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ARAŞTIRMA MAKALESI / RESEARCH ARTICLE

ANALYSIS OF SIMILARITIES AND DIFFERENCES IN BEEKEEPING BETWEEN TÜRKİYE AND EUROPEAN UNION COUNTRIES

Türkiye ve Avrupa Birliği Ülkeleri Arasında Arıcılıktaki Benzerliklerin ve Farklılıkların Analizi

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ABSTRACT

This study aims to determine the similarities and differences between Türkiye and European Union countries in terms of beekeeping and classify similar countries. The main materials of the study consist of the number of beekeepers, the amount of honey produced, and the trade balance values of European Union countries and Türkiye. In this study, multidimensional scaling analysis and cluster analysis were conducted to reveal the similarities and differences between Türkiye and European Union countries regarding beekeeping. The analysis results indicate that Spain and Romania are the most similar countries and Türkiye and Germany significantly differ from other European Union countries regarding beekeeping. Specifically, Türkiye was differentiated from other countries by its high honey production amount. The key characteristics that differentiated Germany from other countries were the number of beekeepers and a high trade deficit. In order to compete effectively with European Union countries in beekeeping, Türkiye should prioritize policies that encourage the export of honey in small, branded packaging.

Keywords: Beekeeping, Multidimensional Scaling Analysis, Cluster Analysis, Türkiye, European Union Countries

ÖZ

Bu çalışmanın amacı Türkiye ile Avrupa Birliği ülkeleri arasında arıcılık açısından benzerlikleri ve farklılıkları belirlemek ve benzer ülkeleri sınıflandırmaktır. Çalışmanın ana materyalini Avrupa Birliği ülkeleri ve Türkiye'nin arıcı sayısı, üretilen bal miktarı ve dış ticaret dengesi değerleri oluşturmaktadır. Bu çalışmada Türkiye ile Avrupa Birliği ülkeleri arasında arıcılık konusundaki benzerlik ve farklılıkları ortaya koymak için çok boyutlu ölçekleme analizi ve kümeleme analizinden yararlanılmıştır. Analiz sonuçları İspanya ve Romanya'nın en benzer ülkeler olduğunu, Türkiye ve Almanya'nın ise arıcılık açısından diğer Avrupa Birliği ülkelerinden belirgin şekilde farklı olduğunu göstermektedir. Türkiye'yi diğer ülkelerden ayıran temel özellik üretilen bal miktarıdır. Almanya'yı diğer ülkelerden ayıran temel özellikler ise arıcı sayısı ve yüksek ticaret açığı olmuştur. Türkiye'nin arıcılıkta Avrupa Birliği ülkeleriyle etkin bir şekilde rekabet edebilmesi için küçük, markalı ambalajlarda bal ihracatını teşvik eden politikalara öncelik vermesi gerekmektedir.

Anahtar Kelimeler: Arıcılık, Çok Boyutlu Ölçekleme Analizi, Kümeleme Analizi, Türkiye, Avrupa Birliği Ülkeleri

GENİŞLETİLMİŞ ÖZET

Amaç: Bu çalışmanın amacı Türkiye ile Avrupa Birliği (AB 27) ülkeleri arasında arıcılık açısından benzerlikleri ve farklılıkları belirlemek ve benzer ülkeleri sınıflandırmaktır. Elde edilen bulgular arıcılığa yönelik yapılacak karşılaştırmalı üstünlük çalışmaları ve bu alanda geliştirilecek politikalar için değerlendirilebilir niteliktedir.

