THE EFFECTS OF MEDICAL AND AROMATIC PLANT EXTRACTS ON SOME PHYSIOLOGICAL CHARACTERISTICS OF HONEYBEE (APIS MELLIFERA L.) COLONIES

Tıbbi ve Aromatik Bitki Ekstraktlarının Balarısı (Apis mellifera L.) Kolonilerinin Bazı Fizyolojik Özellikleri Üzerine Etkisi

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ABSTRACT

In this study, the effects of extracts obtained from medicinal and aromatic plants added to syrups used to feeding honeybee (Apis mellifera L.) colonies on some physiological characteristics of colonies were investigated. The experiment was carried out on 6 groups of 5 colonies. These groups are syrup (S), syrup + Urtica dioica (SU), Syrup + Melissa officinalis (SM), Syrup + Hypericum perforatum (SH), Syrup + Achillea millefolium (SA) and syrup + Thymus serpyllum (ST). As a result of the research, the sealed brood area data were determined as 3013.24±1939.26, 3107.00±2060.42, 3270.81±2194.80, 3091.20±1962.69, 3273.90±2095.49 and 3613.06±2348.27 cm² in S, SU, SM, SH, SA, ST groups, respectively. When we compare the honey yields of the experimental groups, according to group S, SU increased by 18.48%, SM 43.10%, SH 16.04%, SA 27.35% and ST 53.86%. Therefore, syrup + medicinal and aromatic plant extract mixture given to honey bee colonies may have a positive effect on colony development and honey yield.

Key words: Honeybees, feeding, plant extract, honey yield

Öz

Bu çalışmada, bal arısı (Apis mellifera L.) kolonilerinin beslenmesinde kullanılan şuruplara eklenen tibbi ve aromatik bitkilerden elde edilen ekstraktlarını, kolonilerin bazı fizyolojik özellikleri üzerindeki etkileri araştırılmıştır. Denemede 5’er koloniden oluşan 6 grup bulunmaktadır (şurup (S), şurup + Urtica dioica (SU), Şurup + Melissa officinalis (SM), Şurup + Hypericum perforatum (SH), Şurup + Achillea millefolium (SA) ve şurup + Thymus serpyllum (ST). Araştırmanın sonucunda, kapalı kuluçka alanı S, SU, SM, SH, SA, ST gruplarında sırasıyla, 3013.24±1939.26, 3107.00±2060.42, 3270.81±2194.80, 3091.20±1962.69, 3273.90±2095.49 ve 3613.06±2348.27 cm² olarak tespit edilmiştir. Ayrıca ek beslenmenin arı kolonilerinin bal verimi açısından S grubuna göre, SU %18,48, SM %43,10, SH %16,04, SA %27,35 ve ST %53,86 oranında artış göstermiştir. Balarısı kolonilerine verilen şurup + tibbi ve aromatik bitki ekstrakti karışıminin koloni gelişimi ve bal verimi üzerinde etkili olabilidigi tespit edilmiştir.

Anahtar Kelimeler: Bal arıları, besleme, bitki özü, bal verimi
Giriş: Bal arıları yeryüzündeki en önemli canlılardan birisidir. Üretimi oldukları bal, polen, propolis, arı sütü, arı kovanları ve bazı fizyolojik özelliklerini artırmak için kullanılan ekstraktların etkisi araştırılmıştır. Bal arıları hayatiyetlerini sağlamak için karbonhidratlar, proteinler, yağlar, mineral madde ve vitaminnin yanı sıra nektar, polen ve su ile beslenir. Bal arıları bu besinlerle ilgili farklı proteinlerde ve hücrelerde birleşik etkilerle birikirler ve firari olarak kovanlarda saklanır. Bu arı kovanları, bal verimliliğini ve kovanlarda çalışan işçilerin sayısını artırmaktadır. Bal arılarının kovanlarda beslenmesi, özellikle ekstraktlar ve şeker şurubunun etkisi araştırılmıştır.

