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Research Article

Comparison of Usage Possibilities of Feeder Types Used in Feeding Honey Bee (*Apis mellifera* L.) Colonies in Erzincan Province Conditions

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Abstract

The aim of this study is to compare the usage possibilities of feeder types used in feeding honey bee colonies and to determine the most appropriate feeding time and feeder type. The study was conducted in Yalnızbağ neighborhood (39°47'36.7"N 39°24'01.2"E), 15 km west of the center of Erzincan province, at an altitude of 1.185 m. As bee colonies, 36 Caucasian honey bee (*Apis mellifera caucasia*) colonies, which are suitable for the region, were used. The feeding experiment was carried out during the period of scarcity of pollen and nectar of the flora due to environmental and climatic conditions. Feeding was carried out in 3 different time periods (08:00-10:00 am, 10:00 am-12:00 pm and 12:00-14:00 pm). Sugar syrup was prepared at a ratio of 1:1 (sugar to water). According to the results of the present study, the differences between the groups in terms of the amount of syrup consumed, feeder type and feeding time were significant ($p<0.05$). In addition, it was determined that the differences between the feeder type groups were significant ($p<0.05$) when evaluated in terms of the ease of colony feeding and post-feeding bee mortality. In conclusion, this study shows that the most suitable time period for feeding honey bees is between 10:00 am-12:00 pm and in line with the opinions of the people who feed honey bee colonies, it is more useful to use turbo feeder type which offers ease of use instead of bag/compartment, boat and jar type feeders for feeding defensive honey bees.

Keywords: Honey bee, feeding, colony, feeder type.

Erzincan İli Koşullarında Bal Arısı (Apis mellifera L.) Kolonilerinin Beslenmesinde Kullanılan Besleyici Tiplerinin Kullanım Olanaklarının Karşılaştırılması

Öz

Bu çalışmanın amacı, bal arısı kolonilerinin beslenmesinde kullanılan yemlik tiplerinin kullanım olanaklarını karşılaştırmak ve en uygun besleme saatini ve yemlik tipini belirlemektir. Araştırma, Erzincan ili merkeze bağlı 15 km batısında bulunan Yalnızbağ Mahallesi'nde (39°47'36.7"N 39°24'01.2"E), 1.185 m yükseklikte yürütüldü. Arı kolonisi olarak, yetiştirilmesi bölgeye uygun olan 36 adet Kafkas bal arısı (*Apis mellifera caucasia*) kolonileri kullanıldı. Besleme deneyi çevre ve iklim koşullarına bağlı olarak bitki florasının polen ve nektar bakımından kıtlık dönemi sonbaharda gerçekleştirildi. Besleme, 3 farklı (08:00-10:00, 10:00-12:00 ve 12:00-14:00 saatleri arasında) zaman diliminde gerçekleştirildi. Şeker şurubu 1:1 (şeker-su) oranında hazırlandı. Mevcut araştırma sonucundan elde edilen bulgulara göre gruplar arasında tüketilen şurup miktarı yemlik tipi ve besleme zamanı bakımından farklılıklar önemliydi ($p<0,05$). Ayrıca besleme yapan kişilerin koloni besleme kolaylığı ve besleme sonrası arı ölümleri açısından değerlendirildiğinde besleyici tipi grupları arasındaki farklılıkların önemli olduğu tespit edilmiştir ($p<0,05$). Sonuç olarak bu çalışma, bal arılarını beslemek için en uygun zaman diliminin 10:00-12:00 saatleri arasında olduğunu ve bal arısı kolonilerini besleme yapan kişilerin görüşleri doğrultusunda savunmacı bal arılarını beslemek için çanta/bölme, kayık ve kavanoz tipi yemlik yerine kullanım kolaylığı sunan turbo yemlik tipinin kullanımının daha yararlı olduğunu göstermektedir.

Anahtar Kelimeler: Bal arısı, besleme, koloni, besleyici tipi.

