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Motivation of Honey Bee, *Apis mellifera*, Colonies to Draw out Wax Foundations and to Build Combs

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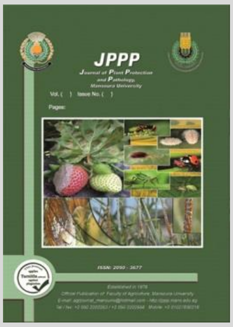

ABSTRACT

Replacement of old-dark combs is an important practice to eliminate comb contaminants, control brood diseases, and provide new combs for exportation. There are several reasons affect drawn out of beeswax foundations and brood distribution in many apiaries. Therefore, this work designed to specify some characteristics of wax combs naturally built by local honey bees, to develop paint materials to motivate bee workers to build wax foundations and to determine if foundation quality and removal degree of brood combs influence speed of drawing out foundations, brood rearing and brood survival rate. The maximum variation between colonies in characteristics of naturally building combs were 0.78, 0.20, 0.55mm, and 32.75mm^3 for wax cell length, width, depth, and size, respectively. Beeswax paints with lemon, rose and coconut oils exceeded control in build foundations by 25.33, 8.00 and 3.66%, respectively. The removal degree of brood combs was consistent with significant increase in drawing out foundations as the removal degrees increased. High quality beeswax foundations (10% paraffin) were significantly more acceptable and drawn out rapidly by workers than low ones by adulterated (50% paraffin) after 24 and 48 hours. The same pattern was obtained for brood rearing activity after 12 and 24 days, but brood rearing activity in combs built on low quality foundations after 24 days did not significantly differ when 2 or 3 brood combs removed. However, using low quality foundations resulted in significantly lower brood survival rate than the high ones after 12 and 24 days, regardless removal degrees of brood combs.

***Keywords*: Beeswax, foundation, constructing, comb, honey bees, coconut oil, lemon oil, rose oil, paraffin.**

INTRODUCTION

Loss of honey bee, *Apis mellifera*, colonies and reduction of colony productivity are the major concerns for beekeepers in Egypt and around the world. The threats for honey bees are increasingly well studied and understood and range from abiotic stressors, such as pesticides, to biotic stressors (Steinhauer *et al*., 2018; Belsky, 2019; Neov *et al*., 2019). Hence, honey bee parasites and pathogens, and chemicals used to control them are major factors responsible for these problems to bee industry. Beeswax is a natural product from bee colonies (Tulloch, 1980; Bogdanov, 2004; Bogdanov, 2009). Honey bees produce this wax from glands on the abdomen (i.e. wax glands) to make combs (Hepburn *et al*., 1991). Combs, the highly regular and double-sided hexagonal structure, are suitable to repeatedly storing food and housing reared brood, economizing on building materials and space (Gallo and Chittka, 2018). Therefore, pollen, traces of propolis, cocoons and fecal matters are simultaneously accumulated on the inner surfaces of cells resulting in reduced cells size. Further, mite-borne viruses, various pathogens such as *Nosema ceranae* and *Paenibacillus* larvae, applied 'hard' acaricides and antibiotics, and their residues contaminate combs due to the lipophilic nature of beeswax to be detrimental and devastating to honey bees' health (vanEngelsdorp and Meixner, 2010; Traynor *et al*., 2016; Colwell *et al*, 2017). The use of these acaricides are followed by residues in all hive products: highest concentrations were proven in beeswax and propolis, lower in pollen and bee bread, and lowest in honey (Bogdanov, 2006; Adamczyk *et al*., 2007; Rosenkranz *et al*., 2010; Stevanovic *et al*., 2012). Unfortunately, dormant spores of these parasites and pathogens, and co-viruses linger specially in combs and thrive when the conditions become optimum (James, 2011).

Beekeepers do their best to keep strong and healthy colonies by improving management practices to reduce or eliminate beeswax chemicals (de Guzman *et al*., 2019) and included pathogens. Replacement of old and dark combs is considered a sanitary measure in beekeeping to eliminate comb contaminants, control most brood diseases, and provide new combs demanded for exporting bee packages (Fries, 1988). Although new combs can optimize health and performance of honey bee colonies (Berry and Delaplane, 2001), many beekeepers in Egypt and other countries keep most of their old combs in managed honey bee colonies for many years. They may take this practice to minimize the cost of frame foundations, and the consumption of pollen and collected nectar or stored honey. Further, the low quality of beeswax foundations, slow and improper drawing out of sheets, and bad appearance of first circle of reared brood may be potential reasons. Various reports recently informed about the impacts of adulterated contaminated or beeswax foundations as a main cause of poor brood and colony development (Alkassab *et al*., 2020). Thus, various potential reasons may prevent or slow down construction of combs and display scattered brood. On the other hand, the increasing demand for exporting bee packages with new constructed combs emphasize the importance of routine practice of exchange old combs. Therefore, enhancing proper drawing out of beeswax foundation sheets to construct new combs by bee workers as well as preventing or diminish death of reared brood in them is appropriate action.

