RESEARCH PAPER

Interrelation ship between honey bee workers activity and artificial foods
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ABSTRACT:
This study was conducted in March 2015 during seasonal period; spring, early summer, late summer and autumn respectively at the apiary of the Grdarasha research station of Agriculture College, Salahaddin University - Erbil / Kurdistan Region- Iraq. The result showed that the highest numbers of workers prefer fed on dry yeast was 529,000 workers inside the hives and 252,333 workers outside the hives. The highest average age of longevity was 31.5 days when fed on dry yeast and the lowest average was 26.0 days fed on bean. The highest percentage of protein content in workers body was 48.922% fed with dry yeast and the lowest was 40.915% fed with bean. The workers fed on dry yeast gave the higher resistant to cooling at 15°C for 14 days, at 12°C for 11 days at 8°C for 8 days and at 4°C 6 days for both dry yeast and broad bean. The workers fed with bean and sugar solution gave the lower resistant to cooling at 15°C for 11 days, at 12°C for 10 days, at 8°C for 6 days, at 4°C for 5 days. The highest average of body weights of mature larvae fed on dry yeast was 106.20 mg but the lowest was 79.45 mg fed on bean in spring season. The highest body weight of ten day old workers was 121.15 mg fed on broad bean and the lowest was 102.95 fed on bean in spring season.

KEY WORDS: honey bee, Supplementary food, activity, worker bee.
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INTRODUCTION:
Beekeeping and honey production were well known to the ancient Kurdish people, the honey has become one of the important foods in Kurdistan. In northern part of our country Erbil governorate, summer season is so longer and hot as compared to other parts. The natural bee flora starts disappearing for the months causing dearth of food (pollen and nectar) for bees.

The periodical dearth periods of pollen result into low nutritional reserves which adversely affect the colony performance due to stoppage or reduction of egg laying, brood rearing and low honey production.

The necessity of artificial diets to honey bees has been long-standing interest to the beekeeping industry. Pollen grains, nectar and honey are the necessary constituent for the growth and development of the honey bee. (Haydak 1967). Heinrich (1979) indicated that honey bees drop into a cold comatose condition when the temperature decreased below 10°C and could not voluntary recover without external warming. Dietz et al., (1989) found that both Africanized and European honey bee colonies died when exposed to the temperature
0°C. Targany (2008) found that the workers tolerated cold temperature dependent on different types of foods. Daly and Morse, 1991; Shamdin, 2003 and Bas, 2013. Mentioned that the amount foods of honey bee larvae had effects on adult body weight.

1. MATERIALS AND METHODS

This study was conducted at the apiary of the Grdarasha research station of agriculture college, 10 km south of the college of Agriculture – salahaddin university in Erbil in March, 2015 in order to study the effect of some supplemental foods on the honey bees activities and production of (broods, honey, wax and pollen) during spring, early summer, late summer and autumn seasons under field condition. At the beginning of the research sixteen colonies of Apis mellifera were selected from apiary depending on the following characters:

For measurement, two langstroth frames were prepared, first then changed in way by dividing each frame in to 17 inch (43.2 cm) in length and 8 inch in width, holes made to each frame fastening wires (silk) which was across of two wires equal in length and wide with one square inch in a way that the total number of the inch were equal to 136 inch. (Targany, 2008 and Bas, 2013).

Sugar solution (control) : Sugar solution was prepared by dissolving one kilogram of crystal sugar in one liter of water after the water was heated to 70°C, each colony was supplied with one liter of sugar solution at the same concentration weekly during different season (spring, early and late summer and autumn). The ratio of concentration was 1:2 in summer 1:1 in spring and autumn (Targany, 2008 and Bas, 2013).

The prepared food was given to the bees by using plastic bottles which was put on the frames in the hive. The bottle cover was pierced circularly in an appropriate way to allow the food came down gradually and the bottle were put on two pieces of wood to allow the bees reach the food and eat them, the wood under the bottle was 10cm long and 1.5cm wide. (Targany, 2008).

Samples were taken from experimental colonies containing a considerable number of labeled workers with known ages on colony inspection (Bas, 2013).