Gereç ve Yöntem: Çalışmada, dehydrated ve kurutulmuş 3013,24±1939,215 cm² olarak ortalaması 3613,06±2348,27 cm² ile ST grubunda, en düşük ortalamaya ise 3013,24±1939,215 cm² ile S grubunda tespit edilmiştir (Tablo 1). Yavrulu alan miktarının high'dan etkisi istatistiksel olarak önemli çıkmıştır (<p>.05). Bal arıları kovanlarda beslenmek için, polen ve su ile bal verimliliğini artırmak için kullanılan ekstraktları kovanlarda kullanılmıştır.

Bulgular: Çalışma sonucunda en yüksek kuluçka alanı ortalaması 3613,06±2348,27 cm² ile ST grubunda, en düşük ortalamaya ise 3013,24±1939,215 cm² ile S grubunda tespit edilmiştir (Tablo 1). Yavrulu alan miktarında etkisi istatistiksel olarak önemli çıkmıştır (<p>.05). Bal arılarının kovanlarda beslenmesi, özellikle ekstraktlar ve şeker şurubunun etkisi istatistiksel olarak önemli çıkmıştır (<p>.05). Kovan dışında bal verimliliğini artırmak için ekstraktlar ve şeker şurubunun etkisi istatistiksel olarak önemli çıkmıştır (<p>.05). Bu çalışma sonucunda, S grubunun bal verimliliğinde 16,45±1,55 kg/koloni iken, en yüksek verimlilik ST grubunda 25,31±3,14 kg/koloni elde edilmiştir (Tablo 2). Deneme sonucunda S grubunda, en yüksek verim S grubunda %83,11, ST %53,86, SU %27,35 olarak verimlilik olarak belirlenmiştir. Bu deneme sonucunda, S grubunda Şeker şurubu ile şeker şurubu + ekstrakt karışımı verilmiştir. Bu deneme sonucunda, S grubunda %83,11, ST %53,86, SU %27,35 olarak verimlilik olarak belirlenmiştir. Bu çalışma sonucunda, S grubunda Şeker şurubu ile şeker şurubu + ekstrakt karışımı verilmiştir. Bu deneme sonucunda, S grubunda %83,11, ST %53,86, SU %27,35 olarak verimlilik olarak belirlenmiştir.

Sonuç: En yüksek verim S grubunda, en düşük verim ise SU grubunda %3,11 ile gösterilmiştir. Gereç ve Yöntem: Çalışmada, dehydrated ve kurutulmuş 3013,24±1939,215 cm² olarak ortalaması 3613,06±2348,27 cm² ile ST grubunda, en düşük ortalamaya ise 3013,24±1939,215 cm² ile S grubunda tespit edilmiştir (Tablo 1). Yavrulu alan miktarının high'dan etkisi istatistiksel olarak önemli çıkmıştır (<p>.05). Bal arıları kovanlarda beslenmek için, polen ve su ile bal verimliliğini artırmak için kullanılan ekstraktları kovanlarda kullanılmıştır.

INTRODUCTION

Honeybees are one of the most important creatures on earth. Honeybees supply some people with the products they produce, such as honey, pollen, propolis, royal jelly, and bee venom, but their most important role is their contributions to nature by pollination. Honeybees need carbohydrates, proteins, fats, mineral substances, vitamins, and water to survive. Honeybees gather these needs in nature from nectar, pollen and water.

Pollen is required for tissue and organ development of both larvae and young adult bees (Herbert 1992; Imdorf et al. 1998). In the early spring and late autumn periods, when these nutrients are not enough, additional feedings can be made and the needs of the colony required for survival and...
development can be met. Thus, honeybee colonies develop faster and enter the nectar flow period much stronger. As a result, honeybee colonies spend the season more efficiently. In addition, supplementary feeding in the autumn helps honeybee colonies to enter the winter more strongly and to reaching spring without losing too many bees. Supplementary feeding is of great importance for honeybees. While the honeybee colonies can meet their needs by gathering from the nature during the production season, regular supplementary feeding should be done in the early spring period, when the source is not enough in nature. Supplementary feeding is done with pure sugar syrup or by mixing different vitamins and minerals into the sugar syrup. With the widespread of organic farming, medicinal and aromatic plant extracts have been added to the syrups instead of chemical drugs.

