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Research Article

Economic Feasibility of Package Beekeeping Application in Turkey: A Case Study of Edirne Province

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Abstract

In this study, it was discussed whether the package beekeeping was an economical alternative to traditional beekeeping in Turkey. An experiment involving two different applications was carried out in the province of Edirne, which has a short production season due to the cold climate conditions. The control groups representing the colonies formed by the artificial swarms and the colonies formed by the package bees were compared in terms of economic feasibility in this experiment. The results of this study showed that package beekeeping was more advantageous for beekeeping enterprises when the artificial swarms' application was taken into consideration. The purchase price of package bees for beekeeping enterprises in Edirne Province should be below US$39.52. In other words, package beekeeping for Edirne province is profitable for enterprises at prices below US$ 39.52. The package beekeeping can provide savings for beekeepers whose bees overwinter in cold climates. It was determined that if the bees were not wintered, the beekeeping enterprises could save US$31.63 per hive in this study. According to the results, it is expected that the dissemination of package beekeeping will have a hugely positive impact on beekeeping enterprises for North, Northwest and Eastern Anatolia Regions of Turkey.

Keywords: *Package bees, Beekeeping, Economic feasibility, Profitability*

Türkiye'de Paket Arıcılık Uygulamasının Ekonomik Olarak Uygulanabilirliği: Edirne İli Örneği

Öz

Bu çalışmada, paket arıcılığın Türkiye'de geleneksel arıcılık faaliyetine ekonomik bir alternatif olup olmadığı tartışılmıştır. Bu amaçla, soğuk iklim koşulları nedeniyle kısa bir üretim sezonuna sahip olan Türkiye'nin Edirne ilinde iki farklı uygulamanın yer aldığı bir deneme gerçekleştirilmiştir. Bu denemede yapay oğuldan oluşan kolonileri temsil eden kontrol grupları ile paket arılardan meydana gelen koloniler ekonomik yapılabilirliği açısından karşılaştırılmıştır. Bu çalışmanın sonuçları, arıcılık işletmelerinde yapay oğul uygulamasına göre paket arıcılığın daha avantajlı olduğunu göstermiştir. Edirne ilinde arıcılık işletmeleri için paket arı satın alma fiyatının 39.52 ABD Dolarının altında olması gerekmektedir. Diğer bir ifade ile, Edirne ili için paket arıcılık, 39.52 ABD Doları'nın altındaki fiyatlarda işletmeler için karlı olmaktadır. Paket arıcılık, arılarını soğuk iklimlerde kışlatan arıcılar için tasarruf sağlayabilmektedir. Arılar kışlatılmadığı takdirde arıcılık işletmelerinin kovan başına 31.63 ABD doları tasarruf edebileceği belirlenmiştir. Paket arıcılığın yaygınlaşmasının Türkiye'nin Kuzey, Kuzeybatı ve Doğu Anadolu bölgelerindeki arıcılık işletmeleri üzerinde son derece olumlu bir etki yaratması beklenmektedir.

Anahtar sözcükler: *Paket arıcılık, Arıcılık, Ekonomik uygulanabilirlik, Karlılık*

INTRODUCTION

New honey bee colonies can be acquired in different ways, such as established colonies, nucleus colonies, package bees and swarms. The main advantages of package bees are that they cost cheaper than established colonies or nucs, easy for beginners to handle, and there is little possibility of the bees having a severe brood disease [1].

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Especially, package bees are preferred by beekeepers due to the colony losses caused by wintering. Cengiz and Erdoğan [2] pointed out that the vast majority of colony losses occurred in the winter months. Ucak Koc [3] put forward that significant colony losses during wintering had been reported in the USA (30%), Europe (1.8-53%) and the Middle East (10-85%) since 2006. Maucourt et al.[4] cited that severe winter losses had pushed beekeepers to multiply colony numbers by producing more nuclei during the productive season. According to them, multiplying colonies were achieved by creating a new colony with a young mated queen and either just bees (package bees) or brood and bees (nucleus bees). Withrow et al.[5] emphasized that beekeepers often relied on purchasing 'packages' of bees, consisting of ~10.000-12.000 workers and a young mated queen in order to offset these annual colony losses.

