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ECONOMIC ANALYSIS OF CHESTNUT HONEY PRODUCTION IN THE NATURAL CHESTNUT FORESTS OF EASTERN BLACK SEA REGION, TURKEY

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ABSTRACT

The present study was conducted to determine the production potential and economic significance of chestnut honey and other apiculture products in the Eastern Black Sea Region in Turkey. Although there are several studies on the production and economic aspects of flower honey in the national and international literature, the lack of adequate studies on the production and economic aspects of chestnut honey increases the significance of the present study. The study data were collected with a 19-item survey from 500 beekeepers in the Eastern Black Sea Region (Samsun, Ordu, Giresun, Trabzon, Rize, and Artvin provinces). The study data were analyzed using descriptive statistics, analysis of variance, and correlation analysis. Economic analyzes on chestnut honey production were conducted based on Gross Production Value, Net Profit, Gross Profit, and Profitability. In 2017, the profitability in chestnut honey production was calculated as 86% in the Eastern Black Sea Region. Furthermore, economic revenues in relation to honey production in chestnut forests totaled US $ 76.15 million/year in the region. The results show that chestnut honey apiculture was economically profitable in the Eastern Black Sea Region.

Keywords: Apiculture, profitability, chestnut honey economy, chestnut forests, rural development, Turkey

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INTRODUCTION

Today, rapid developments in several industries, such as pharmacology, textile and food, require efficient planning and operation of forestry resources that produce raw materials for these industries. Thus, apiculture activities are a good alternative business and income source for the rural population due to the unique properties of this mode of production. Although Turkey has a convenient natural ecological condition for apiculture, only a portion of its full potential is utilized (Uzundumlu *et al*., 2011; Vural and Karaman, 2010). The progress in the apiculture industry has been significant both worldwide and in Turkey in recent years. Apiculture has become an industry that includes honey, beeswax, royal jelly, propolis, bee venom production and similar products obtained from the bees, and production of apiculture materials such as honeycomb and hives (Sancak *et al*., 2013).

Apiculture contributes to 81,830 farm owner households by providing a sustainable additional income in Turkey, contributing to economic and rural development. According to the 2018 data, the honey production was 107,920 tons, corresponding to a honey production average revenue of US $ 450 million/year (Anonymous, 2020). The share of chestnut honey production in overall production and revenues is not known due to the unavailability of these statistics in Turkey. Although there are several studies on honey production, there is almost none on the chestnut honey economy conducted in chestnut forests.

The Eastern Black Sea Region forest resources have a significant share in Turkish economy due to the availability of various tree species, and rich flora and fauna. The Eastern Black Sea Region forests, which include various geographical and climate characteristics, are important for both wood and non-wood forest product production. Apiculture is prevalent in the forests of the region. Chestnut honey is the most prominent honey produced in the Eastern Black Sea Region forests. The chestnut forests of the Eastern Black Sea Region, where apiculture activities are conducted, are adversely affected by chestnut bark cancer and social pressures. Significant losses have been observed in chestnut wood due to the lack of required care by forest administration, and chestnut bark cancer, and economic benefits have been hampered (Başer and Bozoğlu, 2020; Diktaş Bulut *et al*., 2018; Gerçek *et al*., 2018). However, chestnut forests have significant potential as non-wood forest product resources. Also, they are effective in terms of preventing erosion, keeping moisture content of the soil, and protecting nature (Bozoğlu *et al*., 2019). In the region, the production of chestnut honey is important for the protection, improvement, and development of rural forest resources.

In scientific studies conducted in recent years, it was determined that chestnut honey produced as single flora honey had very rich content when compared to other flower kinds of honey (Ronsisvalle et al., 2019; Saral, 2018; Kolaylı et al., 2016; Karadal *et al*., 2018; Stoi´c *et al*., 2016; Turski *et al*., 2016). The determination of the production potential of chestnut honey and related products that has been a popular consumption item recently in the Eastern Black Sea Region forests and the economic significance of chestnut honey production would contribute to the sustainable management of forest resources and rural development.

Most chestnut honey producers in the Eastern Black Sea Region are not mobile beekeepers and operate in chestnut forests. The present study was conducted to determine the socioeconomic status, honey production potential, production costs, and profitability in the Eastern Black Sea Region. These results will contribute to the sustainable management of forest resources and rural development.

MATERIALS AND METHODS

Materials:

The study area: The study area included chestnut honey beekeepers active in chestnut forests in the Artvin, Giresun, Ordu, Rize, Samsun, and Trabzon provinces under the administration of the Artvin, Giresun, Trabzon, and Amasya Regional Directorates of Forestry in the Eastern Black Sea Region (Fig. 1).

Based on the General Directorate of Forestry (GDF) Chestnut Action Plan (Anonymous, 2013), the actual pure and mixed chestnut tree number in the Eastern Black Sea Region is 4,382 ha in Samsun, 27,520 ha in Artvin, 30,702 ha in Giresun, and 68,926 ha in Trabzon, which corresponds to a total area of 131,530 ha. The pure chestnut forests cover 14,508 ha, whereas the mixed forests cover 117,022 ha.