Gereç ve Yöntem: Çalışmanın ana materyalini Avrupa Birliği ülkeleri ve Türkiye'nin arıcı sayısı, üretilen bal miktarı ve dış ticaret dengesi değerlerine ilişkin istatistiki veriler oluşturmaktadır. Veriler FAO (Food and Agriculture Organization of the United Nations), ITC (International Trade Centre) ve TÜİK (Türkiye İstatistik Kurumu) veri tabanlarından ve Avrupa Komisyonu tarafından hazırlanan arıcılık sektör raporundan elde edilmiştir. Bu çalışmada Türkiye ile Avrupa Birliği ülkelerinin arıcılık konusundaki benzerliklerini ve farklılıklarını ortaya koyabilmek için çok boyutlu ölçekleme analizi ve ülkelerin sınıflandırılması için kümeleme analizi yapılmıştır. Çok boyutlu ölçekleme analizi kullanımının amacı nesnelerle ilgili birçok özelliği değerlendirerek birimler arasındaki mesafeleri ve yakınlıkları belirlemek ve böylece ülkelerin arıcılık faaliyetlerindeki benzerliklerini ve farklılıklarını ortaya koymaktır. Çalışmada grupları belirlemek için kullanılan kümeleme analizi ise verileri benzerliklerine göre sınıflandırarak araştırmacıya yorumlanabilir özet bilgiler sağlamaktadır. Sınıflandırma çalışmalarının temelini oluşturan bu analiz yöntemi, bireylerin veya nesnelerin sınıflandırılmasını ayrıntılı bir şekilde açıklayabilmektedir.

Bulgular ve Sonuç: Avrupa Birliği ülkeleri dünya bal üretiminin %12,11'ini, Türkiye ise %5,44'ünü gerçekleştirmektedir. Çalışmada Türkiye ile AB ülkeleri arasındaki farklılıklar ve benzerlikler ortaya konulmuştur. Türkiye, birinci boyutta pozitif yükler açısından diğer ülkelerden en fazla farklılaşan ülke olarak öne çıkarken, Almanya ikinci boyutta en fazla farklılaşan ülke konumundadır. Türkiye'yi diğer ülkelerden ayıran temel özellik üretilen bal miktarıdır. Almanya'yı diğer ülkelerden ayıran temel özellikler ise arıcı sayısı ve yüksek ticaret açığı olmuştur. Almanya 2021 yılı verilerine göre hem bal ithalat değeri (314,76 milyon ABD Doları) hem bal ihracat değeri (148,48 milyon ABD Doları) bakımından AB ülkeleri arasında ilk sırada yer almaktadır. Bu durum Almanya'nın ithal ettiği bala katma değer sağlayıp, bunu daha yüksek bir fiyatla yeniden ihraç etme stratejisiyle açıklanabilir. Türkiye'nin bal ithalat değeri ise 378.000 ABD Doları ve ihracat değeri 31,15 milyon ABD Dolarıdır. Ayrıca Almanya, Türkiye'nin bal ihracatının değer bazında %22,32'sini oluşturmaktadır ve Türkiye'nin AB ülkeleri arasında en çok bal ihraç ettiği ülke konumundadır. Analiz sonuçları İspanya ve Romanya'nın en benzer ülkeler olduğunu, Türkiye ve Almanya'nın ise arıcılık açısından diğer AB ülkelerinden belirgin şekilde farklı olduğunu göstermektedir. Türkiye'nin arıcılıkta AB ülkeleriyle etkin bir şekilde rekabet edebilmesi için küçük, markalı ambalajlarda bal ihracatını teşvik eden politikalara öncelik vermesi gerekmektedir. Bu araştırma bal üretim miktarı, arıcı sayısı ve dış ticaret dengesi değişkenleriyle sınırlı kalmıştır. Gelecek araştırmalar arı sütü, polen, propolis gibi ek arı ürünü üretim verilerini modele dahil ederek genişletilebilir. Bu daha geniş veri seti Türkiye ve AB ülkelerindeki arıcılığı daha kapsamlı bir şekilde değerlendirmeye yardımcı olacaktır.

INTRODUCTION

Honey bees are greatly appreciated worldwide for their importance. They are quite important in terms of honey and beeswax production and are essential for pollinating numerous vital crops (VanEngelsdorp and Meixner 2010). Bee products are extensively utilized in industrial manufacturing, food processing, medicine, and the realm of natural healing (Ghanshyam et al. 2021). Furthermore, in natural areas like mountains and forests where beekeeping is practiced, a novel trend known as apitourism has arisen, accompanied by a health-conscious way of living that captures the community's attention (Šuligoj 2021, Topal et al. 2021). According to FAO data for the year 2021, the global honey production amounted to 1771944 tons. 42.84% (759178 tons) of the produced honey was traded internationally, generating a revenue of 2.70 billion US Dollars from foreign trade (ITC 2023). European Union countries (EU 27) account for 12.11% of global honey production, while 5.44% is produced by Türkiye (FAO 2023). Türkiye's honey production quantity is 96,344 tons, whereas Romania, the leading honey-producing country among the EU countries, produces 30,875 tons. Spain (29,393 tons) and Germany (28,651 tons) follow Romania.