Studying the food preference and acceptance by the honey bees for all the replicates and for a period of four continuous days at three different times (9-10, 12-1, 3-4) hourly of the day and calculated the number of honey bee worker coming to feed on the food inside and outside the hives in the each replicate for 45 minutes at the day (Targany, 2008).

For determination of honey bee longevity were numbers of honey bee workers caged for each treatment contained (60 workers) of different ages in small cages with small empty piece of comb used for water and fed on the same prepared food the caged worker bees with the food were put in the hive to determine their longevity monitoring calculating the dead bees and adding food to them when needed to avoid bee death during shortage of food (Abou-EL-Enain et al., 2006 and Targany 2008).

The climatic information was taken from Erbil General Directorate of Metrology and Seismology.

The results were analyzed statistically using factorial design with four replicate. Statistical analysis was performed using SAS program (2002-2003), version 9.1; Duncan’s multiple range Test was used to determine the differences between means at P= 0.05.

2. RESULTS AND DISCUSSION

Table (1) shows that the worker bees prefer feeding on dry yeast plus sugar solution inside and outside the hive then sugar solution, broad bean plus sugar solution and finally bean plus sugar solution. The highest numbers of workers prefer fed on dry yeast were 529,000 workers inside the hives but outside the hives was 252,333 workers. Statistical analysis showed significant difference at level 0.05 between treatments and prefer the foods where the superiority of dry yeast plus sugar solution in comparison with other treatments. The result agreed with Al-Sharhy and Al-Ghamdi (2007) who indicated that honey bee colonies fed on a mixture of yeast meals with gluten or yeast has...
a high palatability by bees similar to palatable natural commercial pollen, with Hayes (1984) who recommended that the soybean flour and yeast added to candy as the food to be given to colonies in the spring. Al-Ghamdi (2002) who observed that the Carniola bee colonies which were fed on pollen supplementary feeding during the experiment period indicated to the highest level of population density, brood rearing, pollen and honey storage compared with the control colonies which were only fed on natural food sources and the number of combs covered with bees in colonies supplement with patty increased gradually. Al-Ansari (1998) stated that the beekeepers often feed their colonies by alternative food or complementary food during the summer to make up for the shortage of both pollen and nectar.

Table (1): Food preference by honey bee workers in and outside the hives during different times of day /2015.

| Food         | Times of day (9-10, 12-1, 3-4 ) hours | Means   |
|--------------|---------------------------------------|---------|
|              | Inside                                | Outside |         |
| Sugar solution | 502.333 B                             | 229.333 f | 365.833 b |
| Broad bean    | 455.667 C                             | 144.000 g | 299.833 c |
| Dry yeast     | 529.000 A                             | 252.333 e | 390.667 a |
| Bean          | 349.333 D                             | 93.000 h  | 221.167 d |
| Means         | 459.083 A                             | 179.667 b |         |

Means with the same letter are not significantly different at the level 0.05.

Table (2) shows the effect of some supplemental food on the caged honey bee workers in the hive and fed on sugar solution was 26.500 days and the longevity ranged between 13-40 days, while the average age of the workers fed on broad bean plus sugar solution was 29.500 days and the longevity ranged between 16-43 days, but the workers fed on dry yeast plus sugar solution reaged 31.500 days and the longevity ranched between 18-45 days and the workers fed on bean plus sugar solution was 26.00 days and the longevity ranged between 13-39 days. The highest average age was 31.500 days treated with dry yeast and compared with the lowest average was 26.00 days fed on bean. Statistical analysis showed significant differences at level 0.05 between dry yeast and other treatments. The results agreed with El-Banby and Gorgui (1970) who revealed that the average age of the longevity of workers when fed on the sugar syrup was (23.42) days while fed corn flour and sugar syrup is 31.35 days and fed a mixture of skim milk, corn flour and sugar syrup (1:2) lived (29.63) days and the average age of workers fed on brewers yeast with skim milk and corn flour and sugar solution was (34.47) days and with Abdullah (1988) who found the effect of nutrition on longevity of caged workers bee was less than the average age of 27.8 days when feeding honey, while the average age of the worker bees fed on soybeans, sugar syrup, sucrose syrup plus soybean and skim milk were (53.28, 29.16, 34.22) days respectively while Jevral protein was (50.55) days. Abou El-Enain, et al., (2006) stated that the age rates for the cages bee it were (15.07, 28.94, 23.0, 15.13, 16.31) days for all deist soybeans, wheat germ, dry yeast, palm dates and sugar syrup respectively, and wheat germ treatment superior of incorporeally the rest of the treatments, said that the cause this is due to the protein content of wheat germ. Targany (2008) who recorded the average age of caged workers bee in the hive when fed on sugar syrup, apricot juice plus sugar syrup, feramil plus sugar syrup and corn flour plus skim milk plus sugar syrup amount to (27.510, 36.220, 42.720, 45.310) days respectively and showed the superior of apricot and feramil on other diets. El-Hady, (2012) who showed the longest mean of age at (16 –18 days) when the newly emergence workers fed on soybean cake. Irandoust and Ebadi (2013) showed that the highest longevity of caged honey bees was (61 days) fed with Wheat gluten supplement and lowest (9.2 days).
longevity fed with lentil substitute of bees in 50% mortality, while in 100% morality pollen and lentil substitutes caused the highest (143.5 days) and lowest (20.7 days) longevity of bees, respectively.

