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ARAŞTIRMA MAKALESİ / RESEARCH ARTICLE

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 cm^2 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 tıbbi ve aromatik bitkilerden elde edilen ekstraktların, 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)*. Araştırma 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 cm^2 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 + tıbbi ve aromatik bitki ekstraktı karışımının koloni gelişimi ve bal verimi üzerinde etkili olabildiği tespit edilmiştir.

Anahtar Kelimeler: Bal arıları, besleme, bitki özü, bal verimi

GENİŞLETİLMİŞ ÖZET

Giriş: Bal arıları yeryüzündeki en önemli canlılardan birisidir. Üretmiş oldukları bal, polen, propolis, arı sütü, arı zehri gibi ürünlerle bir kısım insanlara fayda sağlamakta iken, polinasyonla doğaya yapmış olduğu katkıları sayesinde tüm insanoğluna hizmet etmektedir. Bal arıları hayatiyetlerini devam ettirebilmeleri için karbonhidratlara, proteinlere, yağlara, mineral maddelere, vitaminlere ve suya ihtiyaç duyarlar. Bal arıları bu ihtiyaçlarını doğada nektar, polen ve sudan karşılarlar. Erken ilkbahar ve geç sonbahar dönemlerinde bu besin maddeleri yeterli seviyede bulunmadığında ek beslemeler yapılarak koloninin yaşama ve gelişmesi için gerekli olan ihtiyaçları karşılanabilir. Ek yemleme ya sade şeker şurubu veya şeker şurubuna değişik vitamin ve mineral preparatları karıştırılarak yapılmaktadır. Son zamanlarda organik tarımın yaygınlaşmasıyla birlikte preparatların yerine tıbbi özellikleri bilinen değişik bitkiler ya doğrudan veya ekstraktları çıkartılarak katılmaya başlanmıştır. Bu çalışma, kolonilerin üretim etkinliklerini artırabileceği düşüncesiyle arı beslemesinde şuruba katılan tıbbi ve aromatik bitki ekstraktlarının bal arılarının fizyolojik özellikleri üzerine olan etkilerinin belirlenmesi amacıyla yapılmıştır.

Gereç ve Yöntem: Çalışmada, bir yaşlı Kafkas melezi ana arıya sahip olan 30 adet koloni kullanılmıştır. Arı kolonileri Standart Langstroth tipi ahşap arı kovanlarına yerleştirilmiştir. Arı kolonileri her grupta 5'er koloni olacak şekilde 6 gruba ayrılmıştır. Doğadan toplanıp kurutulmuş ve toz haline getirilmiş bitkiler (*Urtica dioica*, *Melissa officinalis, Hypericum perforatum, Achillea millefolium, Thymus serpyllum)* ekstraksiyonda kullanılmıştır. İki litrelik beher içerisine 250 g bitki tozu konulmuş üzerine 650 ml kaynar çift damıtılmış su ilave edilmiş ve 5 saat demlenmeye bırakılmıştır. Daha sonra 0,45 µm'lik whatman filtresinden geçirilmiştir. Şerbet 1/1 oranında hazırlanmış, 1000 ml şerbete 30 ml ekstrakt katılarak denemede kullanılmıştır. Yemlemeye 15.04.2019 tarihinde başlanıp günlük olarak kovan başına 500 ml verilerek 25.05.2019 tarihinde bitirilmiştir. Birinci gruba sadece şeker şurubu, diğerlerine ise şurup+ekstrakt karışımı verilmiştir. Bu uygulamaların, arı kolonilerinin nektar akış dönemi ağırlık kazancı, arı çerçevesi sayısı, kapalı kuluçka alanı ve bal verimi gibi bazı fizyolojik özellikler üzerine etkisi araştırılmıştır.

Bulgular: Çalışma sonucunda en yüksek kuluçka alanı ortalaması 3613,06±2348,27 cm^2 ile ST grubunda, en düşük ortalamaya ise 3013,24±1939,215 cm^2 ile S grubunda da tespit edilmiştir (Tablo 1). Yavrulu alan miktarı bakımından S ye göre en fazla yüzdelik artışı %19,90 ile ST, en düşük ise %3,11 ile SU göstermiştir. Yemlerin kuluçka alanı gelişimi üzerine olan etkisi istatistiksel olarak önemli çıkmıştır (p<.05). En yüksek ergin arı gelişimi ST grubundan (15,72±6,89 adet/koloni) elde edilmiştir (Tablo 1). Yemlerin, arılı çerçeve sayıları bakımından etkisi istatistiksel olarak önemli çıkmıştır (p<.05). Kovan dışı hizmet yapan işçi arı sayısının artması kovana taşınan nektar miktarını da artırmıştır. ST grubunda (52,26±6,17 kg/koloni) yer alan arı kolonileri S grubundan (28,54±5,03 kg/koloni) %83,11'lik bir artış sağlamıştır. Yemlerin nektar akım dönemi ağırlık artışı üzerine etkisi istatistiksel olarak önemli bulunmuştur (p<.05). Bu çalışma sonunda, S grubundaki kolonilerin bal verim ortalaması 16,45±1,55 kg/koloni iken, en yüksek verimin elde edildiği ST grubunda 25,31±3,14 kg/koloni elde edilmiştir (Tablo 2). Deneme sonucunda S grubuna göre, SU %18,48, SM %43,10, SH %16,04, SA %27,35, ST %53,86'lık bir artış sağlamıştır. Şeker şurubu ile şeker şurubu+ekstrakt karışımı yemlemenin deneme gruplarının bal verimi üzerine etkisi istatistiksel olarak önemli çıkmıştır (p<.05).

Sonuç: Erken ilkbahar döneminde yapılan şerbet yemlemesinde şerbete katılan tıbbi ve aromatik bitki ekstraktları arı kolonilerinin tüm fizyolojik özellikleri üzerinde olumlu etki göstermiştir.