In order to analyze the changes in honey production among countries and to make comparisons between them, the annual relative increase in production

quantity was examined over a 20-year period. In addition, this period was divided into two distinct periods in order to reveal the long-term changes in honey production. When the increase in the average honey production quantities for the periods 2001-2010 and 2011-2020 is examined by country, Croatia (222.43%), Lithuania (115.45%), Latvia (111.24%), and Estonia (70.79%) are the countries with the highest proportional increase in honey production. These countries have the highest average annual relative increase in the 2001-2020 period. The geographical proximity of Lithuania, Latvia, and Estonia as countries suggests that this similarity can be associated with geographical features. Cyprus, Slovenia, and Austria are the countries with the highest negative average annual relative increase rate in honey production in the 2001-2020 period. These countries also rank among the countries that show the highest decrease in honey production when the averages of the two periods are compared. Türkiye increased honey production by 35.20% when the 2001-2010 and 2011-2020 periods are compared, and Türkiye's average annual relative growth rate is 2.88% in the period of 2001-2020 (Table 1).

Table 1. Honey production quantity and average annual relative increase by country[1]

Country	Average honey production quantity (ton, 2001-2010)	Average honey production quantity (ton, 2011-2020)	Change between two periods (%)	Average annual relative increase (2001-2020) (%)
Lithuania	1434	3089	115.45	9.06
Estonia	634	1082	70.79	7.08
Croatia	2349	7573	222.43	6.15
Latvia	783	1654	111.24	5.64
Bulgaria	8689	10376	19.41	4.71
Romania	17745	25068	41.26	3.87
Poland	12169	16815	38.18	3.84
Türkiye	76281	103128	35.20	2.88
Greece	15562	19542	25.57	2.25
Finland	1804	2008	11.31	1.94
France	15748	14985	-4.84	1.68
Slovakia	3945	3759	-4.73	1.61
Portugal	6886	10189	47.97	1.50
Germany	20990	22527	7.32	0.62
Luxembourg	166	124	-25.64	0.61
Ireland	230	258	12.11	0.18
Denmark	1500	1500	0.00	0.00
Sweden	3277	3391	3.49	-0.17
Spain	32381	31907	-1.46	-0.19
Italy	10240	9545	-6.79	-0.32
Hungary	18546	23260	25.42	-0.48
Czechia	7228	8482	17.34	-1.16
Cyprus	675	443	-34.37	-2.02
Austria	6470	4800	-25.81	-3.52
Slovenia	1974	1422	-28.00	-3.57

[1] The data has been calculated by the author using data obtained from the FAO (2023). Data for Belgium, Malta, and the Netherlands could not be accessed, and therefore, they have not been included in the calculation.

The share of the EU (27) in the export value is 32.01%, while Türkiye's share in the global honey export value is 1.15%. When examining the honey trade balance of EU countries, Hungary ranks first with a value of 86.34 million US Dollars, while Türkiye ranks fifth with a value of 30.77 million US Dollars. However, the EU's honey trade balance is -233.09 million US dollars (ITC 2023). Türkiye has 8.18 million beehives, while the countries with the most beehives in the EU are Spain (2.95 million), Romania (2.35 million), Greece (2.18 million), and Poland (2.01 million). There are 89197 beekeepers

in Türkiye, and among EU countries, Germany has the highest number of beekeepers with 129048. Other EU countries with the highest number of beekeepers are Poland (74302), Czechia (61572), Italy (56059), and France (53953) (EC 2023, FAO 2023, TURKSTAT 2023). Within the scope of the national apiculture programs, support is provided to EU countries by the Union, and the total support value in 2021 amounted to 39.44 million Euros. The countries receiving the highest share of this support are Spain (5.64 million Euros), Romania (5.25 million Euros), Poland (3.94 million Euros), and Italy (3.55 million Euros), respectively (EC 2023) (Figure 1) When examining the honey production quantities and the number of beehives by country, it is observed that the amount of support is related to these variables.