Table (2): Effect of some supplemental food on longevity of worker bees in the hives /2015.

| Food      | Number of workers | Range of dates | Means of workers longevity |
|-----------|-------------------|----------------|----------------------------|
| Sugar solution | 6                | 3-40           | 500 b                      |
| Broad bean        | 6                | 6-43           | 500 ab                     |
| Dry yeast         | 6                | 8-45           | 500 a                      |
| Bean           | 6                | 3-39           | 0 b                        |

Means with the same letter are not significantly different at the level 0.05.

The temperature 15ºC: The percentage mortality started among all workers of all treatment at the 24 hours 1day to reach 6.66%, 8.33%, 6.66% and 6.66% respectively as shown in table (3/A). The percentage of mortality rate was reached 100% at the 11 days for treatment of sugar solution and bean, at the 12 days for treatments of broad bean and dry yeast. The treatment of dry yeast gave the high energy for tolerant than other treatments.

The temperature 12ºC: The percentage mortality started among all workers of all treatment at the 24 hours 1day to reach 8.33%, 6.66%, 6.66 % and 6.66 % respectively as shown in table (3/B). The percentage of mortality rate was reached 100% at the 10 days for treatments of sugar solution and bean, at the 12 days for treatment of broad bean, at the 14 days for treatment of dry yeast. The treatment of dry yeast gave the high energy for tolerant than other treatments.

The temperature 8ºC: The percentage mortality started among all workers of all treatment at the 24 hours 1day to reach 18.33%, 11.66%, 6.66%, and 11.66 % respectively as shown in table (3/C). The percentage of mortality rate was reached 100% at the 6 days for both treatments of sugar solution and bean, at the 7 days for treatment of broad bean, at the 8 days for treatment of dry yeast. The treatment by dry yeast was more tolerant the cool temperature of other treatments at the 8ºC.

The temperature 4ºC: The percentage mortality started among all workers of all treatment at the 24 hours 1day to reach 18.33%, 23.33%, 26.66% and 26.66% respectively as shown in table (3/D). The percentage of mortality rate was reached 100% at the 5 days for treatments of sugar solution and bean, at the 6 days for treatments of broad bean and dry yeast. The treatment of dry yeast and broad bean gave more tolerant the cool temperature at 4ºC. These results agreed with Shamdin (2003) who recorded that the workers in caged which fed by vitamin C with sugar solution remained on lived at the 5ºC for 5 days, at the 10ºC for 7 days and at the 15ºC for 16 days. Villa and Rinder (1993) who found that the worker in caged lower significantly amounts of sucrose syrup at 15 ºC. Bas (2013) who recorded that the caged workers bee fed on vitamin C tolerated the cold temperature when exposed to 15ºC for 15 days, 10ºC for 7 days, 5ºC for 7 days, on other hand disagreed with Targany (2008) who found that the workers tolerated cold temperature dependent on different types of foods the workers when exposed at 15 C. for longer period of cold temperature about 156 hours fed of apricot juice, feramil, sugar solution and corn flour respectively while about 120 hours at 8 ºC, 72 hours at 6 ºC and 60 hours at 4 ºC while workers fed on apricot juice and feramil for longer period to tolerated cold temperature when exposed at 0ºC for 24 hours, at 4ºC for 60 hours, at 8 ºC for 120 hours, at 15ºC for 156 hours.