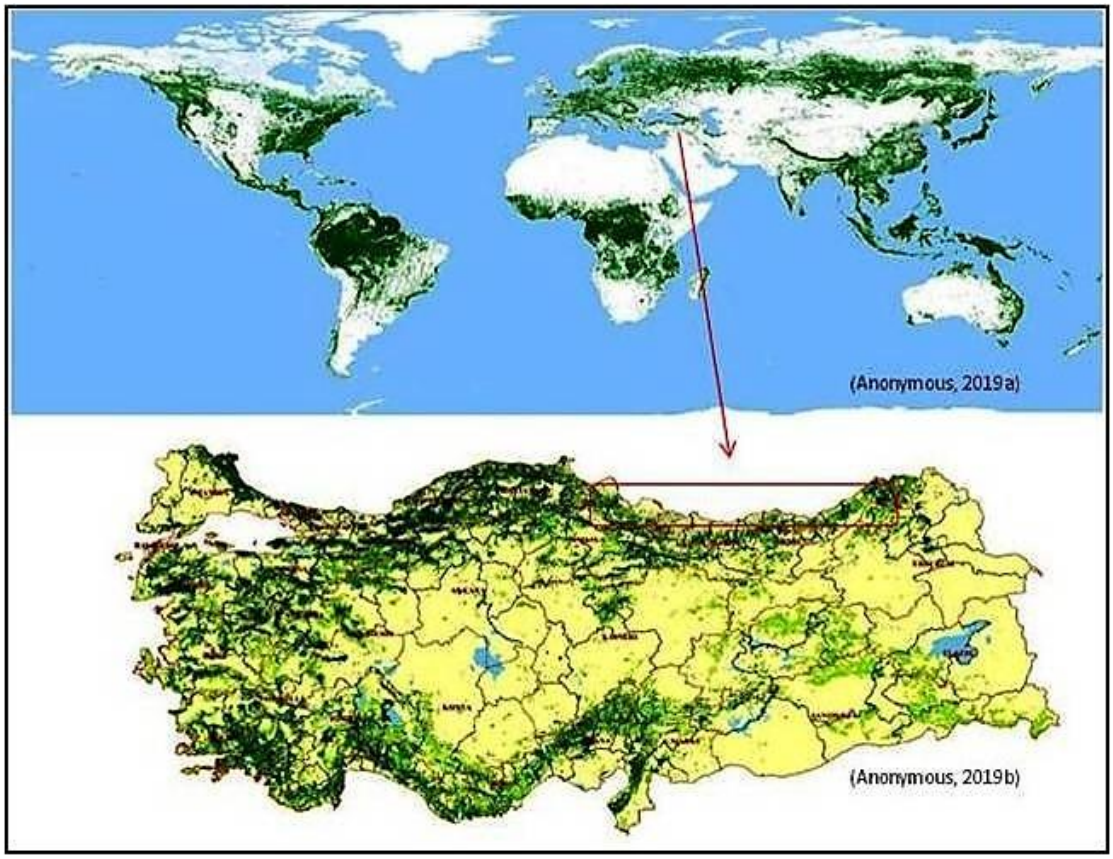

Figure 1. Study area

Study data: The study data were collected with face-to-face surveys from the sample farms. The survey forms, which were prepared by the authors, included chestnut honey production volume, sales, marketing of the products, annual costs in chestnut honey production, working capital requirements, production problems, and other factors. Also, the data obtained from the GDF Honey Forest Action Plan (Anonymous, 2018), Agriculture and Forestry Provincial Directorates and Bee

Breeders Association official records, and Turkstat statistics were used as secondary data.

Methods: The study was conducted in two main stages. In the first stage, the study data were collected, and in the second stage, the study data were analyzed. In the data collection stage, the information on chestnut honey beekeepers and their farm location were determined using the official records of the beekeeper associations in the provinces, while other information was obtained from institutional and organizational records.

The data analysis was conducted in two sub-stages. In the first sub-stage, the profile of the beekeepers in the provinces of Artvin, Giresun, Ordu, Rize, Samsun, and Trabzon, and the problems they faced in production and marketing activities were determined. In the second stage, chestnut honey production activities were analyzed. For this purpose, the economic analysis of production was conducted with Gross Production Value (GPV), Net Profit (NP), Gross Profit (GP), and Profitability (P) by reviewing the cost elements, annual production quantity and revenues, based on the data collected with the interviews with chestnut forest beekeepers and official records. The research is based on measuring the economic annual results of the beekeepers' annual activities, and for this purpose, the inputs and outputs of the beekeepers were evaluated within the same year (Kıral and Kasnakoğlu, 1999). These criteria were also preferred, as they were suitable for measuring the economic results of the beekeepers' annual activities.

Data collection method: The vast majority of the study data (i.e., age, gender, educational status, experience, cost and price determination, problems, and expectations on production and marketing) were collected with a survey conducted with chestnut honey beekeepers. It was determined that the number of chestnut honey producers in the region was 2,890 according to the provincial beekeeper association official records. The following formula (Eq. 1) was used to determine the number of interviewees (Orhunbilge, 2000; Daşdemir, 2019):

$$n \geq (NxZ^2xpxq)/[(NxD^2)+(Z^2xpxq)] \text{ (Eq. 1)}$$

where N depicts the community size (number of chestnut honey producers = 2,890), Z is the confidence coefficient (1.96 at 95% confidence level), p depicts the ratio of the presence of the measured criterion in the population (p = 0.5), q reflects the ratio of the non-presence of the measured criterion in the population (1-p) (q = 0.5), D is the accepted sampling error (D = 0.05), and n reflects the sample size.

Based on the above-mentioned formula, the sample size (n) was calculated as ≥384. However, this size was exceeded in the study and the survey was conducted with 500 beekeepers. The survey was applied between May 2017 and December 2017 with a face-to-face interview method through the stratified random sampling method. The number of questionnaires applied in each stratum (province) was determined with the n/N ratio (0.17 = 500/2,890) (Tab. 1).

Table 1. The distribution of the population and the sample based on provinces (strata).