Medicinal and aromatic plants are generally used in beekeeping due to the antibacterial, antifungal, antioxidant, antiviral effects on the honeybees on the digestive system. (Diğrak et al. 1999; Keleş et al. 2001; Soycan and Açıkgoz 2005). It has been reported that medicinal aromatic plants increase the performance and durability of poultry (Adiyaman and Ayhan 2010). This study was carried out to determine the effects of medicinal and aromatic plant extracts on the physiological properties of honeybees.

MATERIAL AND METHOD

The research was done at the beekeeping application station of Bayburt University Demirözü Vocational High School in 2019.

Honeybee colonies (30 colonies) with a one-year-old Caucasian hybrid queen bee, were equalized in terms of sealed brood area, number of frames covered with bee and food stock. Honeybee colonies were placed in Standard Langstroth type wooden beehives. These colonies had a total of eight frames, 5 of which had a sealed brood area. There were five honeybee colonies in each group. These groups are 1) Sugar syrup (S), 2) Sugar syrup + Urtica dioica extract (SU), 3) Sugar syrup + Melissa officinalis extract (SM), 4) Sugar syrup + Hypericum perforatum extract (SH), 5) Sugar syrup + Achillea millefolium extract (SA), 6) Sugar syrup + Thymus serpyllum extract (ST).

Plants collected from nature to obtain plant extracts were dried in the air circulating drying cabinets at 40°C for 40 hours (Türküsay and Onogur 1998). The dried plants were ground very finely. The ground plants were used to obtain the extract. 250 g of ground plant powder was placed in a two-liter beaker, and 650 ml of boiling double distilled water was added and left to brewed for 5 hours then filtered through a 0.45 μm whatman filter (Gunasegaran et al. 2011). The sugar syrup used in the study was prepared at a ratio of 1:1 (1 part sugar 1 part water). Of the extracts obtained, 30 ml was added to 1000 ml of sugar syrup and 500 ml was given daily to each colony in the trial groups from the formed solution.

Colonies in the control group were given 500 ml of pure sugar syrup daily (Fresnaye and Lensky 1961; Dodoloğlu 2000). Feeding of the colonies started on 15.04.2019 and finished on 25.05.2019.

In this study, some physiological properties of honeybee colonies fed with different medicinal and aromatic plant extracts such as nectar flow period weight gain, number of bee frames, which covered with bees, size of sealed brood area and honey production were investigated.

Number of Frames Covered with Bees

All colonies were equalized in terms of the number of frames covered with bee at the beginning of the experiment. The number of frames covered with bees was counted at 30-day intervals until September 5, when the honey harvest was made. The values obtained were recorded as the development of adult bees of the experimental groups (Cengiz and Erdoğan 2017).

Sealed Brood Area

The sealed brood area of the trial colonies was measured at 30-day intervals from the start of the experiment. The data obtained were calculated in cm² using the PUCHTA method. (Fresnaye and Lensky 1961).

Nectar Flow Period Weight Gain

All colonies in the experiment were weighed at the beginning of the nectar flow period and before harvest. The difference was recorded as the weight gain of the colonies in the nectar flow period (Genç 1994; Cengiz et al. 2019).

Honey Yield

At the end of the experiment (September 5), honey was harvested. The harvest was made only from honey supers. The number of the hive was written on each frame that was taken during the harvest.
After the frames were weighed and filtered, the empty frames were weighed again, and the difference was recorded as the honey yield of honeybee colonies (Genç and Aksoy 1993; Dodoloğlu 2000; Carbonari et al. 2016; Cengiz and Dülger 2018).

All data were analyzed using ANOVA (IBM SPSS 22 statistical software: IBM SPSS Statistics, Armonk, NY). Models used to measure repeated ANOVA (MANOVA) and simple ANOVA. In all analyses, the significance level was taken as $p < .05$. Duncan's post hoc test was used to compare averages.