Naturally, each honey bee colony can build wax combs with specific characteristics (Hepburn *et al*., 1991). These characteristics are still unknown for the local hybrid bees in Egypt. So, the first objective of this work is to specify the characteristics of wax cells build by bee workers in different colonies. Wax

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foundation is a thin sheet of beeswax impressed on both sides with the pattern of worker cells. The foundation is suspended from the top bar of the frame and supported firmly by horizontal wires in which wax sheet is embedded. Bees are mostly reluctant to draw out foundation and will gnaw holes in it when nectar and pollen are scarce, or if it is adulterated. In fact, producing beeswax requires huge energy from bee workers (Carrillo *et al*., 2015). Therefore, wax foundations have been developed to save bee energy. However, some commercial wax foundations are not easily accepted by some bee colonies to draw out sheets constructing new combs. The low quality of foundation wax is associated with addition of much cheaper substances: paraffin, stearin, tallow, or vegetable fats to the relatively expensive beeswax (Bogdanov, 2016). Adulteration of foundation beeswax with stearin, paraffin, or palm oil exerts a negative effect on bee colonies, and presence of 15–35% of stearic acid in beeswax foundation in relation to pure beeswax leads to death of up to 71% of larvae reared in combs built on such a wax foundation (EU Food Fraud Network 2018; Reybroeck, 2017 and 2018). On the other side, beeswax can be used as a base to produce some materials including creams and has some medicinal uses (Fratini *et al*., 2016). At present, the problem of wax adulteration has not been sufficiently studied. Only few studies have been carried out to assess the effects of paraffin and other additives (Castro *et al*. 2010; Semkiw and Skubida 2013; Chęć *et al*., 2021). Thus, another objective of this work is to develop paint materials (beeswax based creams) to motivate building wax foundation by bee workers. Other objectives of this study are to determine if foundation quality and removal degree of brood combs influence the speed of drawing foundations, brood rearing and brood survival rate. Furthermore, the negative impacts on bee health and beekeeping due to wax adulteration are discussed.

MATERIALS AND METHODS

1. Characteristics of natural wax combs built by local honey bees.

Six local honey bee colonies were randomly chosen from those of the apiary of Faculty of Agriculture, Damanhour University, Damanhour city to characterize some characteristics of naturally constructed wax combs. Indeed, groups of honey bee workers were required for the building of natural wax combs (Fig. 1). Some characteristics of beeswax were measured using a ruler. These characteristics were wax cell length, width, and depth, as well as the size of wax cell was measured using the equation on https://www.vcalc.com after measuring the length of one side of the cell (Fig. 2). The measurements were done on 20 cells for three wax pieces per colony.

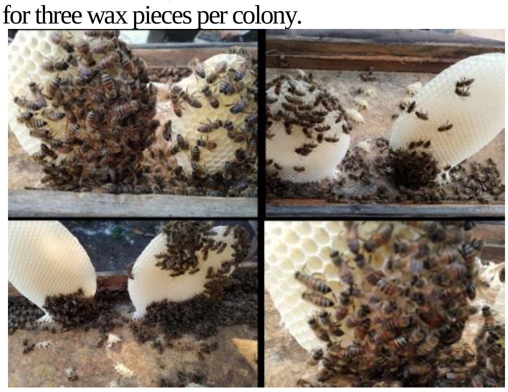

Fig. 1. Shapes of the natural wax combs by bee workers inside Langstroth hives.

2. Developing paint materials to motivate building wax foundation.

Three honey bee colonies in hives with five-frames covered with bees were used in this experiment. Pure beeswax mixed with each of tested oils at rate of 1:1 by weight was used to develop waxy material (cream). Three oils: Coconut oil, Lemon oil and Rose oil were added individually to pure beeswax to make three different creams (Fig. 3). The prepared oily/waxy materials were used to paint each tested foundation sheet. Indeed, each wax foundation was divided into four pieces (about 10 × 20 cm for each piece): each of the three pieces was painted with a test cream, while the last piece was left without any paint as control (Fig. 4). After three days of inserting one prepared foundation frame inside each of the three tested hives, the percentages of built cells on foundations were counted. The experiment was repeated three times.