Provinces	Artvin	Giresun	Ordu	Rize	Samsun	Trabzon	Regional average
# of chestnut honey producers	620	530	250	680	210	600	2,890
%	21	18	9	24	7	21	100
Sample size (n)	105	90	45	120	35	105	500

Data analyzes: Descriptive statistics (percentage, frequency, mean) were used to analyze the socioeconomic status, tool-equipment ownership, production structure, problems, and expectations of the chestnut honey producer and beekeepers. The economic analysis of the chestnut honey production was conducted based on production cost, gross production value (GPV), profit (net, gross), and profitability (P) as detailed below.

Chestnut honey production costs were considered in two categories as fixed and variable costs. Fixed costs included depreciation of apiculture tools and equipment, equipment and bee capital interests, general administrative expenses, and family labor allowances in the present study. The depreciation rate was accepted as 10% in calculating the depreciation of tools and equipment, a fixed cost item (Kıral and Kasnakoğlu, 1999; Marinkovic and Nedic, 2010). The accrued interest was calculated with the application of Ziraat Bank 2017 real interest rate (0.2%) on half of the equipment and bee capital investment value (Kıral and Kasnakoğlu, 1999). On the other hand, the current capital interest reserve was calculated based on the application of Ziraat Bank's 2017 agricultural loan interest rate (4%) for apiculture on half of the total variable cost expenditures (Öztürk *et al*., 2015). General administrative expenses were accepted as 3% of the total variable costs (Mülayim, 2001; Öztürk *et al*., 2015). The family labor allowances were based on fair wages paid to the external labor force in the region. The total production costs were calculated as the sum of fixed and variable costs.

Gross Production Value (GPV*)*: It was calculated by multiplying the annual quantity of chestnut honey and related other products by each farm and the market price as follows:

Gross Production Value (GPV) = [(Price of honey x Honey Output)] + Apiculture Product Gross Production Values

After the GPV for each producer was calculated, the province-based contribution to the economy was calculated with the total output by province for one year. Net profit was calculated by subtracting total production costs from gross production value, and gross profit was calculated by subtracting the variable costs from the gross production value in honey production.

Net Profit (NP) = Gross production value (GPV) – Total production costs (TPC)

Gross Profit (GP) = Gross production value (GPV) – Total variable costs (TVC)

and profitability (P) per farm was calculated in chestnut honey production as follows (Eq. 2):

P = [(Net Profit/Total Capital) x 100] (Eq. 2)

The sum of fixed and variable capital in apiculture was considered as the total capital. The profit and profitability calculations were conducted based on the producer, province and region.

Whether there were differences in chestnut honey production between the provinces (Samsun, Ordu, Giresun, Trabzon, Rize, and Artvin) were tested with analysis of variance based on Gross Production Value, Net Profit, Gross Profit, and Profitability; different groups were determined with the Duncan test; and correlation analysis was employed to determine the correlations between production and associated variables (Kalıpsız, 1988; Özdamar, 2002; Daşdemir, 2019). For this purpose, MS Excel and SPSS 22.0 programs were used.

RESULTS

Socioeconomic structure of the beekeepers: Table 2 shows the socio-demographic features of the beekeepers. Ninety-nine percent of the chestnut honey producers and beekeepers were male and 1% was female. The mean age of the farm owners was 49.9. The review of the educational status of the surveyed farm owners demonstrated that 45% were primary school graduates, 25% were high school graduates, 16.2% were secondary school graduates, 11.6% were college graduates, and 2.2% were illiterate. The vast majority (77.8%) of the surveyed apiculture farm owners in the Eastern Black Sea Region lived in villages. The analysis of the number of workable individuals in chestnut honey production farm owner households, excluding the farm owners (Tab. 2), demonstrated that there was 1 workable individual in 33.8% of the households, 2 individuals in 28.8%, 3 individuals in 11.6%, 4 individuals in 3.4%, and that there were no workable individuals in 22.4% of the households. The mean apiculture experience of the farm owners was 16.63 years, whereas 60.6% of the farm owners had 11-year or more experience.

Tool-equipment ownership: The annual activity season between the placement of the beehives in chestnut forests and the transfer of the hives to wintering locations after honey production differed between the provinces, and the mean season was 60 days in the Eastern Black Sea Region (Tab. 3).

It was determined that the number of hives, which are the most important equipment in apiculture, per farm was 75.32 in Artvin, 46.72 in Giresun, 51.27 in Ordu, 39.88 in Rize, 66.80 in Samsun, and 70.17 in Trabzon (Tab. 3).

Production structure: Although the final product of the chestnut honey production farms in the Eastern Black Sea Region is “chestnut honey”, these farms also produce “bee products” such as beeswax, propolis, pollen, royal jelly, queen, and cluster bees. The mean honey production in the scrutinized farms in the present study was 501.45 kilograms in 2017 (Tab. 4).

Table 2. Beekeepers’ socio-demographics features.