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1. Introduction

The honey bee (Apis mellifera L.) is a very important source of pollinator for agriculture and human beings [1]. Nutrition is the intake of nutrients required by the body from the outside through the mouth, and honey bees also need nutrition to survive [2]. The feeding of honey bee (*Apis mellifera* L.) colonies is usually done during periods when the flowers in nature are insufficient. This is mainlydone in order to prevent the population decline of colonies that cannot be fed sufficiently and to increase productivity. In timeswhen the supply of flowers is inadequate, the population of honey bee colonies that are not sufficiently fed can decline, which ultimately leads toweaker colonies. In Addition, such colonies are vulnerable to natural pests inside and outside the hive, as nutrient stress is known to act synergistically with other environmental stressors [3,4]. Providing bees with additional nutritionthrough feeders is very important to protect colonies and increase their productivity.

In recent years, climate change has led to fluctuations intemperature and humidity, and as a result, plant biodiversity has declined. Thus, honey bees, which feed on the pollen/nectar of plants in nature, are greatly negatively affected. In addition, the use of chemical pesticides in agricultural activities and the gradual increase in these practices are limiting the ability of honey bees to find natural food from plants to meet their needs. It has been reported that colony population losses are largely caused by feed-nutrition deficit, environmental stress sources, climate change, parasites and pathogens [5,6,7].

In honey bees, there should be enough nutrients in order for the colony population to be continuously developed, queen colony management to be active and to fight against diseases and pests. However, sometimes additional food is needed according to the changes in environmental and climatic conditions and physiological conditions of bees. In periods of nutrient scarcity, the generally accepted practice is to supplement a mixture prepared from honey, bee cake (honey, pollen, powdered sugar) and sugar solution in certain proportions [3,8]. For this purpose, feeding methods with different types of feeders have been used to feed honey bee colonies. However, the types of feeders used were randomly selected depending on the materials available to the beekeepers themselves and the types of commercial feeders selling beekeeping supplies. Among these, the most commonly used feeding method is syrup made with a mixture of sugar and water [9,10].

In Türkiye, there are some studies on supplementary feeding of honey bees in different periods and using different nutrients. However, the possibilities of using feeder types during feeding and beekeepers' opinions on colony feeding practices have not been evaluated. The aim of this study was to compare the possibilities of using feeder types during feeding of honey bee colonies and to determine the ease of feeding a colony with the most appropriate feeding time.

2. Material and Methods

2.1. Honey Bee Material and Study Area

The research was conducted at an altitude of 1,185 m in Yalnızbağ neighbourhood (39°47'36.7 'N 39°24'01.2 'E), 15 km west of the Centre of Erzincan province. Caucasian honey bee (*Apis mellifera caucasia*) colonies, which are suitable for the region, were used as bee colonies. For these colonies, Langstroth type wooden hives with plastic bottom were used.

2.2. Preparation of Feeders and Setting Up the Experimental Design

The choice of the feeders (syrup holders) used in the study was determined from the 5 most preferred feeders after the preliminary interview with beekeepers and bee material sellers (Figure 1). Since the volumes of the determined feeders varied, each feeder was fed with 1 L 1/1 (sugar-water) beet sugar syrup during the application for the sake of illustration. The feeders were obtained from local bee equipment dealers. The top covers of the hives provided sufficient space for additional feeding, so no additional treatment was applied.