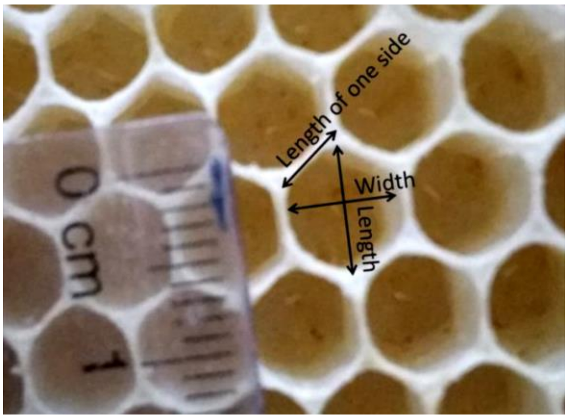

Fig. 2. Example of measuring characteristics of wax cells.

Fig. 3. Creams prepared from beeswax using different oil types.

Fig. 4. Method of applying treatments on wax foundation.

3. Effects of foundation quality and removal degree of brood combs on speed of foundation drawing, brood rearing and brood survival rate.

Eighteen honey bee colonies, headed by naturally mated local queens with similar strength and structure occupying 5-Langstroth frames were chosen. Commercial beeswax foundations were provided from two different sources. Eighteen frames with high quality wax foundation (10 % paraffin) and eighteen frames with low quality wax foundation (50% paraffin) were constructed. Experimental colonies were divided into six 3-colonies groups. During experiment period: nectar and pollen shortage, each colony was weekly fed a 300 gm patty of supplementary protein diet (25 % dried medical brewer yeast, 65 % powdered sucrose sugar and 10 % warm honey solution). The experimental frames with wax foundations were inserted into hives in the beginning of experiment. Three groups received frames with high quality foundations, while the others received the low quality foundations. One group of both categories was provided with one, two or three frames instead of one, two or three removed brood combs, respectively. Colonies of group which received one foundation sheet each are considered controls. Drawn areas of foundations were measured in square inches after 24 and 48 hours using empty wooden frame divided with wires into one-inch^2 squares. Also, sealed worker brood areas were measured using the measurement frame as mentioned above, but after 12 and 24 days. On the other hand, percentages of brood survival rate were estimated after 12 and 24 days based on proportion of sealed brood cells number to unsealed cells number counted in brood section area (6 rows X 20 columns) in which the wire is not embedded.

3. Statistical analysis.

The obtained data were checked for normality followed by analysis using analysis of variance (ANOVA), and then a post-hoc test using Tukey test at 0.05 probability level was applied to compare means. The statistical analysis was done using Statistical Package for the Social Sciences (SPSS).

RESULTS AND DISCUSSION

Results

1. Characteristics of natural wax combs built by local honey bees

Table (1) presents a summary of the measured characteristics of beeswax samples from six local honey bee colonies. No statistical variations were found between colonies in cell width only while the other characteristics showed statistical variations between some colonies. One colony had the highest mean for wax length while two colonies showed the highest means for the other characteristics (Fig. 5). The maximum variations between colonies in characteristics of naturally building combs were 0.78, 0.20, 0.55 mm, and 32.75 mm^3 for wax cell length, width, depth, and size, respectively.

Table 1. Measured parameters (Means±S.E.) for six beeswax samples from six colonies. Means are statistically compared using Tukey test0.05.

Colonies	Length (mm)	Width (mm)	Depth (mm)	Size (mm^3)
1	5.008±0.01 c*	5.292±0.05 a	8.10±0.12 ab	192.13±2.46 a
2	5.000±0.01 c	5.267±0.05 a	8.17±0.11 ab	130.13±7.18 c
3	5.783±0.07 a	5.467±0.07 a	8.48±0.10 a	168.58±6.76 b
4	5.417±0.07 b	5.450±0.07 a	8.27±0.13 ab	191.77±2.25 a
5	5.367±0.06 b	5.333±0.06 a	8.47±0.11 a	163.85±6.45 b
6	5.483±0.08 b	5.283±0.05 a	7.93±0.12 b	159.38±6.47 b
Overall mean	5.343±0.02	5.349±0.02	8.24±0.05	167.64±2.55