Socio-demographics features	Artvin	Giresun	Ordu	Rize	Samsun	Trabzon	Regional average
Age (year)	51.5	50.5	46.9	47.9	47.8	54.8	49.9
Education (%)							
Illiterate	0.0	1.1	2.2	3.3	2.9	3.8	2.2
Primary school	44.8	53.3	51.1	39.2	45.7	41.9	45.0
Secondary school	13.3	17.8	26.7	14.2	28.6	11.4	16.2
High school	28.6	21.1	17.8	27.5	8.6	30.5	25.0
College	13.3	6.7	2.2	15.8	14.3	12.4	11.6
Residency (%)							
Village	94.3	73.3	68.9	79.2	74.3	68.6	77.8
District	5.7	25.6	28.9	18.3	20.0	25.7	19.6
Urban	0.0	1.1	2.2	2.5	5.7	5.7	2.6
Workforce in family (person) (%)							

0	20.0	13.3	17.8	23.3	17.1	35.2	22.4
1	38.1	30.0	37.8	21.7	54.3	38.1	33.8
2	24.8	38.9	33.3	26.7	22.9	26.7	28.8
3	14.3	15.6	8.9	19.2	5.7	0.0	11.6
4	2.9	2.2	2.2	9.2	0.0	0.0	3.4
Experience (%)							
1-10 year	17.1	45.6	53.3	51.7	51.4	32.4	39.4
11-20 year	41.9	40.0	22.2	23.3	28.6	26.7	31.2
21-30 year	21.9	10.0	13.3	18.3	8.6	24.8	17.8
31-40 year	17.1	4.4	11.1	5.8	11.4	10.5	9.8
≥41year	1.9	0.0	0.0	0.8	0.0	5.7	1.8
Mean (year)	22.30	13.98	14.24	14.69	14.17	20.43	16.63

Table 3. The annual activity period and tool-equipment ownership per farm.

	Artvin	**Giresun**	**Ordu**	**Rize**	**Samsun**	**Trabzon**	**Regional average**
Annual activity period (day/year)	85	60	46	57	61	45	60
Tool-equipment ownership							
Beehive	75.32	46.72	51.27	39.88	66.80	70.17	57.79
Nucleus hive	16.15	4.82	9.69	4.76	10.91	9.45	9.02
Beekeeper hut	0.48	0.34	0.22	0.35	0.17	0.45	0.37
Beekeeper tent	0.37	0.28	0.44	0.27	0.29	0.46	0.35
Honey conditioning vessel	0.30	0.33	0.33	0.38	0.51	0.50	0.35
Extractor	0.15	0.41	0.20	0.32	0.17	0.36	0.39
Feeder	75.88	47.03	51.27	41.85	66.66	70.17	58.46
Eyelet punch	0.69	0.61	0.71	0.34	0.51	0.38	0.52
Electrical comb honey foundation	0.64	0.24	0.02	0.19	0.29	0.26	0.30
Bottom board	4.50	10.44	6.53	9.47	28.09	21.97	12.26
Pollen trap	10.25	2.50	4.51	6.78	32.26	22.84	11.69
Capping spinner	0.88	0.91	0.80	0.88	0.94	0.87	0.88

Table 4. The mean chestnut honey and bee product output

Products	**Artvin**	**Giresun**	**Ordu**	**Rize**	**Samsun**	**Trabzon**	**Regional average**
Extracted chestnut honey (kg)	513.10	426.44	598.12	386.52	505.71	543.81	480.70
Chunk chestnut honey (kg)	14.23	19.12	28.44	17.00	24.29	28.46	20.75
C. honey (extracted+chunk) (kg)	527.33	445.56	626.56	403.52	530.00	572.27	501.45
Beeswax (kg)	24.77	5.58	41.67	22.22	22.77	19.98	17.75
Pollen (kg)	0.45	3.89	0.69	1.68	9.54	8.59	3.73
Royal jelly (gr)	2.38	1.11	0.00	0.08	0.03	0.10	0.04
Cluster (N)	6.92	1.08	2.04	1.65	7.54	5.53	3.92
Propolis (kg)	0.40	2.78	0.11	0.48	0.57	4.56	1.12
Queen bee (N)	22.82	3.74	2.11	3.36	24.06	12.41	10.75

Economic analyses: Chestnut honey production costs in the Eastern Black Sea Region provinces and active farms are presented in Tab. 5. Thus, 51.32% of the apiculture production costs were variable costs and 48.68% were fixed costs. The farms with the highest variable cost (60.19%) were in Trabzon. Trabzon was followed by Ordu with 56.49%, Samsun with 53.61%, Giresun with 53.37%, Rize with 47.05%, and Artvin with 45.6%. The cost factor with the highest share in the variable costs was feed items (sugar, cake, etc.) with 15.84%, and the lowest share was the cost of water with 0.11%. The fuel/shipping costs were 7.99% of the variable costs. It was determined that the enterprises with the highest fixed cost ratio (54.4%) were in the Artvin province. Among the fixed costs, the cost item with the highest share was the household labor equivalent (33.41%), and the lowest share was the tool-machine capital interest (0.96%).

The average production cost for one-kilogram chestnut honey was US $ 9.45 /kg in the Eastern Black Sea Region (Tab. 6). Based on the analysis of variance

and Duncan test results, it was determined that production cost for one kilogram of chestnut honey differed statistically significantly based on the province ($F=11.765$; $p = 0.000<0.05$) and that the provinces could be classified in three groups based on production costs. The first group with the lowest production costs included the Trabzon, Ordu, and Samsun provinces, the second group included the Samsun and Giresun provinces, and the third group with the highest production costs included the Giresun, Artvin, and Rize provinces.

The chestnut honey GPV per farm in the Eastern Black Sea Region was US $ 19,704.98 /year with 2017 prices. GPV was US $ 25,328.38 /year in Trabzon, US $ 21,074.70 /year in Artvin, US $ 20,798.13 /year in Samsun, US $ 19,368.53 /year in Ordu, and US $ 13,979.09 /year in Giresun. The average GPV per hive was US $ 393.75 /year.

The chestnut honey gross profit per farm in the region was US $ 17,774.68 /year with 2017 prices. Based on the provinces, it was US $ 23,512.93 /year in Trabzon, US $ 18,926.33 /year in Samsun, US $ 18,921.94 /year in Artvin, US $ 17,489.07 /year in Ordu, US $ 16,025.01 /year in Rize, and US $ 11,769.41 /year in Giresun. The mean gross profit per hive in the scrutinized farms was US $ 353.87 /year.