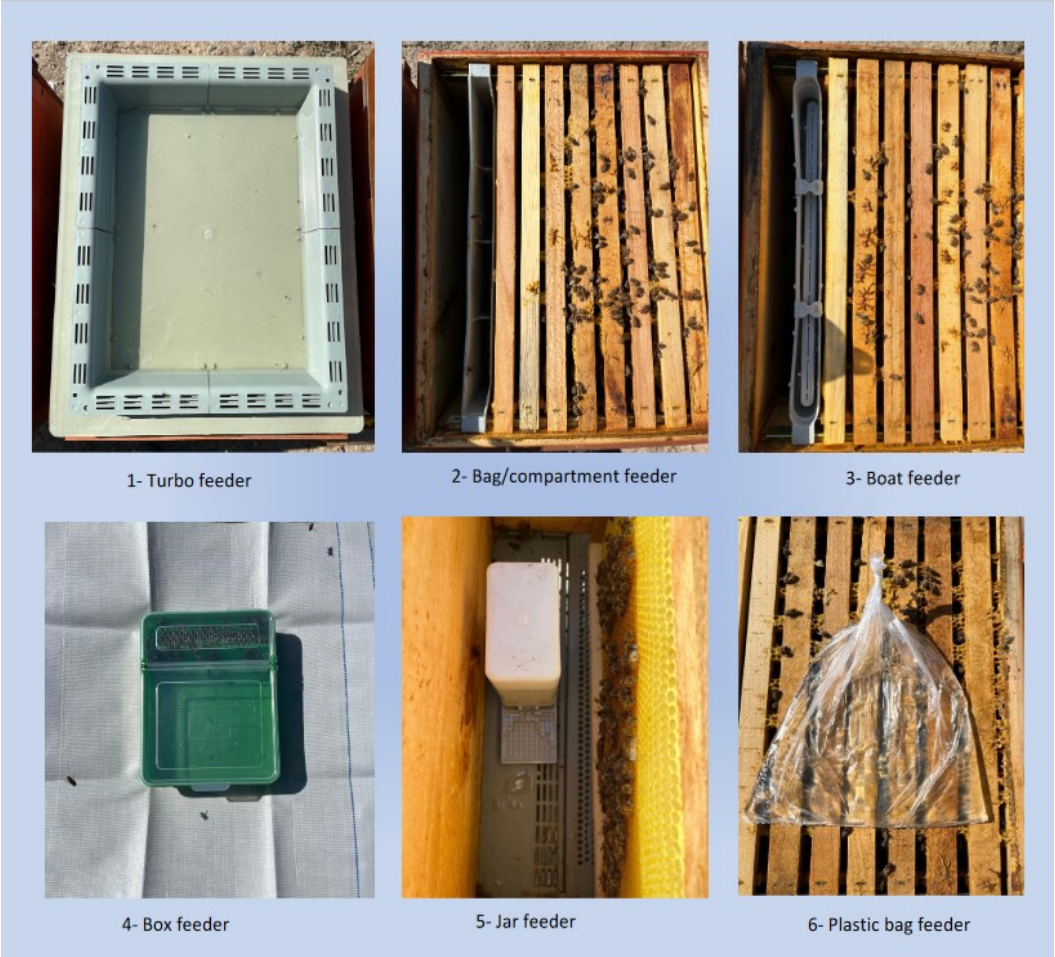

Figure 1. Feeder types used in the experiment.

For this study, 36 honey bee colonies of approximately equal strength were used. The research was conducted in the second week of September 2024. The strength of colonies was subjectively estimated and determined by the number of frames covered with adult bees, brood, honey and pollen. Colonies were equalised to 8 frames each [11]. The colonies were randomly distributed for 6 experimental groups (Turbo feeder, Bag/split feeder, Boat feeder, Box feeder, Jar type feeder, Plastic bag). The study was conducted in 5 replicates in each beehive.

2.3. Evaluation of feeders

The feeding experiment was carried out in autumn, which is a period of scarcity for the plant flora in terms of pollen and nectar, depending on environmental and climatic conditions. Feeding was carried out in 3 different time periods (08:00-10:00, 10:00-12:00 and 12:00-14:00). Sugar syrup was prepared in a 1:1 (sugar-water) ratio. For each feeding group, 1 L of sugar syrup was given at the same time and the amount of syrup consumed by the bees within 2 hours was recorded. In addition, the number of bee deaths in and around the feeder during feeding was recorded. For each feeding group, five different beekeepers with experience in bee feeding practices were fed alternately. Beekeepers were asked to rate each type of feeder on a scale of 0-100 and were asked to give their opinion on the convenience of the feeder types for beekeepers for labour-intensive applications during feeding such as pouring the syrup, opening and closing the hive, removing and carrying the feeder. Their responses regarding the convenience of each feeder type were recorded as less convenient (0-35), moderate (36-70) and very convenient (71-100). For this purpose, five experienced beekeepers were given the chance to feed one colony of each treatment (feeder type) during each feeding [10].