***: Means followed by the same letter in the same column are not statistically different (α = 0.05).**

2. Developing paint materials to motivate building wax foundation.

The preliminary results of using three cream types (beeswax + oils) showed statistical variations in mean percentages of cells built on wax foundation by bee workers (Fig. 6). Lemon oil showed the best results in attracting bees to build wax foundations, followed by rose oil, and finally coconut oil and the control group. Beeswax paint scented with lemon oil enhanced workers to build significantly more cells on foundation than those built when scented with coconut oil or untreated (control), but the difference was not significant in case of beeswax paint scented with rose oil. Moreover, beeswax paints exceeded control (no treatment) with percentages of 25.33, 8.00 and 3.66 % when scented lemon oil, rose oil or coconut oil, respectively. Perhaps the scent of lemon oil was more attractive to bees than the other oils. So, the best results were to this specific oil. It could be said that using lemon oil mixed with beeswax is promising for encouraging bees to rapidly build beeswax foundations.

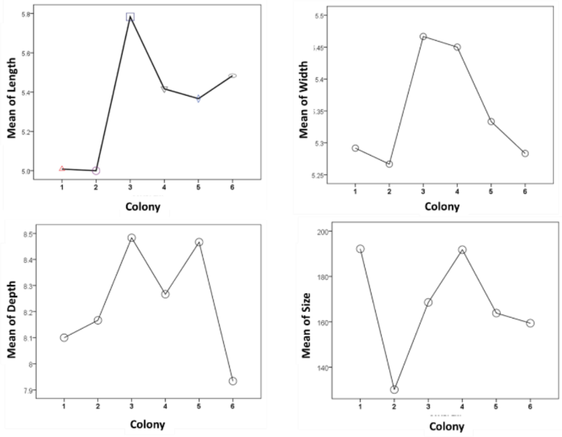

Fig. 5. Comparisons between beeswax samples in measured parameters.

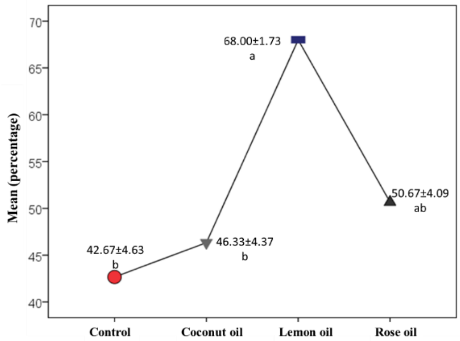

Fig. 6. Variations among beeswax paints scented with lemon, rose and coconut oils in enhancing bee workers to build cells on wax foundation. Values above each symbol are means ± S.E. Means followed by the same letter are not significantly different.

3. Effects of foundation quality and removal degree of brood combs on speed of foundation drawing by honey bee workers

Table (2) illustrates means of measured drawn areas (inch^2) of foundations from two sources 24 and 48 h after removal of one, two or three brood combs from colonies. Statistical analysis revealed that the effect of removal degree of brood combs was consistent showing significant increase in drawing out foundations as the removal degrees increased. Also, high quality beeswax foundations (10 % paraffin) were significantly more acceptable and drawn rapidly by workers than low quality foundations adulterated with high paraffin content (50%) after 24 and 48 hours, whatever the removal degree of brood combs.

Table 2. Measured drawn areas (means ± S.E.) of foundations (inch^2) from two sources: 24 and 48 h after removal of one, two or three brood combs from colonies. Pairwise comparisons within each source period were tested using t- test (α = 0.05).

Removed brood combs (N.)	Drawn area of foundation (inch^2) 24 h: High quality foundation (10 % paraffin)	24 h: Low quality foundation (50% paraffin)	48 h: High quality foundation (10 % paraffin)	48 h: Low quality foundation (50% paraffin)
One	37±2.17c	11.66±1.01c	72.66±2.74c	60.33±2.20c
	t = 10.53, df = 4, P < 0.05		t =3.50, df = 4, P = 0.03	
Two	516±2.02b	323.8±10.82b	520±0.00b	409±4.82b
	t = 17.49, df = 4, P < 0.05		t = 23.02, df = 4, P < 0.05	
Three	655±6.08a	440.83±16.53a	660.8±5.93a	544.5±25.47a
	t = 12.15, df = 4, P < 0.05		t = 4.44, df = 4, P = 0.01	
Overall mean	402.83±93.63	258.77±64.29	417.83±88.67	337.94±72.49
	t = 1.26, df=16, P P > 0.05		t test =0.69, df=16, P > 0.05	

Means followed by the same letter in the same column are not statistically different (ANOVA followed by Tukey test, α = 0.05).