Table (4) shows the effect of some supplemental food on body weights of mature larvae supplemented with sugar solution, broad bean, dry yeast and bean in spring season were 83.00, 96.95, 106.20 and 79.45 mg respectively. The highest average was 106.20 mg fed on dry yeast while the lowest average was 79.45 mg fed on bean. Statistically significant difference at level 0.05 between treatments and body weight of mature larvae fed on dry yeast where superior compared with other treatments.
The average of body weights of mature larvae supplemented with sugar solution, broad bean, dry yeast and bean in early summer season were 85.30, 91.20, 99.80 and 77.85 mg respectively. The highest average was 99.80 mg fed on dry yeast while the lowest average was 77.85 mg fed on bean. Statistically shows significant difference at level 0.05 between treatments and body weight of mature larvae fed on dry yeast where superior compared with other treatments.

The average of body weights of mature larvae supplied with sugar solution, broad bean, dry yeast and bean in late summer season were 87.20, 93.65, 100.80 and 76.80 mg respectively. The highest average was 100.80 mg fed on dry yeast while the lowest average was 76.80 mg fed on bean. Statistically, there was significant difference at level 0.05 between treatments and body weight of mature larvae fed with dry yeast where superior compared with other treatments.

The average of body weights of mature larvae supplemented with sugar solution, broad bean, dry yeast and bean in autumn season were 81.85, 86.90, 98.50 and 75.90 mg respectively. The highest average was 98.50 mg fed on dry yeast while the lowest average was 75.90 mg fed on bean.

Statistically, there was significant difference at level 0.05 between treatments and body weight of mature larvae fed on dry yeast where superior compared with other treatments. Statistically had significant differences at level 0.05 between treatments and body weight of mature larvae in four seasons fed on dry yeast where the superiority in comparison with other treatments. Statistically the effect of supplemental foods there were a significant difference between the body weight and foods, dry yeast considered as a best food compared with other treatments as shown in table (4). These results agreed with Shamdin (2003) who recorded that the highest rates of weights was (126.58mg) of the mature larvae fed with soya bean. Bas (2013) record highest rate of body weights (mg/larva) of mature larvae fed with gevral protein were 121.50, 116.20 and 112.03 in spring, summer and autumn respectively.

Table (5/A, B, C and D) shows the effect of some supplemental food on body weights of workers from four treatments with four ages in spring, early summer, late summer and autumn seasons. The comparison among the body weight in each ages showed significant differences at level 0.05 between treatments in all seasons. Highest weight of one day old workers was 111.45 mg fed on dry yeast in autumn season while the lowest weight was 83.02 mg fed on bean in early summer. The highest mean of body weight was 104.91 mg fed on dry yeast and lowest was 86.85 mg fed on bean. The highest body weight of ten day old workers was 121.15mg fed on broad bean in spring season while the lowest body weight was 81.32 mg fed on bean in early summer and the highest mean of body weight was 112.76mg fed on dry yeast and lowest was 89.17mgfed on bean. The highest body weight of twenty day old workers was 98.60 mg fed on dry yeast in early summer season while the lowest body weight was 70.55 mg fed on bean in early summer. Also the highest mean of body weight was 94.33mg fed on dry yeast and lowest was 73.28mgfed on bean. The highest body weight of thirty day old workers was 94.32 mg fed on dry yeast in spring season while the lowest body weight was 66.62 mg fed on bean in late summer. The highest mean of body weight was 87.60 mg fed on dry yeast and lowest wa 87.60 mg fed on dry yeast and lowest was 69.04mg fed on bean. Figure 1, 2, 3, and 4 shows the effect of supplemental food on the body weight in different seasons.

The results agreed with Daly and Morse (1991) who mentioned that the amount foods of honey bee larvae had effects on adult body weight. Shamdin (2003) found highest rate body weight of one day old was (109.15mg) and (91.14mg) thirty day old workers when fed on soy bean.