2.4. Statistical Analyses

Descriptive statistics of the data obtained from the honey bee feeding study were calculated and numerical and percentage (%) frequencies were determined for each parameter. In the study, Pearson's Chi-square test was used to test the relationship between feeder type and feeding time, bee mortality and ease of feeding and for comparisons between feeder types. In the analyses, $p<0.05$ was accepted as significance level [12]. IBM SPSS 22.0 Statistics version programme was used to calculate frequencies and Chi-square analyses [13].

3. Results and Discussion

In the study, six different feeder types (turbo feeder, bag/section feeder, boat feeder, box feeder, jar type feeder, plastic bag) were used in three different time periods (between 08:00-10:00, 10:00-12:00 and 12:00-14:00) in order to compare the possibilities of using feeder types during in-hive feeding of honey bee colonies and to determine the most suitable feeding time and the ease of feeding a colony. Data on the amount of sugar syrup consumed by the colonies in different time periods are presented in Table 1.

Table 1. Amount of syrup consumed in different time periods (Liters).

Feeder types	Feeding time		
	08:00-10:00	**10:00-12:00**	**12:00-14:00**
	$\overline{X}\pm s_{\bar{x}}$	$\overline{X}\pm s_{\bar{x}}$	$\overline{X}\pm s_{\bar{x}}$
Turbo feeder	0.256 ± 2.18^{A}	0.298 ± 2.06^{A}	0.251 ± 1.94^{B}
Bag/compartment feeder	0.194 ± 1.72^{B}	0.285 ± 1.75^{A}	0.222 ± 1.68^{B}
Boat feeder	0.196 ± 1.72^{B}	0.246 ± 1.69^{B}	0.231 ± 1.71^{B}
Box feeder	0.235 ± 1.96^{A}	0.314 ± 2.14^{A}	0.298 ± 2.13^{A}
Jar type feeder	0.172 ± 1.02^{B}	0.230 ± 1.56^{B}	0.255 ± 1.97^{B}
Plastic bag feeder	0.110 ± 0.61^{C}	0.156 ± 0.74^{C}	0.142 ± 0.59^{C}
p	**	**	**

**: $p<0.001$, ^{A,B,C}: Differences between values with different letters in the same column are significant ($p<0.05$)

According to the results of the present study, the differences between the groups in terms of the amount of syrup consumed, feeder type and feeding time were significant ($p<0.05$). The highest sugar syrup consumption within the two-hour feeding period was determined between 10:00-12:00 hours as feeding time and 0.314±2.14 liters of box feeder as feeder type. The least consumption time was 08:00-10:00 and the feeder type was determined as plastic bag feeder 0.110±0.61 liters. In addition, in general, the amount of sugar syrup consumed in the feeding between 10:00-12:00 hours was higher in all feeder types.

To feed honey bees, beekeepers in different parts of the world feed sugar syrup to honey bee colonies. Many different methods and types of feeders have been used to feed colonies. Each type of feeder has its own advantages and disadvantages [14]. The most common method used in feeding honey bees is sugar syrup feeding. Syrups are given through special feeding containers (syrup dispensers) placed in beehives. It has been shown that sugar syrup feeding accelerates the spring development of bees and contributes to colony growth before the nectar flow begins [15]. It is very important to use the appropriate time and type of feeder to feed honey bees. According to the data of this study, the most suitable time for feeding honey bees is between 10:00-12:00. However, the flight activities of bees are more intense in the early hours of the day and there may be looting during feeding. Hive entrance holes should be narrowed to prevent bees from other colonies from plundering the food. In addition, feeding the colonies at the same time contributes to the prevention of looting.

The data on bee deaths occurring during feeding in the study and the thoughts of the feeders about the ease of feeding according to different feeder types during colony feeding are given in Table 2.

Table 2. Bee mortality during feeding and thoughts of the feeders about feeding.