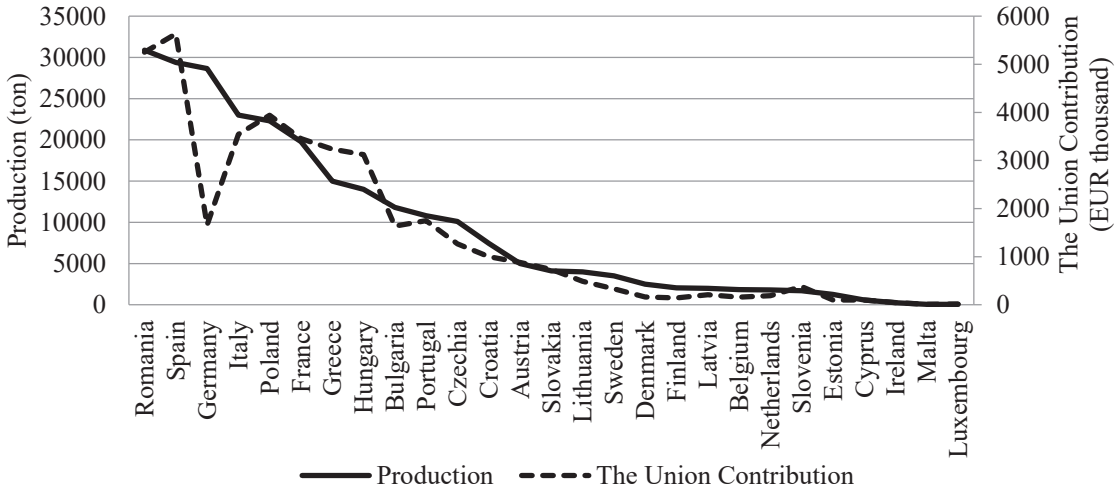

Figure 1. The Union contribution and the honey production quantity of the EU countries

Among the EU countries, Germany has the highest honey yield, with a yield of 29.18 kg per hive in the year 2021. Following Germany are Estonia (25.06 kg/hive), Finland (23.94 kg/hive), the Netherlands (22.98 kg/hive), and Belgium (22.44 kg/hive). The honey yield per hive in Türkiye is 11.78 kg. When looking at per capita honey consumption in 2020, Croatia leads among EU countries with a per capita consumption of 1.86 kg per year. Following Croatia are Greece (1.75 kg/year), Germany (1.05 kg/year), Austria (1.04 kg/year), and Lithuania (1.04 kg/year). Bulgaria and Hungary have the lowest per capita honey consumption among EU countries, at 0.01 kg per year. Türkiye's per capita honey consumption is 1.14 kg per year (FAO 2023).

The production and trade of bee products are directly related to bee populations, and the honey bee population has decreased in many countries in Europe (VanEngelsdorp and Meixner 2010). Climate change also significantly affects beekeeping in Europe (Van Espen et al. 2023). The number of beehives, the number of beekeepers, the amount of honey produced, and the balance in value vary significantly from country to country in beekeeping (EC 2023). However, beekeeping is supported in both EU countries and Türkiye. Determining whether these supports are consistent between countries and whether they are based on rational decisions can provide guidance. Furthermore, revealing the similarities and differences between Türkiye, which ranks first in global honey production, and EU countries can be beneficial for reviewing support policies for beekeeping in terms of Türkiye's competitiveness.