De Groot (1953) who observed that the mean dry weight of worker bees 28 days old lower than worker bees 14 days old was (20.7 and 22.4 mg).

Ayoub (2011) who found that the weight of 10 days old workers higher than the body weight of newly emerged and forager workers. Bas (2013) who recorded the highest rate of body weight of newly emerged workers
in colonies fed with gevral protein was 113.60 mg/ workers in autumn season and The highest body weight of seven day old workers in colonies fed with gevral protein was 123.97 mg. in spring season, The highest body weight of twenty one day old workers in colonies fed with apricot juice was 97.33 mg in summer season and the highest body weight of twenty eight day old workers in colonies fed with gevral protein was 96.73 mg. in spring season. Disagreed with Winston (1987) who stated the weight of honey bee workers ranged from 81-140 mg.

Table (6) shows the effect of some supplemental food on length and width of body dimension of the mature larvae fed on sugar solution, broad bean, dry yeast and bean in different seasons. In spring season, the length were 8.77, 9.28, 9.65 and 8.75 mm respectively. The width were 4.11, 4.13, 4.29 and 4.10mm respectively. Highest average length was 9.65 mm fed with dry yeast while the lowest average length was 8.75 mm fed with bean. In early summer season the length were 8.59, 9.35, 9.42 and 8.65 mm respectively. The width were 4.12, 4.14, 4.20 and 4.11 mm respectively. The highest average length was 9.42 mm fed with dry yeast while the lowest average length was 8.59 mm fed with sugar solution. In late summer season the length were 8.51, 8.99, 9.25 and 8.57 mm respectively. The width were 4.11, 4.43, 4.50 and 4.16 mm respectively. The highest average length was 9.25 mm fed on dry yeast while the lowest average length was 8.51 mm fed on sugar solution. In autumn season the length were 8.48, 8.95, 9.21 and 8.45 mm respectively. The width were 4.10, 4.13, 4.20 and 4.10 mm respectively. The highest average length was 9.21 mm fed on dry yeast while the lowest average length was 8.45 mm fed on bean.

The effect of foods on body dimensions the highest length of dry yeast was 9.38 mm where superior in compare with the lowest average length was 8.59mm in sugar solution. The highest average width was 4.29 mm fed with dry yeast where the superior in comparison with the lowest average width was 4.11 for each of the sugar solution and bean. Statistically there were insignificant difference between treatments and average length and width except bean and sugar solution. The effect of season on body dimensions the highest average length in spring season compared with other seasons and the highest width in late summer season. The result agreed with Bas (2013) who recorded highest rates of length of body dimensions of mature larvae were 9.93, 9.57 and 9.20 mm in colonies fed with apricot juice in spring, gevral protein in summer and autumn seasons respectively. Shamdin (2003) who recorded that the highest rate of length was 12.16mm and the highest rate of width was 4.27mmbut without significant difference between treatments and body dimension.

Table (3/A): The percentage of mortality of the workers fed on some supplemental food at 15°C.

| Food          | Mortality of workers % |
|---------------|-------------------------|
|               | 1st day  | 2nd day | 3rd day | 4th day | 5th day | 6th day | 7th day | 8th day | 9th day | 10th day | 11th day | 12th day | 13th day | 14th day |
| Sugar Solution| 6.66     | 7.14    | 9.61    | 12.76   | 14.64   | 20.00   | 25.00   | 28.57   | 33.33   | 60.00    | 100      |          |          |          |
| Broad bean    | 8.33     | 7.27    | 7.84    | 10.63   | 14.28   | 16.66   | 20.00   | 25.00   | 27.77   | 38.46    | 75.00    | 100      |          |          |
| Dry yeast     | 6.66     | 7.14    | 7.69    | 8.33    | 13.63   | 15.78   | 12.50   | 14.28   | 16.66   | 20.00    | 25.00    | 33.33    | 62.50    | 100      |
| Bean          | 6.66     | 9.92    | 11.76   | 13.33   | 17.94   | 21.87   | 24.00   | 26.31   | 35.71   | 66.66    | 100      |          |          |          |
### Table (3/B): The percentage of mortality of the workers fed on some supplemental food at 12°C.