4. Effects of foundation quality and removal degree of brood combs on brood rearing activity.

Table (3) presents means of measured sealed brood area (inch^2) in combs built on foundations from two sources, 12 and 24 d after removal of one, two or three brood combs from colonies. Also, the same pattern was obtained regarding brood rearing activity after 12 and 24 days, but brood rearing activity in combs built on low quality foundations after 24 days did not significantly differ when 2 or 3 brood combs were removed.

5. Effects of foundation quality and removal degree of brood combs on brood survival rate.

Table (4) presents means of estimated brood survival rate (%) in combs built on foundations from two sources, 12 and 24 d after removal of one, two or three brood combs from colonies. Obtained data showed that using low quality foundations resulted in significantly lower brood survival rate compared the high quality foundations after 12 and 24 days at all removal degrees of brood combs.

Table 3. Means ± S.E. of measured sealed brood area (inch^2) in combs built on foundations from two sources, 12 and 24 d after removal of one, two or three brood combs from colonies. Pairwise comparisons within each source period were tested using t- test (α = 0.05).

Removed brood combs (N.)	Sealed brood area (inch^2)			
	12 d		24 d	
	High quality foundation (10 % paraffin)	Low quality foundation 50% paraffin)	High quality foundation (10 % paraffin)	Low quality foundation (50% paraffin)
One	109±3.32c	83±3.68b	172.66±6.52c	87±3.32b
	t = 5.23, df = 4, P < 0.01		t =11.7, df = 4, P < 0.05	
Two	174.33±3.34b	146.16±4.51a	209.5±5.48b	156.33±3.65a
	t = 5.01, df = 4, P < 0.01		t = 8.06, df = 4, P < 0.01	
Three	211.83±5.19a	159.5±6.37a	242±5.22a	166.5±4.76a
	t = 6.63, df = 4, P < 0.01		t = 10.67, df = 4, P < 0.05	
Overall mean	165.05±15.15	129.55±12.05	208.05±10.42a	136.61±12.64b
	t = 1.833, df = 16, P > 0.05		t = 4.36, df = 16, P < 0.05	

***: Means followed by the same letter in the same column are not statistically different (ANOVA, Tukey test, α = 0.05).**

Table 4. Estimated brood survival rate (Means±S.E.) (%) in combs built on foundations from two sources 12 and 24 d after removal of one, two or three brood combs from colonies. Means are statistically compared using Tukey test0.05.

Removed brood combs (N.)	Brood survival rate (%)			
	12 d		24 d	
	High quality foundation (10 % paraffin)	Low quality foundation (50% paraffin)	High quality foundation (10 % paraffin)	Low quality foundation (50% paraffin)
One	77±3.61a	51.66±4.91a	79.5±4.91a	50.33±2.20a
	t = 4.14, df=4, P < 0.01		t = 5.42, df=4, P < 0.01	
Two	77±2.75a	48.5±2.75a	78.5±1.60a	54.33±2.35a
	t = 7.31, df=4, P < 0.01		t = 8.48, df=4, P < 0.001	
Three	73.5±2.75a	55.83±3.65a	80.50±3.40a	61.16±4.20a
	t = 3.86, df=4, P < 0.01		t =3.57, df=4, P < 0.05	
Overall mean	75.83±1.64a	52±2.21b	79.5±1.80a	55.27±2.20b
	t = 8.65, df=16, P < 0.05		t = 8.50, df=16, P < 0.05	

Means followed by the same letter in the same column are not statistically different (ANOVA followed by Tukey test, α = 0.05).

Discussion

Honey bee workers manipulate wax scales by their legs and mandibles, assess how and where the construction needs to be amended using their antennae and other sensors, and process information from nest mates to complement the efforts of building combs efficiently. Workers build combs, in the typical manner, from the top and working downwards. To build a natural wax cell, workers form first a "block" made from balls of wax softened by a process of chewing and moistening, then sculpt it to form the rhombic bases, and add further balls of wax to form the cell walls and edges (Gallo and Chittka, 2018). The mismatch between the natural cell size and that suggested by the foundation required adaptive modification of the bees' natural construction habit. Workers build larger hexagonal cells for drones and smaller ones for workers, but they can also build pentagonal or heptagonal cells depending on need. Worker cells are a little smaller than drone cells. The comparative sizes are best presented as: 4 drone cells or 5 worker cells per linear 25.4 mm of comb. Both types of are used to store honey and pollen besides its using in raising specific brood. Naturally, bees prefer to store honey in drone comb, but in modern beekeeping bees are compelled to construct mostly worker comb because of wax foundation sheet used by beekeepers.