Beekeepers in Turkey also produce a relatively small amount of pollen besides honey. The sales of live bees, i.e. package bees, is very important to obtain alternative income in beekeeping. However, due to long wintering and hard climate conditions, significant colony losses are experienced. The fact that both the cold zone beekeeper and the hot zone beekeeper have the potential to generate additional income with the apiculture application reveals the importance of the issue. This can be seen as an opportunity to increase production alternatives in beekeeping, to improve beekeeping and the economic situation of beekeepers.

Beekeepers in the Mediterranean and Aegean regions of Turkey, which are suitable for the production of package bees, will be able to obtain additional income by this method and produce healthy and clean honey to be presented to consumers. From package beekeepers to entrepreneurs, beekeepers who aim to increase the capacity and to strengthen their colonies will have the opportunity to find a healthy and cheap colony [6].

The colony production in spring season is also done in the Aegean and Mediterranean regions of Turkey which have a suitable climate for bee production in spring season. These bee colonies can be sent to North and West Anatolia regions that have the negative weather conditions and short-term source of nectar, and also to North West Anatolia, that experiences adverse weather conditions after early spring. Thus, while the beekeeper in the Aegean and the Mediterranean will obtain safe and high income with colony production, the bee producers in North, Northwest and Eastern Anatolia will be less affected by the colony losses caused by wintering, and will be able to benefit from the nectar stream in the spring season [7].

Package beekeeping practices are carried out in countries with different climates. Therefore, the economic conditions of the country directly affect the applicability. The risk of winter loss increases the beekeeping enterprises in the regions where the climate conditions are severe and prolonged, and harsh winters are experienced. Package beekeeping began to develop in the US in the late 19th century. In order to reinforce the bee colonies in the northern region of North America, the beekeepers in the more tempered Southern region tried to meet the bee demand of the Northern beekeepers, where heavy winter conditions and bee colonies yield significant winter losses. According to the increasing demands, Southern beekeepers have turned to bee and queen bee production, which is more secure than honey production and they have created a model called *Package Beekeeping* by transporting bees in small packages in order to minimize transport inputs [8].

Package beekeeping is widespread in North America, Australia, New Zealand and Russia [6]. The winter losses in the beekeeping sector in Europe caused the ¼ of all colonies to collapse and due to the weakness of honey bee colonies at harvest time, packaged bee transfer from Austria had to be done and success was obtained from the package bees transferred to the hives in early spring season [9].

According to a study carried out in Saudi Arabia by A.A. Al-Ghamdi et al.[10], the country imports 200,000 exotic package bees annually due to the shortage of local bees. However, the imported colonies are only surviving for one honey harvest or season [10]. There is a literature on how to make more applications of package beekeeping. Package sizes vary according to the producers of the region. The most common dimensions are 15x25x35 and 15x22.5x40 cm. The packages are sold to the extent that they are suitable to the desired bee quantity.

The weight of the packages is usually 1.5 kg but can vary between 1 kg and 2.5 kg. For instance, in Canada, packaged bees usually exist in 1 or 1.5 kg packages, containing 8.000 and 12.000 bees, respectively [11]. Package bees are usually purchased in the spring season because they are used to replace winter losses or to obtain a new colony. Approximately 1 kg worker bee refers to a population of 7.000 worker bees. Packages may be with queen bees and/or except queen bees. A queen-package contains a fertilized queen bee, a young worker bee and a feeder with the desired weight in the cage [8,12-15].