The average net profit of the apiculture farms in the region was US $ 15,943.53 /year in 2017. Net profits by province were as follows: US $ 22,311.99 /year in Trabzon, US $ 17,306.51 /year in Samsun, US $ 16,356.58 /year in Artvin, US $ 15,473.36 /year in Ordu, US $ 14,154.03 /year in Rize, and US $ 9,838.74 /year in Giresun. The average net profit per hive was US $ 307.35. The net profit from one-kilogram chestnut honey was US $ 43.11 /kg in the region. The net profit from one kilogram of chestnut honey based on the province varied between US $ 40.93 /kg and US $ 45.93 /kg.

In 2017, the profitability rate of chestnut honey production in the Eastern Black Sea Region was determined as 86.07%. The highest profitability was recorded in Ordu (142.17%), followed by Trabzon (98.80%), Samsun (92.06%), Giresun (78.31%), Rize (69.05%), and Artvin (60.07%), respectively.

Based on the analysis of variance results at 99% confidence level, there were significant differences between the provinces based on GPV ($F=4.751$; $p = 0.000<0.05$), gross profit ($F=5.530$; $p=0.000<0.05$), net profit ($F=6.509$; $p=0.000<0.05$) and profitability ($F=11.115$; $p= 0.000<0.05$) in chestnut honey production. Based on the Duncan test, three different groups were determined based on GPV, net profit, gross profit, and profitability.

Accordingly, Giresun, Rize, and Ordu were included in the first group with the lowest GPV, the second group with a moderate GPV included Rize, Ordu, Samsun, and Artvin, and the third group with the highest GPV included the Ordu, Samsun, Artvin, and Trabzon provinces. The group with the lowest gross profit included Giresun, Rize, and Ordu, the second group with a moderate gross profit included Rize, Ordu, Artvin, and Samsun, and the third group with the highest gross profit included the Artvin, Samsun, and Trabzon provinces. Based on net profit, the first group included Giresun and Rize with the lowest net profit, the second group with a moderate net profit included Rize, Ordu, Artvin, and Samsun, and the third group with the highest net profit included the Samsun, Trabzon provinces. The group with the lowest profitability included the Artvin, Giresun, and Rize provinces, the group with moderate profitability included Giresun, Rize, Samsun, and Trabzon, and the third group with the highest productivity included the Ordu province.

The honey yield per hive was calculated as 9.93 kg in the Eastern Black Sea Region, and it differed statistically based on the province ($F=14.796$; $p =0.000<0.05$), and the provinces were categorized into four groups based on honey yield. Thus, the first group with the lowest honey yield included the Artvin province, the second group included Trabzon and Samsun, the third group included the Samsun, Rize, and Giresun provinces and the fourth group with the highest honey yield included the Ordu province. The honey yield was the lowest in the Artvin province, while it was the highest in the Ordu province.

In 2017, the average bee product output was reported as US $ 1,051.73 /year. The highest bee product output was observed in the Trabzon province with US $ 1,698.17 /year, whereas the lowest was observed in the Giresun province with US $ 330.26 /year.

The correlations between honey production and certain variables: The correlation analysis demonstrated that there was a positive correlation between the production cost of one kilogram of chestnut honey and the annual activity period and that there was a negative correlation between the number of beehives and beehive yield (Tab. 7). As seen in Tab. 7, there was a positive correlation between GPV and the number of hives, experience, hive yield, and annual activity period. Similarly, there was a positive correlation between gross profit and the number of hives, experience, hive yield, and annual activity period. Also, there was a positive correlation between net profit and number of hives, hive yield, and experience. The correlation analysis results demonstrated that there were negative correlations between honey yield and age and experience of the beekeeper, annual activity period, number of hives, and per kilogram cost of honey.

Table 5. Cost factors based on province and farms.