| Food       | Mortality of workers % |
|------------|------------------------|
|            | 1st day | 2nd day | 3rd day | 4th day | 5th day | 6th day | 7th day | 8th day | 9th day | 10th day | 11th day |
| Sugar solution | 8.33    | 9.09    | 12.00   | 13.63   | 18.42   | 22.58   | 29.16   | 47.05   | 77.77   | 100      |
| Broad bean  | 6.66    | 7.14    | 7.69    | 8.33    | 9.09    | 22.50   | 22.58   | 29.16   | 41.17   | 60.00    | 100      |
| Dry yeast   | 6.66    | 7.14    | 9.61    | 12.76   | 14.63   | 17.14   | 24.13   | 31.81   | 46.66   | 75.00    | 100      |
| Bean        | 6.66    | 7.14    | 15.38   | 18.18   | 25.00   | 37.03   | 41.17   | 50.00   | 80.00   | 100      |

### Table (3/C): The percentage of mortality of the workers fed on some supplemental food at 8°C.

| Food       | Mortality of workers % |
|------------|------------------------|
|            | 1st day | 2nd day | 3rd day | 4th day | 5th day | 6th day | 7th day | 8th day |
| Sugar solution | 18.33   | 20.40   | 35.84   | 52.00   | 58.33   | 100     |
| Broad bean  | 11.66   | 20.75   | 21.42   | 36.36   | 42.85   | 58.33   | 100     |
| Dry yeast   | 6.66    | 12.50   | 16.32   | 24.39   | 35.48   | 50.00   | 60.00   | 100     |
| Bean        | 11.66   | 22.64   | 26.82   | 43.33   | 64.70   | 100     |

### Table (3/D): The percentage of mortality of the workers fed on some supplemental food at 4°C.

| Food       | Mortality of workers % |
|------------|------------------------|
|            | 1st day | 2nd day | 3rd day | 4th day | 5th day | 6th day |
| Sugar solution | 18.33   | 24.48   | 45.94   | 75.00   | 100     |
| Broad bean  | 23.33   | 30.47   | 34.37   | 42.85   | 66.66   | 100     |
| Dry yeast   | 26.66   | 29.54   | 48.38   | 50.00   | 62.50   | 100     |
| Bean        | 26.66   | 36.36   | 46.42   | 66.66   | 100     |

### Table (4): Effect of supplemental food on the body weight of mature larvae (mg)

| Food       | Weight of mature larva(mg) |
|------------|-----------------------------|
|            | Spring season | Early season | Summer season | Late summer season | Autumn season | Means |
| Sugar solution | 83.00 fg     | 85.30 f      | 87.20 ef      | 81.85 f-h         | 84.33 c      |
| Broad bean  | 96.95 bc     | 91.20 de     | 93.65 cd      | 86.90 ef          | 92.17 b      |
| Dry yeast   | 106.20 a     | 99.80 b      | 100.80 b      | 98.50 bc          | 101.35 a     |
| Bean        | 79.45 g-i    | 77.85 g-i    | 76.80 hi      | 75.90 i           | 77.50 d      |
Means with the same letter are not significantly different at the level 0.05.

Table (5/A): Effect of some supplemental food on body weight of one day old workers (mg).

| Food        | weight of one day old worker(mg) | Spring season | Early summer season | Late summer season | Autumn Season | Means |
|-------------|----------------------------------|---------------|---------------------|-------------------|---------------|-------|
| Sugar solution | 99.15 ef                          | 90.32 h       | 95.27 g             | 95.02 g           | 94.94 c       |
| Broad bean    | 103.65 bc                         | 96.65 fg      | 100.12 de           | 101.67 c-e        | 100.52b       |
| Dry yeast     | 102.65 b-d                        | 100.32 de     | 105.22 b            | 111.45 a          | 104.91 a      |
| Bean          | 94.12 g                           | 83.02 j       | 84.25 ij            | 86.02 i           | 86.85d        |
| Means         | 99.89 a                           | 92.58 c       | 96.21 b             | 98.54 a           |               |

Means with the same letter are not significantly different at the level 0.05.