Punnett and Winston [16] compared various combinations of package and nucleus production in April. In their study, conducted at Southwestern British Columbia, colonies were monitored through the season following the removal of packages and nuclei to determine the biological and economic impact of the package and/or nucleus production. They found that all colonies used for bee production yielded greater economic returns than the control colonies, from which no packages or nuclei were removed. According to the authors, the results indicate

that both package and nucleus production is feasible in the Lower Fraser Valley area of BC, and would provide local beekeepers with additional income [16].

Tahirov et al.[17] stated that population density and honey yield have increased depending on the convenient transport of bee colonies to favorable regions during the season. According to the results of another research, it was reported that the wax production was higher in the colonies supported by the package bees [18]. In a study in which an economic analysis of feeding periods and varieties of bees were made, it was determined that in the autumn season, high protein content (21%) was found to be more profitable and economical than pollen feeding in spring season [19].

It has been seen that the production and trade of package bees have been done in different countries of the world for many years. On the other hand, the option to establish new colonies with package bees in Turkey has been neglected until now. In recent years, there has been considerable debate on whether package beekeeping is feasible to the beekeeping enterprises in Turkey. However, no study has been carried out to determine whether package beekeeping is feasible or not regarding the beekeeping enterprises in the cold climate regions of Turkey.

In this study, it was discussed whether the package beekeeping was an economical alternative to traditional beekeeping in Turkey. For this purpose, an experiment involving two different applications was carried out in Edirne province of Turkey, a region having a short production period due to the cold climate conditions. In this experiment, the control groups representing the colonies formed by the artificial swarms and the colonies formed by the package bees were compared economically.

MATERIAL and METHODS

Data

This study was performed on the data from experiments conducted in Edirne province, Turkey [20] *(Fig. 1)*. One of the reasons for the selection of this province in the study is that the region has cold climate conditions. Therefore, the wintering period in the beekeeping activity in the region is longer. Besides, Edirne Province also represents the region with high colony losses due to the climate changes observed in early spring. Edirne also has wide sunflower planting areas.

Thrace is the region where wintering loss is especially the highest. In addition, this study was also carried out in Yozgat province with heavy winter conditions. But, the production in the same year did not occur due to adverse climate conditions and the data was not used in this research.

The genotype of the Anatolian bee *(Apis mellifera* L.) adapted West Aegean conditions was used in the experiments. This genotype has been obtained from the treatment material by the Aegean Agricultural Research Institute about 10 years. The control group of Edirne is local genotype which is adapted to the conditions of Thrace. In all groups, the queen bees are sisters of the same queen bee.

The experiments were established on May 2, 2016. Two groups were formed as package bee and artificial swarm in the experiments. The experiments were carried out according to the Completely Randomized Design, which will cover 12 beehives in each group *(Table 1)*. Considering the main nectar flows in the region, package bees and artificial swarms were sent eight weeks before the beginning of the main nectar flow. After the package bees were

Fig 1. The geographic location of the study region

Table 1. *The design of experiments by groups*

Groups	Design of Experiments	The Number of Colonies
Group 1	1.5 kilogram packages of bees	12
Group 2	Artificial swarms (3 to 5 frames)	12

transferred to the hives, the colonies were fed intensively up to the nectar flow. The honey was harvested in July 2016.

Economic Analysis

In this study, the economic feasibility of package beekeeping in terms of the enterprises dealing with beekeeping was examined with some economic evaluations.

In the course of the economic analyses carried out in the study, production costs, unit cost, absolute profitability, relative profitability, gross margin and net return were calculated. Besides, a break-even analysis was used in order to determine which price levels for package bees will be profitable for the beekeeping enterprises.

The cost items of honey production were classified into variable and fixed [21,22]. In honey production, total variable costs include subsequently, feed costs (sugar), medication (parasite and disease control), wax foundation, transportation of hives, hired labor, location rental fees, colony replacement costs, packaging of honey (jar), and repairs and maintenance. After taking the total variable costs of honey production, an interest of the total variable costs was calculated by charging a rate of 7% (annual average nominal credit interest rate for Turkish Lira) on total variable costs and added to total variable costs [23,24].