Cost item	Artvin		Giresun		Ordu		Rize		Samsun		Trabzon		Regional average	
	US $	%	US $	%	US $	%	US $	%	US $	%	US $	%	US $	%
Feed (sugar, etc.)	731.06	15.5	713.19	17.23	615.22	18.49	451.14	12.77	604.30	17.31	513.68	17.03	595.71	15.84
Pharmaceutical costs	178.30	3.8	133.93	3.23	77.24	2.32	102.18	2.89	170.90	4.89	85.38	2.83	122.92	3.27
Honeycomb costs	385.69	8.2	390.47	9.43	388.61	11.68	279.31	7.90	323.54	9.27	314.26	10.42	341.93	9.09
Water	0.41	0.0	10.76	0.26	8.02	0.24	4.88	0.14	4.06	0.12	0.00	0.00	4.20	0.11
Fuel/transportation	311.69	6.6	301.93	7.29	225.06	6.76	292.38	8.27	223.78	6.41	356.20	11.81	300.69	7.99
Temporary labor	54.52	1.2	112.06	2.71	53.66	1.61	60.37	1.71	0.00	0.00	32.47	1.08	57.76	1.54
Land lease (accommodation)	137.45	2.9	55.87	1.35	47.35	1.42	91.34	2.58	65.42	1.87	153.82	5.10	101.98	2.71
Packaging costs (tin canister, jar, labels etc.)	98.39	2.1	68.45	1.65	70.86	2.13	73.02	2.07	63.23	1.81	57.52	1.91	73.39	1.95
Colony renewal	163.15	3.5	291.35	7.04	287.25	8.63	220.60	6.24	297.08	8.51	234.98	7.79	235.64	6.26
Tools and equipment repair and maintenance	50.97	1.1	90.53	2.19	70.39	2.12	56.11	1.59	82.79	2.37	32.20	1.07	59.36	1.58
Interest on current capital	41.14	0.9	41.13	0.99	35.80	1.08	31.42	0.89	36.70	1.05	34.96	1.16	36.72	0.98
A. Total Variable Costs	2,152.76	45.6	2,209.67	53.37	1,879.46	56.49	1,662.73	47.05	1,871.81	53.61	1,815.45	60.19	1,930.30	51.32
General administrative expenditures	64.58	1.4	66.29	1.60	56.38	1.69	49.88	1.41	56.15	1.61	54.46	1.81	57.91	1.54
Household labor equivalent	1,835.77	38.9	1,440.97	34.80	962.75	28.94	1,408.50	39.86	1,024.76	29.35	549.92	18.23	1,256.79	33.41
Interest on bee capital	167.44	3.5	87.26	2.11	89.55	2.69	109.36	3.09	122.28	3.50	118.13	3.92	118.54	3.15
Tools and equipment depreciation	452.34	9.6	305.59	7.38	308.04	9.26	275.67	7.80	378.75	10.85	434.94	14.42	361.73	9.62
Interest on tools and equipment capital	45.23	1.0	30.56	0.74	30.80	0.93	27.57	0.78	37.88	1.08	43.49	1.44	36.17	0.96
B. Total Fixed Costs	2,565.36	54.4	1,930.67	46.63	1,447.53	43.51	1,870.99	52.95	1,619.81	46.39	1,200.94	39.81	1,831.14	48.68
C. Total Production Costs	4,718.12	100	4,140.35	100	3,326.99	100	3,533.72	100	3,491.62	100	3,016.39	100	3,761.44	100

Table 6. Economic analyses based on province and farms.

Criteria	Artvin	Giresun	Ordu	Rize	Samsun	Trabzon	Regional average
Honey production (kg)	527.33	445.56	626.56	403.52	530.00	572.27	501.45
Honey yield per hive (kg/hive)	7.28	11.06	13.07	10.89	10.26	9.05	9.93
Honey production cost (US $/kg)	11.05	9.88	6.84	11.62	7.95	6.63	9.45
Bee products (propolis, pollen, etc.) output (US $)	1,662.09	330.26	540.56	544.31	1,533.52	1,698.17	1,051.73
Fixed Assets (US $)	21,267.39	11,781.92	12,035.59	13,693.04	16,015.56	16,161.90	15,471.52
Current Assets (US $)	6,405.84	3,452.49	3,486.74	7,172.94	6,763.80	7,181.41	5,983.55
Loans (US $)	1,145.83	628.53	347.22	368.37	983.77	188.45	581.96
Total capital (US $)	26,527.41	14,605.31	15,175.11	20,497.61	20,811.82	23,154.87	20,873.11
GPV (US $)	21,074.70	13,979.09	19,368.53	17,687.74	20,798.13	25,328.38	19,704.98
Gross profit (US $)	18,921.94	11,769.41	17,489.07	16,025.01	18,926.33	23,512.93	17,774.68
Net Profit (US $)	16,356.58	9,838.74	15,473.36	14,154.03	17,306.51	22,311.99	15,943.53
Profitability (annual)	60.07	78.31	142.17	69.05	92.06	98.80	86.07
GPV (US $/hive)	296.15	350.30	413.94	496.33	409.87	385.61	393.75
Gross profit (US $/hive)	280.18	304.73	374,61	444.34	445.07	352.93	353.87
Net Profit (US $/hive)	22.46	249.18	340.44	377.69	364.53	328.47	307.35
Net Profit (US $/kg)	41.50	42.71	45.72	40.93	44.60	45.93	43.11

Table 7. Correlation analysis.

Variables	Age	Education	Experience	Activity Period	# of hives	Production Cost	Profitability	Gross Profit	Net Profit	GPV	Honey Yield
Age	1	-0.209**	0.600**	0.043	0.106*	0.036	-0.182**	0.046	0.04	0.048	-0.171**
Education	-0.209**	1	-0.078	-0.054	0.029	-0.002	-0.055	0.045	0.049	0.04	-0.031
Experience	0.600**	-0.78	1	0.133**	0.223**	0.010	-0.144**	0.139**	0.129**	0.141**	-0.199**
Activity Period	0.043	-0.054	0.133**	1	0.167**	0.368**	-0.150**	0.099*	0.039	0.105*	-0.109*
# of hives	0.106*	0.029	0.223**	0.167**	1	-0.210**	0.054	0.787**	0.775**	0.802**	-0.305**
Production Cost	0.036	-0.002	0.01	0.368**	-0.210**	1	-0.407**	-0.355**	-0.410**	-0.330**	-0.250**
Profitability	-0.182**	-0.055	-0.144**	-0.150**	0.054	-0.407**	1	0.399**	0.419**	0.381**	0.622**
Gross Profit	0.046	0.045	0.139**	0.099*	0.787**	-0.355**	0.399**	1	0.996**	0.997**	0.119**
Net Profit	0.04	0.049	0.129**	0.039	0.775**	-0.410**	0.419**	0.996**	1	0.992**	0.128**
GPV	0.048	0.04	0.141**	0.105*	0.802**	-0.330**	0.381**	0.997**	0.992**	1	0.104*
Honey Yield	-0.171**	-0.031	-0.199**	-0.109*	-0.305**	-0.250**	0.622**	0.119**	0.128**	0.104*	1

**. *Correlation is significant at 0.01 level (2-tailed)*

*. *Correlation is significant at 0.05 level (2-tailed)*

The current honey production output of chestnut forests: The average market sales price of chestnut honey in the Eastern Black Sea Region was US $ 42.61 /kg for extracted chestnut honey and US $ 62.5 /kg for chunk chestnut honey. In the calculations, the average chestnut honey market price was taken as US $ 52.55 /kg.