**RESULTS**

The amount of sealed brood area from April, when the experiment started, increased continuously until July, and decreased in August. As a result of the study, the highest sealed brood area was determined at $3613.06\pm2348.27$ cm$^2$, in the ST group, and the lowest average was $3013.24\pm1939.215$ cm$^2$ in S group (Table 1). In terms of the amount of sealed brood area and compared to the control group the highest and the lowest rates of increase were in the ST group (19.90%) and in the SU group (3.11%), respectively. The effect of feeding with sugar syrup + extract mix on sealed brood area development was found to be statistically significant ($p<.05$). In terms of sealed brood area, S group, SU group and SH group were in group a, SM group and SA group were in group b, and ST group was in group c. In July, the highest and the lowest sealed brood areas value were measured in the ST group (6980.34 cm$^2$) and in the SA group (4622.04 cm$^2$), respectively (Figure 1).
| Application groups | Development of brood area (sealed brood/cm²) | Development of honeybee colonies (frames/colony) |
|-------------------|---------------------------------------------|--------------------------------------------------|
| S                 | Mean 3013.24+1939.26 a                      | 12.24+5.06 a                                     |
|                   | P Value .00                                | .00                                              |
|                   | SEM 387.84                                 | 1.01                                             |
| SU                | Mean 3107.00+2060.42 a                      | 13.84+6.26 bc                                    |
|                   | P Value .00                                | .00                                              |
|                   | SEM 412.74                                 | 1.25                                             |
| SM                | Mean 3270.81+2194.80 b                      | 14.68+7.02 d                                    |
|                   | P Value .00                                | .00                                              |
|                   | SEM 438.96                                 | 1.40                                             |
| SH                | Mean 3091.20+1962.69 a                      | 13.12+5.69 b                                    |
|                   | P Value .00                                | .00                                              |
|                   | SEM 392.54                                 | 1.14                                             |
| SA                | Mean 3273.90+2095.49 b                      | 14.52+5.63 cd                                   |
|                   | P Value .00                                | .00                                              |
|                   | SEM 419.09                                 | 1.38                                             |
| ST                | Mean 3613.06+2348.27 c                      | 15.72+6.89 e                                    |
|                   | P Value .00                                | .00                                              |
|                   | SEM 469.65                                 | 1.60                                             |

| Measuring periods | Mean 380.39+24.71 a                         | 5.00+0 a                                        |
|                   | P Value .00                                | .00                                              |
|                   | SEM 4.40                                  | .00                                              |
| May               | Mean 1530.36+172.14 b                      | 9.77+0.81 b                                     |
|                   | P Value .00                                | .00                                              |
|                   | SEM 54.24                                 | .15                                              |
| June              | Mean 3187.15+79.51 c                       | 13.77+0.82 c                                    |
|                   | P Value .00                                | .00                                              |
|                   | SEM 413.40                                 | .15                                              |
| July              | Mean 5700.73+319.05 a                      | 18.83+1.96 d                                    |
|                   | P Value .00                                | .00                                              |
|                   | SEM 81.77                                  | .42                                              |
| August            | Mean 4267.55+386.18 d                      | 22.73+2.34 e                                    |
|                   | P Value .00                                | .00                                              |
|                   | SEM 88.56                                  | .53                                              |

SEM: standard error of mean.

\( a,b,c,d,e \) \( p<.05 \).

Adult bee development, which has increased continuously since the beginning of the experiment, reached the highest level towards the end of the nectar flow period. The highest adult bee development was obtained in the ST group (15.72±6.89 frame/colony) as in the development of sealed brood area (Table 1). The average value obtained in the ST group related to adult bee development was 28.43% higher than the S group (Table 1). The average values obtained from other groups were all higher than the S group. The effect of feeds consisting of sugar syrup + extract mixture on the number of frames covered with bees was statistically significant (\( p < .05 \)). In August, the highest number of frames covered with bees was measured in the ST group (26.8 frame/colony) and the lowest value in the S group (18.8 frame/colony) (Figure 2). The values we obtained in terms of the number of frames covered with bees were higher than previous studies (Kumova 2000; Yeninar et al. 2015; Bekret et al. 2015; Dodoloğlu and Emsen 2007).

The weight gain during the nectar flow period in ST group increased by 83.11% compared to S group. The effect of sugar syrup + extracts mixture feed on nectar flow period weight gain was statistically significant (\( p < .05 \)). These values that we obtained were lower than the value obtained by Dodoloğlu et al. (2004), but higher than the results obtained by Taha (2014) (Table 2).