Pesticides which remain in the hive may lead to toxic home syndrome which may not be solved by wax replacement because the lipophilic property of acaricides residues remaining in beeswax even after recycling (Mullin *et al*., 2010). Also, trace residues of plant protection products and biocides were detected (Alkassab *et al*., 2020; Wilmart *et al*., 2021). Further, synergistic effects of single factors may add up to a threat greater than sum of them. Consequently, these factors or contaminants exacerbate the potential challenges not only for worker bees, but also for drones and queens (Rinderer *et al*., 1999; Johnson *et al*, 2009; Fisher and Rangel, 2018; Leska *et al*., 2021). Further, replacement of comb reduces the amount of old comb that the wax month can feed upon. Thus, higher exchange rates (>30%) of old brood frames in the previous summer and using natural comb (without foundation) tend to lower winter honey bee colony loss rate, but purchasing wax from outside the own operation may result in higher loss rates (Oberreiter and Brodschneider, 2020). Therefore, it is good management to insert some frames containing good foundation to the hive every year instead very dark, leathery, combs with thickened cell walls.

Bees will not draw out comb unless they need it, so unless there is a need foundation will not be drawn. Therefore, removal of one brood comb or more expected to increase bees need to rapidly replace the lost part of their nest. For example, young bees of a swarm are ready to draw comb, and are motivated to build a new home. Likewise, if managed colony nest is reduced, provided with foundations and fed well it will draw out all available frames to be fully drawn combs quickly. Un-dyed, unscented good paraffin wax added to crude beeswax during manufacturing foundations at 10 % rate was acceptable by worker to draw sheets within 24 h. On contrary, foundations made from dyed crude beeswax adulterated with 50 % bad paraffin wax were not attractive enough to be completely drawn before 48 h. Abd El-Wahab *et al*. (2018) found variation in the quality of certain beeswax foundation sheets locally marketed in Egypt, which affected comb building and brood rearing. Moreover, obtained results showed that the increased amounts of brood reared were probably associated with drawing out more new cells and combs built on high quality foundation sheets. On the other hand, scattered brood were noticed during the first cycle of brood reared in combs built on bad foundation sheets. This fining was not in accordance with Chęć *et al*. (2021) who found that in combs built on wax foundation adulterated with 10, 30 or 50% of paraffin did not reduce the survival of the brood. But, obtained results were consonant with their results regarding wax foundations adulterated with 10, 30 or 50% of stearin: the survival of brood significantly decreased compared to the survival rates noted on pure beeswax foundations resulting in scattered brood caused by the death of young larvae.

Paraffin wax is mostly found as a white, odorless, tasteless, waxy solid derived from petroleum, coal or oil shale. It has a melting point between about 46 and 68 °C, but it may begin to melt below these degrees. Pure beeswax has a good aroma, is soft and pliable around 35-40 °C, and melts at 64.5 °C. Kind and percentage of paraffin content of foundation wax may depress melting point affecting softness and pliability of sheets and consequently handling foundation frames. Also, high ambient or hive temperature over 35 °C can affect sheets after inserted inside hives, and the drawn combs may lose their strength and collapse. Foundation should not be fixed in frames too early before the expected time of placement in the hive because it may warp if it was made of wax with high content of paraffin. This in turn results in a warped comb that is difficult to remove from the hive. To remedy this problem, many factories may add harder stearic acid. Also, bleaching materials such as sulphuric acid or hydrogen peroxide may be added if crude beeswax was dark. These procedures could diminish the quality of foundations, and later increases the potentiality of scattered brood appearance. Pay attention to these problems is desired, hence the need for beeswax quality control (Daniele *et al*., 2018; Eshete and Eshetie, 2018; Chęć *et al*., 2021).