It was determined that the average annual honey production per farm was 501.45 kg in the Eastern Black Sea Region (extracted + chunk honey). Since the number of chestnut honey farms was 2890 in the region, the honey production output (HPO) and the honey production value (HPV) were calculated as follows for 2017 in the study area:

HPO = The number of farms x average honey production output

HPO = 2,890 x 501.45 = 1,449,190.5 kg

HPV = Average honey production output x market sales price

HPV = 1,449,190.5 x 52.55= 76,154,960.76 US $

The current problems of apiculture farms and their expectations: Considering the problems and expectations of the chestnut honey producers in the Eastern Black Sea Region, it was determined that “infrastructure problems” were the most common problem with 29.86% in chestnut honey production. This problem was followed by the “establishment of honey forests, disease control, and treatment” with 23.09%. The remaining 47.05% included "inspection", "organic apiculture projects and assistance", "marketing/pricing" problems and expectations. The most important problem for the farms was marketing and pricing. The farms wanted to prevent illegal honey sales. They also wanted the State's support for organic beekeeping.

DISCUSSION

The mean age of the farm owners was 49.9, and it could be suggested that chestnut honey production was conducted by middle-aged individuals. Similarly, Emir and Peri (2016) reported the average age of flower/chestnut honey producers in Salıpazarı/Samsun as 52; Aksoy *et al*. (2018) reported the average age of flower honey producers in the Eastern Anatolia Region as 48.9; Al-Ghamdi *et al*. (2017) reported the same figure as 46.6 in Saudi Arabia; Vural and Karaman (2010) reported the average age of the Bursa province beekeepers as 43.9; and Ceyhan *et al*. (2016) reported the mean age of beekeepers in Turkey in general as 49. Ceyhan *et al*. (2016) found that the oldest beekeepers were in the Black Sea Region and that, as the farm owner got older, they tended to turn to stationary apiculture instead of mobile apiculture.

The educational status of the surveyed apiculture farm owners were primary school graduates. The apiculture farm owners in the Eastern Black Sea Region lived in villages. The average household size was 4-6 individuals. In fact, Ceyhan *et al*. (2016) reported that 57% of the apiculture farm owners were primary and middle school graduates and that the average household size was 3-5 individuals.

The mean apiculture experience of the farm owners was 16.63 years. It could be suggested that the beekeepers, who were in the provinces of Trabzon and Artvin, were more experienced. Similarly, Ceyhan *et al*. (2016) determined that the mean experience of the farm owners was 21 years; Emir and Peri (2016) reported that the mean experience of the farm owners was 15 years; and Vural and Karaman (2010) found that the mean experience of the farm owners was 14 years.

The mean number of hives per farm in chestnut honey production was 57.79. Aksoy *et al*. (2018) reported the mean number of hives per farm as 168.1; Al-Ghamdi *et al*. (2017) reported the mean number of hives per farm as 349; Emir and Peri (2016) reported the mean number of hives per farm as 90; and Öztürk *et al*. (2015) reported the mean number of hives per farm as 179.06. It could be suggested that the number of hives per farm in chestnut honey production was due to the fact that the beekeepers preferred chestnut forests close to their villages for production, that the majority of the chestnut honey producers were not mobile beekeepers, and that the mobile beekeepers employed only a few beehives in chestnut honey production. The average number of hives in the farms, the majority of which were not mobile beekeepers, was quite low when compared to the number of hives per farm in flower honey production. Aksoy *et al*. (2017) reported that beekeepers with a large number of hives were more professional and that farms with a smaller number of hives were not mobile beekeepers.

The highest honey production was in Ordu (626.56 kg). The fact that Ordu is the leading province in Turkey in flower honey production in relation to a high level of experience of the Ordu province beekeepers due to mobile apiculture led to higher success in chestnut honey production as well. In fact, Marinkovic and Nedic (2010) reported that professional beekeeping farms were mostly mobile beekeepers since income per hive was higher in mobile apiculture.

The mean production figures for bee products by chestnut honey farms were 3.73 kg pollen, 1.12 kg propolis, and 0.04 g royal jelly. Ceyhan *et al*. (2016) reported bee product output per colony as 1.13 kg pollen, 156 gr propolis, and 53 gr royal jelly.

The farms with the highest variable cost (60.19%) were in Trabzon, while the farms with the lowest variable cost (45.6%) were in Artvin. Similarly, in a study conducted on the Mediterranean Region, Öztürk *et al*. (2015) reported that 56.02% of flower honey production costs were variable costs and that 43.98% were fixed costs, Ceyhan *et al*. (2016) reported that variable costs were %60 of all costs and that fixed costs

were 40% of all costs nationwide. Saner *et al*. (2004) determined that variable costs constituted 46.85% of the total production costs and that the fixed costs were 53.15%. Feed, labor, and honeycomb costs were important input items in apiculture farms. The fact that fuel/transportation costs were low was due to fact that the majority of the chestnut honey producers in the Eastern Black Sea Region were not mobile. The low cost of water was due to the utilization of in-forest water resources by the beekeepers. Saner *et al*. (2004) reported that the share of feed costs in total variable costs was16.29% and that it was 6.68% in total production costs. Fuel/transportation costs constituted 16.29% of the total production cost and pharmaceutical costs constituted 1.46% of the total production costs. Öztürk *et al*. (2015) found that the largest share in variable costs was fuel/transportation costs with 17.48% and that the share of feed costs was 8.05%.