	Bee mortality (numbers)	**Ease of feeding (%)**
Feeder types	$\overline{X}\pm s_{\bar{x}}$	$\overline{X}\pm s_{\bar{x}}$
Turbo feeder	0.25 ± 0.55^{C}	83.33 ± 1.18^{A}
Bag/compartment feeder	12.25 ± 1.70^{A}	65.83 ± 0.11^{B}
Boat feeder	10.56 ± 1.56^{A}	64.16 ± 0.16^{B}
Box feeder	0.15 ± 0.24^{C}	61.66 ± 0.16^{B}
Jar type feeder	4.16 ± 1.02^{B}	38.33 ± 0.14^{C}
Plastic bag feeder	0.00 ± 0.00^{C}	34.16 ± 0.13^{C}
P	**	**

**: $p<0.001$, ^{A,B,C}: Differences between values with different letters in the same column are significant ($p<0.05$)

When the findings obtained from this research were evaluated in terms of the ease of colony feeding and post-feeding bee mortality, it was found that the differences between the feeder type groups were significant ($p<0.05$). It was determined that the least number of bee deaths after feeding was in the feeding made with plastic bags (0.00±0.00 pieces) and the highest number was in the feeding made with bags/compartment feeders (12.25±1.70 pieces). Considering the opinions of the feeders, the easiest feeder type was turbo feeder (83.33±1.18%) and the most difficult feeder type was plastic bag feeder (34.16±0.13%).

In order to feed a colony of honey bees as quickly and easily as possible, it may depend on the use of an inner cover in the form of an upper nest (turbo feeder, etc.), which does not require the removal of the existing frame and can be implemented only by adding an additional top layer under the hive lid. Within the framework of this method, it is possible to make feeding even easier and in a shorter time. In addition, when the inner cover is used as a feeder, since the size of this inner cover is such that it completely covers the hive body, the bees will be prevented from flying out during feeding. Thus, the aggression in the defensive behaviour of the bees will be prevented and the work of the feeder will be easier [10]. When the upper feeders remaining on the frame from the feeder types are fully replaced, it will be easier to fill and add liquid nutrients such as sugar syrup. Thus, even without wearing a beekeeper's suit, the feeders will ensure that the bees are fed with minimal disturbance to the colony [15].

In the present study, feeding with turbo feeder, which is considered as an in-hive top feeder, was determined as the most advantageous feeder type in terms of ease of use among the feeder types among the groups. The low bee mortality after feeding also supports this advantage. In line with the opinions of the feeders, it is thought that this advantage is due to the ease of use such as opening the hive lid, feeding without directly dealing with the defensive behavior of the bees and feeding all colonies in a short time. In addition, the results of the study were compatible with the possibilities of using the top feeder type used in the study of Hora [8], for feeding bee colonies.

Honey bees are generally defensive during any external intervention to the colony. This defensive behavior is very important for honey bees in terms of maintaining colony integrity and defending their own resources such as honey, pollen and propolis [16]. However, this defensive behavior of honey bees makes the colony management difficult for feeders [17]. Because the in-hive work of the feeders may create a provocative situation for honey bees to defend their own colonies [18]. For this reason, it is thought that honey bees show collective defence behavior and encourage each other when beekeepers remove a frame from a hive, replace it with a plastic frame feeder, check the syrup in these feeders and make syrup additions, place box feeder types in the hive [19]. As a result, this may cause more bees to die during feeding. In the present study, although there were no bee deaths during feeding with bag-type feeders, which have recently been used in the field, it was determined as the most difficult feeder type. It is thought that the reason for this may be due to the difficulties such as the lack of any special equipment and the feeding of the feeders using a cabinet bag.

4. Conclusion

As a result, this study shows that the most suitable time period for feeding honey bees in the autumn is between 10:00-12:00 hours and in line with the opinions of the people who feed honey bee colonies, it is more useful to use turbo feeder type which offers ease of use instead of bag/compartment, boat and jar type feeders for feeding defensive honey bees. Feeding of honey bee colonies is very important in terms of providing additional food to bees during periods when natural flowers are insufficient, protecting colonies and increasing their productivity. Therefore, it is recommended that beekeepers, especially those with a large number of hives, should prefer feeder types that minimize disturbance to bees while feeding colonies and prevent bee deaths after feeding, in terms of the need to feed more colonies in a short time. There is also a need for a comprehensive comparative study of the optimal honey bee feeding time and feeder types in terms of cost, durability and possibilities for more beneficial use.

Ethics in Publishing

There are no ethical issues regarding the publication of this study.

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