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. (Dığrak et al. 1999; Keleş et al. 2001; Soycan and Açıkgöz 2005). It has been reported that medicinal aromatic plants increase the performance and durability of poultry (Adıyaman 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 cm^2 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±2348.27 cm^2, in the ST group, and the lowest average was 3013.24±1939.215 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).

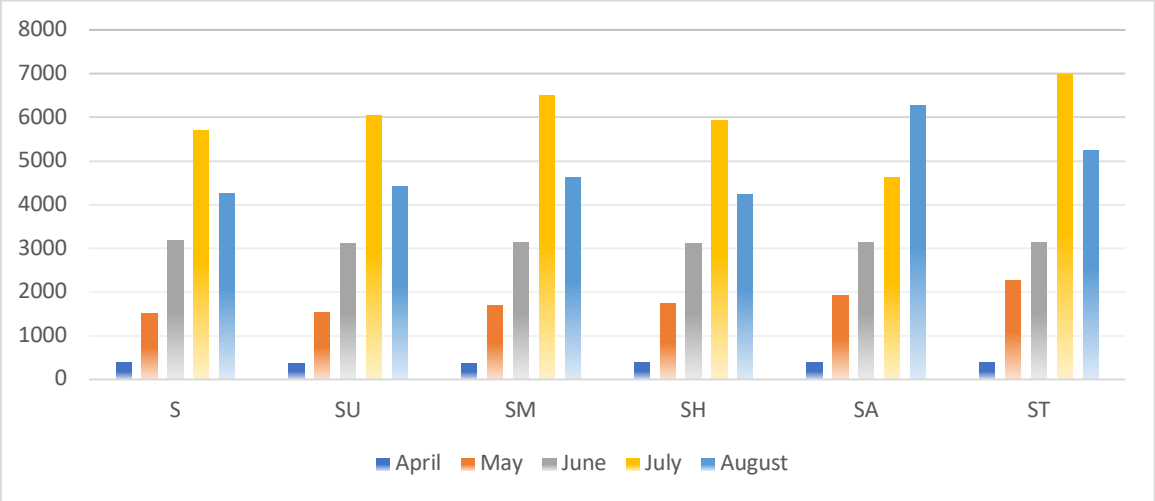

Figure 1. Sealed brood area development of experimental groups fed by syrup + medicinal and aromatic plant extracts by months.

Table 1. The effect of syrup + medical and aromatic plant extract on colony performance parameters of honeybees.

Application groups		Development of brood area (sealed brood/cm^2)	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			
April	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 [e]	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 [a]	16.45+1.55 [a]
	P Value	.00	.00
	SEM	2.27	.69
SU	Mean	39.24+2.59 [b]	19.49+1.21 [ab]
	P Value	.00	.00
	SEM	1.16	.54
SM	Mean	47.14+4.44 [c]	23.54+2.86 [cd]
	P Value	.00	.00
	SEM	1.98	1.28
SH	Mean	33.60+3.94 [ab]	19.09+2.74 [ab]
	P Value	.00	.00
	SEM	1.76	1.22
SA	Mean	37.68+5.60 [b]	20.95+1.94 [bc]
	P Value	.00	.00
	SEM	2.50	.87
ST	Mean	52.26+6.17 [c]	25.31+3.14 [d]
	P Value	.00	.00
	SEM	2.76	1.40

SEM: standard error of mean.
[a,b,c,d] *p*<.05.

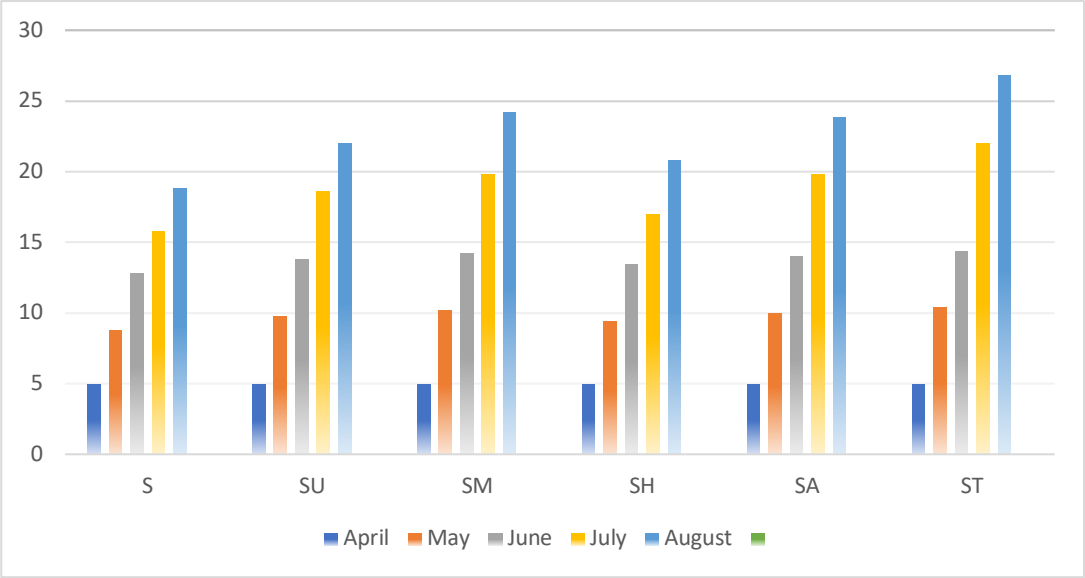

Figure 2. The development of the number of frames covered with bee of the experimental groups fed with syrup + medicinal and aromatic plant extracts by months.

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 (p <. 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; Karacaoğlu 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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