Fixed costs involve the interest on the hive, machinery and equipment investment, depreciation and administrative costs. Interest on the hive, machinery and equipment investment was calculated by charging a rate of 8% [24]. Interest amounts added to the variable and fixed costs were calculated by taking the production periods into consideration in Edirne Province. The production period covers 5 months for the package bee application and 7 months for the artificial swarm application. Administrative costs were estimated at 3% of total variable costs [19]. Depreciation was estimated using the straight-line method and the depreciation rate for hive, machinery and equipment was accepted 10% [21].

The total production cost equals fixed costs plus variable costs. The net return was calculated by subtracting total production costs from total gross revenues. The unit cost of honey (per kg) was identified by dividing the total production costs that were incurred by the total of variable and fixed costs of the honey production.

Gross margin analysis was carried out in this study in order to compare the profitability of the colonies formed by the artificial swarms and the colonies formed by the package bees. Gross margin analysis is one of the oldest and simplest analytical tools used in farm management. It has been used in some economic studies for analyzing the profitability of farm production practice [25].

Kay et al.[26] defined gross margin as a difference between gross income and variable costs. They also cite that income above variable costs is sometimes called the gross margin of an enterprise.

One of the most important objectives of this study is to determine the purchase price of the package bee in terms of the beekeeping enterprises that buy package bees. The break-even analysis was used to determine the price level which beekeeping enterprises can buy package bees.

One of the most common tools used in evaluating the economic feasibility of a new enterprise or product is the break-even analysis. The break-even point is the point at which revenue is precisely equal to costs. There is no profit and no loss occurs at this point [27]. In the break-even analysis, the package bee price was found to same net return to zero since the price of the package bee, which was one of the variable cost items, was not known.

The economic analysis values calculated in Turkish Lira were converted to US Dollar with the exchange rates released by the Central Bank of the Republic of Turkey. The average exchange rate between Turkish Lira (TRY) and the US dollar (USD) for May, June, and July 2016 was taken as 2.94 USD/TRY [28].

RESULTS

The results of production costs and profitability analysis were shown by artificial swarm and package bee applications in this section. According to both applications, production costs were given in *Table 2* and it is seen that the production costs vary according to the applications.

Variable and fixed costs associated with honey production per hive are given in *Table 2* by the artificial swarm and package bee applications and it is seen that these costs do not differ much from the applications. While the total variable costs per hive in artificial swarm application was US$94.25, this cost was US$94.91 in the package bee application. In variable costs, hired labor and colony replacement costs were identified as significant cost items.

It was determined that the colony replacement cost was slightly lower in the package bee application than the artificial swarm application. The colony replacement cost per hive was US$39.52 for package beekeeping, while it was US$42.52 in artificial swarm application. In the package bee application, the price level equalizing the net income

Table 2. *Production costs by applications (US$ per hive)*

Items	Artificial Swarm	Package Bees
Feed costs (sugar)	10.88	13.06
Medication (Parasite and disease control)	1.02	0.68
Wax foundation	2.81	2.81
Transportation of hives	6.29	6.29
Hired labor	21.41	21.41
Location rental fees	0.68	0.68
Colony replacement costs	42.52	39.52
Packaging of honey (jar)	5.69	7.49
Repairs and maintenance	0.28	0.28
Interest on variable costs (7%) (2)	2.67	2.69
Total Variable Costs (1+2)=3	**94.25**	**94.91**
The interest on the hive investment** (8%)	1.48	1.48
The interest on the machinery and equipment investment ** (8%)	0.50	0.50
Depreciation for hives	4.46	4.46
Depreciation for machinery and equipment	1.41	1.41
Administrative costs (3%)	2.83	2.85
Total Fixed Costs (4)	**10.68**	**10.70**
Total Production Costs (3+4)	**104.93**	**105.61**

