containing bees in the control group. Although ALLSOPP and HEPBURN (1997) found that in the Cape honeybee supersedure is statistically independent of changes in brood production which ultimately results in changes of adult worker population, this is supported by ANON (1997) who found that brood rearing starts at a time when the day length starts to increase and is controlled largely by the amount of food available. IANNUZZI, (1983) found a positive correlation between the amount of propolis produced and the size of the swarm. He assessed hive strength by means of flight counts (numbers of worker bees arriving during a given period) and comparing this with the production of propolis. Swarms with 80 bees/min, 109 bees/min and 99 bees/min entering the hive produced ¾ oz, 2 oz and ¾ oz of propolis respectively.

Propolis production by means of a propolis trap significantly influenced propolis production. This is supported by KRELL (1996), who states that trap harvesting is faster and more productive than scraping propolis from frames, entrances of hives and hive covers. The different methods used to harvest propolis have an influence on the amount and the quality of the propolis produced. IANNUZZI (1983) found that the flexible plastic grid produced the purest quality propolis. Temperature has an influence on propolis production because the bees use propolis to insulate and protect the hive from the external environment. IANNUZZI (1983) found that propolis is deposited at a greater rate on a propolis trap when placed on the cold face (the side that receives very little warmth from the sun) of the hive. ORGEN (1990) states that in cooler regions bees are prone to propolize the hive a great deal more than in warmer regions. Increased temperatures soften the waxes and resins of plants making them more pliable and easier for the bees to process and manipulate. According to ROOT (1947), and IANNUZZI (1983), bees have not been observed collecting propolis in the early morning hours, when temperatures are low. However, as the temperature rises during the day, the number of worker bees collecting propolis tends to increase. This is in contrast to pollen collection, which occurs early, and late in the day. ROOT (1947) further states that propolis is predominantly gathered during the summer months. However, an increase in propolis production towards the autumn months has been reported (IANNUZZI, 1983). This can be ascribed to the bees preparing for the cold winter, by insulating the hive from the external environment making the temperature inside the hive easer to regulate. In contrast, BONNEY (1995) ascribed this increased propolis production in the late summer to be a normal occurrence in behaviour, initiated by the reduction in wax secretion and not as the result of temperature. While KRELL (1996) finds it possible that propolizing will be more active at the beginning of the rain season due to the increase of resin produced by plants during this period.

Propolis production with propolis traps significantly influenced the resin %. Propolis produced by means of a trap had an 11% higher resin percentage than propolis produced in the control hives. The findings of this study are in agreement with those obtained KRELL (1996) and IANNUZZI (1983) which stated that the cleanest collection methods employ special traps placed on top of the hive, below the covers or next to the lateral walls inside the hive. Bees do not mix as much wax with the propolis and no contamination occurs during harvesting when this method is used. This results a cleaner resin yield as contamination of propolis with wax, pieces of wood, paint and other debris reduces quality and should be avoided. Bees collect resins from a large variety of plants. A greater diversity of plant growth will result in greater diversity of resin production, which influences the chemical composition and quality of the propolis. According to WOISKY (1998), the chemical composition of propolis varies greatly and depends directly on the local flora and penology of the host plants, and indirectly on the locality and time of collection. Bees gather resins for propolis production from a variety of tree species. The species composition often differs in different geographic localities. BONNEY (1995) found that bees preferred the resins from eucalyptus, pine, poplar, oak and willow trees. The amount of propolis produced depended on the density of resin producing trees (MANN LAKE L.t.d., 2000). MACADAM (2000) observed increased resin and subsequent propolis production in the vicinity of pine trees.

Conclusion

The introduction of a propolis trap into the hive increased the amount and quality of propolis produced. The amount of honey produced increased and it seems that propolis production has a positive effect on honey production. Propolis production did not adversely affect hive size over the period. Therefore commercial propolis production seams to be a viable practice in the Southern Cape for the commercial beekeeper as total hive income increased substantially without affecting total hive productivity.

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