Finally, wax foundation is used to encourage bee workers to draw out comb to cover the full surface area o f a frame. Regular removal of heavily infected or contaminated old and dark combs from bee hives, and replacing them with frames with high quality foundations is part of the hygiene management of colonies, and could be the most important prevention and management practice in beekeeping. However, if conditions are poor, the bees may not readily draw the foundations. This practice could eliminate comb contaminants, control most brood diseases, and provide new combs demanded for exporting bee packages. However, many kinds of commercial beeswax foundations are drawn slowly to build new combs. Also, low brood survival rates became common in many apiaries due to different potential reasons. Therefore, characteristics of wax combs naturally built by local honey bees were studied. These characteristics were wax cell length, width, depth, and the size of wax cell. Further, evaluating paint materials, based on beeswax scented with lemon oil, rose oil or coconut oil, to motivate building wax foundations by bee workers. Lemon oil was the most effective oil in attracting workers to build combs on foundations. On the other hand, foundation quality according to paraffin content, and removal degree of brood combs were investigated if they influence speed of drawing foundations, brood rearing and brood survival rate. The high quality beeswax foundations (10 % paraffin) were significantly more acceptable and drawn out rapidly by workers than low quality foundations (50% paraffin) whatever the removal degree of brood combs. Further, the same pattern was obtained regarding brood rearing activity especially during the first cycle of reared brood. Using low quality foundations resulted in significantly lower brood survival rate compared the high quality foundations. Thus, it is recommended that a beekeeper regularly rotate the comb in their operation to maintain relatively fresh and clean wax in their hives using good foundations made of high quality beeswax. Finally, this work proved the importance of lemon oil, removal of combs and high quality of foundation wax in motivation of honey bee colonies to draw foundation sheets or to build new combs.

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تحفيز طوائف نحل العسل *Apis mellifera* لمط الأساسات الشمعية وبناء الأقراص

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تعتبر عملية استبدال الأقراص الداكنة القديمة إحدي الممارسات المهمة لتقليل ملوثات الأقراص والسيطرة علي معظم أمراض الحضنة وتوفير أقراص جديدة للتصدير. يوجد عوامل عديدة تؤثر علي مط الأساسات الشمعية وتوزيع الحضنة في مناحل عديدة. لذلك فإن هذا العمل صمم لتحديد بعض خصائص أقراص الشمع المبنية طبيعيا بواسطة نحل العسل المحلي وتطوير مواد دهان لتحفيز شغالات نحل العسل لبناء الأساسات الشمعية ولتحديد ما إذا كان لجودة الأساس ودرجة إزالة أقراص الحضنة من الخلية تأثيرات علي سرعة مط الأساس وتربية الحضنة ومعدل بقاء الحضنة. وكأحد النتائج فإن أقصي اختلافات بين الطوائف في بناء أقراص الشمع طبيعيا كانت 0.78 ، 0.20 ، 0.55 مم ، 32.75 مم^3 في طول العين السداسية وعرضها وعمقها وحجمها علي الترتيب. أيضا تفوقت دهانات شمع النحل بزيت الليمون ، زيت الورد ، زيت جوز الهند عن المقارنة (بدون معاملة) في دفع شغالات نحل العسل لبناء الأقراص بنسب مئوية قدرها 25.33 ، 8.00 ، 3.66 % علي الترتيب. بالإضافة إلي ذلك كان تأثير درجة إزالة أقراص الحضنة ثابت حيث أظهر زيادة معنوية في مط الأساسات مع زيادة درجات الإزالة. ونتيجة هامة أخري تتعلق بجودة الأساس أكدت أن الأساسات الشمعية عالية الجودة (10 % بارافين) تم قبولها ومطها بسرعة بواسطة شغالات نحل العسل بدرجة معنوية أعلي من الأساسات الشمعية الرديئة التي تم غشها بنسبة عالية من شمع البارافين (50 %) بعد 24 ، 48 ساعة أيا ما كانت درجة إزالة أقراص الحضنة. أيضا وجد نفس الوضع فيما يخص نشاط تربية الحضنة بعد 12 ، 24 يوم ولكن نشاط تربية الحضنة في الأقراص المبنية علي أساسات رديئة بعد 24 يوم لم يختلف معنويا عندما تم إزالة 2 أو 3 أقراص حضنة. وعلي جانب أخر فإن استعمال أساسات رديئة أدي إلي معدل بقاء حضنة أقل معنويا بالمقارنة بالأساسات الجيدة وذلك بعد 12، 24 يوم في بصرف النظر عن درجات إزالة أقراص الحضنة.