** The average exchange rates between Turkish Lira (TRY) and the US dollar (USD) for May, June, and July 2016 is $1 = 2.94 TL [28]*
*** Represents potential interest income if funds were placed elsewhere*

Table 3. *Honey cost, absolute and relative profit in artificial swarms and package bee applications*

Items	Artificial Swarm	Package Bees
Production cost per hive (US$)	104.93	105.61
Honey yield per beehive (kg)	14.20	18.70
Honey cost per kg (US$)	7.39	5.65
Average price paid to beekeepers for honey (US$ per kg)	5.10	5.10
Absolute profit (US$ per kg)	-2.29	-0.54
Relative profit	0.69	0.90

Table 4. *Gross margin and net return in artificial swarms and package bee applications (US$ per hive)*

Gross Revenue (1)	Artificial Swarm	Package Bees
	82.65	105.61
Honey	72.45	95.41
Beeswax	10.20	10.20
Total Variable costs (2)	94.25	94.91
Gross Margin (1-2) (3)	-11.60	10.70
Total Fixed Costs (4)	10.68	10.70
Net return (3-4)	-22.28	-

Table 5. *Break-even price above total expenses and net returns for purchase price combinations of package bees, per hive*

Purchase Price of Package Bees (US$ per hive)	Net Returns (US$ per hive)	Extra Income Earned Due to Absence of Winter Losses (US$ per hive)	Total Net Returns (US$ per hive)
17.01	23.86	31.63	55.50
25.51	14.85	31.63	46.48
34.01	5.83	31.63	37.47
39.52 (Break-even price)	**0.00**	**31.63**	**31.63**
42.52	-3.18	31.63	28.45
51.02	-12.19	31.63	19.44
59.52	-21.21	31.63	10.43
61.22	-23.01	31.63	8.62
68.03	-30.22	31.63	1.41

to zero at the break-even point was taken as the basis as the colony replacement cost. When considering the fixed costs, the total production cost per hive was US$104.93 in artificial swarm application and US$105.61 in package bee application.

The highest honey yield per colony/beehive was obtained from the package bee application. In the artificial swarm and package bee applications, the average honey yields per colony were 14.20 kg and 18.70 kg respectively *(Table 3)*. While the honey cost per kg in package bee application was US$5.65, this value was calculated as US$7.39 in the artificial swarm application *(Table 3)*. The relative profit per hive was observed that package bee application was more profitable than artificial swarm application.

Although the relative profit value was less than 1 in both applications, this value was found to be closer to 1 (0.90) in the package bee application. It is important to note that the relative profit obtained for the package bee application

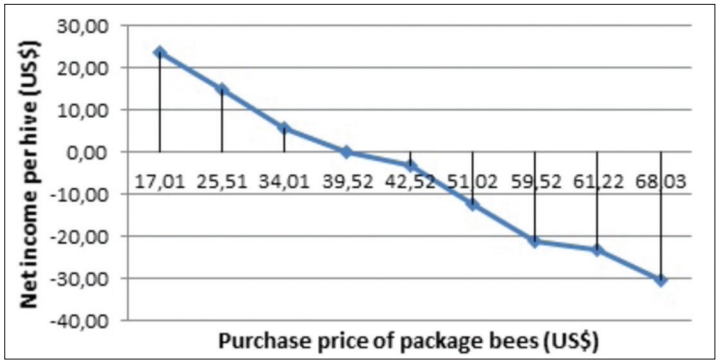

Fig 2. Breakdown of net returns for purchase price combinations of package bees by the break-even point

is calculated according to the price at the breakeven point. It is predicted that the relative profit will be higher in package bee prices below the break-even point.

While the gross margin per hive in package bee application was US$10.70, this value was calculated as -US$11.60 in the artificial swarm application *(Table 4)*. When considering only variable costs, this result shows that package bee application is a profitable activity regarding beekeeping enterprises.