Table (5/B): Effect of some supplemental food on body weight of ten day old workers (mg).

| Food        | weight of ten day old worker(mg) | Spring season | Early summer season | Late summer season | Autumn Season | Means |
|-------------|----------------------------------|---------------|---------------------|-------------------|---------------|-------|
| Sugar solution | 112.30 cd                         | 98.22 i       | 100.18 hi           | 105.15 fg         | 103.96 b      |
| Broad bean    | 121.15 a                          | 101.65 g-i    | 106.83 ef           | 113.17 b-d        | 110.70a       |
| Dry yeast     | 116.75 a-c                        | 106.77 ef     | 110.22 de           | 117.32 ab         | 112.76a       |
| Bean          | 102.95 f-h                        | 81.32 k       | 83.07 k             | 89.35 j           | 89.17c        |
| Means         | 113.28 a                          | 96.99 d       | 100.08 c            | 106.25 b          |               |

Means with the same letter are not significantly different at the level 0.05.

Table (5/C): Effect of some supplemental food on body weight of twenty day old workers (mg).

| Food        | weight of twenty day old worker(mg) | Spring season | Early summer season | Late summer season | Autumn season | Means |
|-------------|-------------------------------------|---------------|---------------------|-------------------|---------------|-------|
| Sugar solution | 80.75 d                            | 79.12 de      | 80.82 d             | 83.65 cd          | 81.08 c       |
| Broad bean    | 91.15 b                            | 92.02 b       | 82.27 cd            | 85.75 c           | 88.80 b       |
| Dry yeast     | 95.17 ab                           | 98.60 a       | 93.23 b             | 94.35 ab          | 94.33a        |
| Bean          | 75.60 ef                           | 70.55 g       | 72.40 fg            | 74.60 fg          | 73.28 d       |
| Means         | 85.66 a                            | 85.07 a       | 82.18 b             | 84.58 a           |               |

Means with the same letter are not significantly different at the level 0.05.

Table (5/D): Effect of some supplemental food on body weight of thirty day old workers (mg).

| Food        | weight of thirty day old worker(mg) | Spring season | Early summer season | Late summer season | Autumn season | Means |
|-------------|-------------------------------------|---------------|---------------------|-------------------|---------------|-------|
| Sugar solution | 71.57 gh                           | 76.65 f       | 70.82 gh            | 80.12 e           | 74.79 c       |
| Broad bean    | 83.07 de                           | 81.72 de      | 75.35 f             | 84.97 cd          | 84.09 b       |
| Dry yeast     | 94.32 a                            | 90.17 b       | 87.77 bc            | 89.37 b           | 87.60 a       |
Table (6): Effect of some supplemental food on body dimension of mature larvae.

| Food                | Body dimensions of mature larvae (mm) | Food effect |
|---------------------|---------------------------------------|-------------|
|                     | Spring season | Early summer season | Late summer season | Autumn season |
|                     | Length | Width | Length | Width | Length | Width | Length | Width | L | W |
| Sugar solution      | 8.77 de | 4.11 cd | 8.59 e-g | 4.12 c | 8.51 fg | 4.11 cd | 8.48 G | 4.10 cd | 8.59 c | 4.11 c |
| Broad bean          | 9.28 b  | 4.13 bc | 9.35 b  | 4.14 bc | 8.99 cd | 4.43 a  | 8.95 D  | 4.13 bc | 9.14 b  | 4.20 b  |
| Dry yeast           | 9.65 a  | 4.29 b  | 9.42 ab | 4.20 bc | 9.25 b  | 4.50 a  | 9.21 Bc | 4.20 bc | 9.38 a  | 4.29 a  |
| Bean                | 8.75 df | 4.10 d  | 8.65 df | 4.11 c  | 8.57 e-g | 4.16 bc | 8.45 G  | 4.10 cd | 8.60 c  | 4.11 c  |
| Season effect       | 9.11 a  | 4.15 b  | 9.00 a  | 4.14 b  | 8.83 a  | 4.30 a  | 8.77 b  | 4.13 b  |          |          |

Means with the same letter are not significantly different at level 0.05.

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