Among the fixed costs, the cost item with the highest share was the household labor equivalent with 33.41%, and the lowest share was the tool-machine capital interest with 0.96%. In flower honey production in Serbia, Marinkovic and Nedic (2010) determined that labor costs constituted 49.65% of total production costs and that fuel/transportation costs constituted 13.38% of total production costs.

The honey yield was the lowest in the Artvin province (7.28 kg/hive), while it was the highest in the Ordu province (13.07 kg/hive). The results of a previous study on honey yield demonstrated that flower honey yield per hive in Ordu was 36.85 kg, 31.6 kg in Samsun, 11.78 kg in Trabzon, 12.07 kg in Artvin, and 8.84 kg in Rize (Ceyhan *et al*., 2016). The overall honey yield per hive in Turkey was reported as 16 kg (Saner *et al*., 2004) and 19.8 kg (Ceyhan *et al*., 2016), while it was 11.25 kg in the Ağrı, Erzurum, and Kars provinces (Aksoy *et al*., 2018) and 11.4 kg (Aksoy *et al*., 2017) in the Erzurum province. Similarly, the same figure was reported as 4.8 kg (Al-Ghamdi *et al*., 2017) in Saudi Arabia, 11-23 kg (Marinkovic and Nedic, 2010) in Serbia, and 20.54 kg (Anonymous, 2016) worldwide.

Based on the evaluation of the production output of bee products, it could be suggested that the majority of the chestnut honey apiculture farms in the Eastern Black Sea Region did not produce bee products. Thus, bee product revenues remained very low when compared to chestnut honey revenues. This could be due to the fact that the beekeepers did not have adequate knowledge of bee products, experienced marketing problems because of the lack of bee products market knowledge, and avoided spending more time and effort on the production of various bee products. Al-Ghamdi *et al*. (2017) emphasized that all possible bee products should be produced for success in apiculture.

It was determined that as the number of hives increased, the production cost of one kilogram of chestnut honey and hive productivity decreased in chestnut honey production. Production costs increased as the annual activity period increased. Similarly, Saner *et al*. (2004) reported that as the number of hives increased, the unit cost of honey decreased. In a study on flower honey apiculture, Öztürk *et al*. (2015) reported that the per kilogram cost was US $ 4.34 /kg, and Ceyhan *et al*. (2016) reported the same figure as US $ 2.98 /kg. The chestnut honey production costs are higher than those of the flower honey production.

As the number of hives, farm experience, hive profitability, and annual activity period increased, GPV and gross profit increased as well. Net profit increased based on the number of hives, farm experience, and hive efficiency. There were positive correlations between profitability and GPV, gross profit, net profit, hive yield, per kilogram cost, and negative correlations between age, experience, and annual activity period. Profitability increased as honey yield increased; however, it decreased as farm age, experience, and annual activity period increased.

As the honey yield increased, the age of the beekeeper, beekeeper experience, annual activity period, the number of hives and the per kilogram cost of chestnut honey decreased. Similarly, Aksoy *et al*. (2017) reported a negative correlation between honey yield and farm owners' age and education level.

The productivity of chestnut honey in Turkey is lower when compared to flower honey productivity since the most important factor that affects the chestnut honey yield in the Eastern Black Sea Region is the seasonal weather conditions. Precipitation and fog, especially during and after the flowering period of the chestnut tree, reduce the honey yield. Indeed, 55% of the apiculture farms stated that the most important variable that affected honey yield was climate (Ceyhan *et al*., 2016). Similarly, Marinkovic and Nedic (2010) reported that the differences in production per hive were caused by the climate, areal suitability, and utilization of the bee by-products.

Based on the analyses conducted in the present study, it was determined that chestnut honey production was an economically profitable farm in the Eastern Black Sea Region. Apiculture is an important component of the rural development program in Turkey. In addition to creating additional income at the household level, chestnut honey apiculture contributes to both the regional and national economies. However, it is important to improve forestry practices in the Eastern Black Sea Region chestnut forests in order to increase the growth and productivity of apiculture. Thus, the following recommendations could be considered:

- The potential chestnut honey production forests should be mapped based on the Geographic Information System and included in the management plans.

- Chestnut forests, which are the chestnut honey resources, should be improved with maintenance and rehabilitation studies.
- Turkey has a substantial potential for chestnut in terms of climate and soil (Bozoğlu et. al., 2020). Therefore, biodiversity should be preserved, especially in forests with chestnut honey production potential. Thus, rhododendron cultivation, which is prevalent in the forests of the region and plays an important role in apiculture activities, should be planned.
- Apiculture infrastructure should be improved in chestnut forests.
- Chestnut honey producers are generally less educated than beekeepers who produce flower honey. Beekeepers should be trained in collaboration with relevant institutions in order to increase honey yield, develop methods of disease/pest control, reduce costs, adapt to changing economic conditions, and thus ensure sustainability in chestnut honey production.
- The participation of women and young individuals in apiculture farms in rural areas and especially forest villages should be promoted.
- Quality standardization should be prioritized in chestnut honey production, and the state should provide financial and marketing support to compete with global chestnut honey producers and related products.
- To increase the production of bee products such as chestnut propolis, pollen, and royal jelly, which are almost non-existent in the Eastern Black Sea Region, awareness should be raised among beekeepers and training activities should be organized.
- R&D activities should be increased to improve chestnut honey production and raw materials such as chestnut propolis, pollen, royal jelly, and new product ranges with high added value, the market for which is increasing every day in the pharmaceutics, food, and cosmetics industries.

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