Table 2. The effect of syrup+medical and aromatic plan extract colony performance parameters of honeybees.
| Application groups | Weight gain of the application groups (kg/colony) | Honey yield (kg/colony) |
|--------------------|-----------------------------------------------|------------------------|
| S                  | Mean 28.54±5.03<sup>a</sup>                    | 16.45±1.55<sup>a</sup> |
|                    | <i>P</i> Value .00                              | .00                    |
|                    | SEM 2.27                                       | .69                    |
| SU                 | Mean 39.24±2.59<sup>b</sup>                    | 19.49±1.21<sup>ab</sup>|
|                    | <i>P</i> Value .00                              | .00                    |
|                    | SEM 1.16                                       | .54                    |
| SM                 | Mean 47.14±4.44<sup>c</sup>                    | 23.54±2.86<sup>cd</sup>|
|                    | <i>P</i> Value .00                              | .00                    |
|                    | SEM 1.98                                       | 1.28                   |
| SH                 | Mean 33.60±3.94<sup>ab</sup>                   | 19.09±2.74<sup>ab</sup>|
|                    | <i>P</i> Value .00                              | .00                    |
|                    | SEM 1.76                                       | 1.22                   |
| SA                 | Mean 37.68±5.60<sup>b</sup>                    | 20.95±1.94<sup>bc</sup>|
|                    | <i>P</i> Value .00                              | .00                    |
|                    | SEM 2.50                                       | .87                    |
| ST                 | Mean 52.26±6.17<sup>c</sup>                    | 25.31±3.14<sup>d</sup> |
|                    | <i>P</i> Value .00                              | .00                    |
|                    | SEM 2.76                                       | 1.40                   |

SEM: standard error of mean.
<sup>a,b,c,d</sup> <i>p</i>&lt;0.05.

**Figure 2.** The development of the number of frames covered with bee of the experimental groups fed with syrup + medicinal and aromatic plant extracts by months.

At the end of this study, the honey yield average of the colonies in the S group was the lowest 16.45±1.55 kg/colony, while the ST group presented the highest average among groups 25.31±3.14 kg/colony was obtained in the ST group where the highest yield was obtained (Table 2). In terms of honey yield, the SU group increased by 18.48%, the SM group by 43.10%, the SH group by 16.04%, the SA group by 27.35%, the ST group by 53.86% compared to the S group. The effect of sugar syrup+extract mixture feed on honey yield was statistically significant (<i>p</i>&lt; .05).
DISCUSSION

The brood area is one of the important measurements in determining colony development (Genç et al. 1999). The larger the brood area, the greater is the number of worker bees to work for the colony in the future. Our results regarding the sealed brood area are lower than the values obtained by Kumova et al. (1993), but it was higher according to the data obtained by Akyol and Kaftanoğlu 2001; Karacağlı et al. 2003; Arslan et al. 2004.

Adult bee development has increased steadily from the beginning to the end of the experiment. It reached the highest level in September. The values we obtained in terms of the number of frames covered with bees were higher than previous studies (Kumova 2000; Yeninar et al. 2015; Bekret et al. 2015; Dodoloğlu and Emsen 2007).

The increase in the number forager workers also increases the amount of nectar carried to the hive. In this study, the highest nectar flow period weight gain mean was recorded in ST group (Table 2).

The number of worker bees in the honeybee colony, the race of the honeybee, the age of the queen bee, the health of the honeybee colony, the density of the beehive in the region, the nectar flow time, the climate and weather conditions are factors affecting honey production. We obtained different values from the experimental groups related to honey yield. These values were higher than Chaudhary (2001) and lower than Wineman et al. (2003) and Akyol and Kaftanoğlu (2001).

The supplemental additional feeding is very important to honeybee colonies in autumn and spring, especially in regions with long and cold winters. Supplementary feeding eliminates the food shortage of the bee colony and encourages the colony to raise offspring. In our study, medicinal plant extracts added to syrup in the early spring period showed a positive effect on bee colonies. All of the medicinal and aromatic plants we selected were beneficial to honeybee colonies. In particular, Thymus serpyllum and Achillea millefolium had been very effective.

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