In order to determine which price levels will be profitable for the beekeeping enterprises, the net return to be obtained by the beekeeping enterprises was calculated for purchase price combinations of package bees. As mentioned above, the break-even price which can be accepted as the point of transition to the profitability of the enterprises was determined as US$39.52. According to this result, the purchase price of package bees for beekeeping enterprises in Edirne Province should be below US$39.52 *(Table 5; Fig. 2)*. In other words, package beekeeping for Edirne province is profitable for enterprises at prices below US$39.52. There was a cost saving due to absence of winter losses in case of packet beekeeping in Edirne. This value was US$31.63.

DISCUSSION

Package beekeeping becomes profitable for the beekeeping enterprises at prices below US$39.52 for Edirne province. It is not yet known whether the beekeeping enterprises can supply package bees below this price level because the package beekeeping sector shows new developments in Turkey. A private company in Turkey started sales of frameless package bees with queen in 2019. Price of 1.5 kg bees and young queen bee is totally 370 TRY (about US$64) in the spring of 2019 for this private company.

However, in the case of high package bee prices in the domestic market, "importation of package bees may be an option for beekeeping enterprises. According to a study carried out in Saudi Arabia by Al-Ghamdi and Nuru [29], the price of a local *Apis mellifera yemenitica* colony is relatively high at USD 100-120 per colony in Saudi Arabia. The authors point out that the country annually imported around 100.000 *Apis mellifera carnica* and *Apis mellifera ligustica* bee colonies from Egypt and Australia. In this study, the price was shown to be one of the reasons for importation of package bees. The authors emphasized that the average price of imported package bees was US$30-40 per colony [29].

Other countries in the world meet the need for package bees by import. In Canada, almost 100% of bee packages are imported. New Zealand accounted for about 100% of bee packages imported into Canada in 2016 [30].

Live bee exports from New Zealand were 15.139 one kg packages in 2016-17. A package of bees exported from New Zealand generally consists of 1 kg of bees housed within a ventilated cardboard tube or a cardboard and wire screen box about the size of a shoe box. The package may hold a supply of sugar syrup and queen bee in a cage. All packages and the majority of the queen bees go to Canada. The exporting season is from late January to May. The price for bulk bees, which was the price paid to the beekeepers for export in New Zealand, ranged from $31 (US$21.46) up to $35 (US$24.23) in 2016-17 [31].

On the other hand, package bees prices paid to the beekeepers in 2017 are higher in United States. For operations with five or more colonies in United States, the average price paid in 2017 for packages was US$76 per package. The average price paid in 2017 for operations with less than five colonies was US$117 per package [32].

The results of this study showed that package beekeeping was more advantageous for beekeeping enterprises according to the artificial swarm application. The package beekeeping can provide savings for beekeepers whose bees overwinter in cold climates. In this study, it was determined that if the bees were not wintered, the beekeeping enterprises could save US$31.63 per hive.

In line with the break-even point analysis, the price level in which the package beekeeping will be profitable was determined as US$39.52 per hive for beekeeping enterprises in Edirne. In other words, package beekeeping will be an activity that provides profit for the enterprises in the region at every price that occurs below this price level.

Many beekeepers in Turkey do not have enough information about the package beekeeping. According to this study's preliminary results, it is expected that the dissemination of package beekeeping will have a hugely positive impact on beekeeping enterprises in Turkey. However, further studies are needed to determine the economic impact of package beekeeping on beekeeping enterprises. Preliminary findings strengthen the perception that the effectiveness of beekeeping enterprises can be increased with the adoption of this system in Turkey.

The Ministry of Agriculture and Forestry only provides hive and queen bee supports. There is no support for package beekeeping. Package beekeeping should be included to the scope of beekeeping supports by The Ministry of Agriculture and Forestry for dissemination of package beekeeping in Turkey.

It has been seen that package beekeeping system has been applied in the world for many years. It is also known that packaged honey bees are exported to different countries. As a result, with the expansion of package bee production in Turkey, it is expected that the marketing initiatives for exportation of package bees will increase.

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