In this study, multidimensional scaling analysis (MDS) and cluster analysis were conducted to reveal the similarities and differences between EU countries and Türkiye in terms of beekeeping. There are studies in the literature that use these methods together in the field of agriculture. Srivastava et al. (2005) studied genetic diversity in silkmoth species, Şahin et al. (2008) analyzed agricultural and environmental characteristics of provinces in the Aegean Region, Ozturk et al. (2009) investigated

honey bee genotypes in 30 provinces in Türkiye, Türkekul et al. (2010) examined the competitiveness of olive oil-exporting countries worldwide, Gevrekçi et al. (2011) analyzed the structure of provinces in Western Anatolia, and Yüksel (2017) studied the sheep farming structure in the Southeastern Anatolia Region. Turgut (2016) focused on the agricultural structure of provinces in the Central Anatolia Region, Gonzalez-Mejia et al. (2018) investigated the extensive and intensive production structures of dairy cattle farms in England and Wales, and Güler (2021) examined the similarities and differences in sericulture among 24 regions in Türkiye, categorizing them into similar groups. Additionally, there are studies related to animal husbandry that solely utilize multidimensional scaling analysis (Çelik 2015, Güler et al. 2018).

The aim of this study is to determine the similarities and differences between EU countries and Türkiye in terms of beekeeping and classify similar countries. The findings are useful for evaluating comparative advantage studies in beekeeping and for developing policies in this field.

MATERIALS AND METHODS

Materials

The main materials of the study consist of the number of beekeepers, the amount of honey produced, and the trade balance values of EU countries and Türkiye. The data was obtained from the FAO, ITC, and TURKSTAT databases, and the beekeeping sector report (EC 2023).

Methods

In this study, multidimensional scaling analysis (MDS) and clustering analysis have been utilized. All data were evaluated by SPSS 20 software.

Multidimensional scaling analysis

The use of MDS aims to determine the distances and proximities between units by evaluating a multitude of features related to objects (Hair et al. 1998). In this method, the primary goal is to represent the structure of objects as closely as possible to the original form using distance values, with as few dimensions as possible (Özdamar 1999, Tatlıdil 2002). Distances in multidimensional scaling are determined by using distance matrices, so appropriate distance matrices need to be calculated depending on the type of data. If the data is obtained at interval or ratio scales, distances are calculated in the form of Euclidean, Squared Euclidean, Chebyshev, Block, or Minkowski distances (Özdamar 1999). The difference between the actual shape and the shape estimated in k-dimensional space in the analysis forms the stress value. This value indicates the goodness of fit for models created for various dimensions. For non-metric scaling, the stress value is given below, and it is desired to be close to zero (Johnson and Wichern 2007).

$$\text{Stress} = \sqrt{\frac{\sum\sum\left(d_{ij} - \hat{d}_{ij}\right)^2}{\sum \hat{d}_{ij}^2}}$$

$\hat{d}_{ij}$ = The data distance between individuals i. and j.

d_{ij} = The configuration distance between individuals i. and j.

The adequacy of the obtained solution is explained with a low stress ratio. A high value represents poor fit. The goodness of fit corresponding to the stress value introduced by Kruskal (1964) are given in Table 2.

Table 2. Goodness of fit relationship by stress

Stress	Goodness of fit
20%	Poor
10%	Fair
5%	Good
2.5%	Excellent
0%	Perfect

Approaching zero for the stress statistic indicates an increase in the degree of fit. In multidimensional scaling analysis, the measure of how well the data fits the obtained model called the 'Fit Index,' is determined by R^2, and values greater than 0.60 are considered suitable (Hair et al. 1998). In this study, the ALSCAL algorithm was used for multidimensional scaling analysis.

Cluster Analysis

Cluster analysis, one of the multivariate statistical analysis methods, was used to determine the groups in the study. The general purpose of cluster analysis is to classify data based on their similarities, providing interpretable summary information to the researcher (Tatlıdil 2002). This analysis method, which forms the basis of classification studies, can

explain in detail the classification of individuals or objects (Erilli 2012). Cluster analysis is divided into two main groups based on the approaches followed in determining groups: hierarchical clustering and non-hierarchical clustering (Blashfield and Aldenderfer 1978). At the initial stage of the data matrix, depending on how many clusters are formed and which criterion is initially selected to determine cluster members, stepwise methods are divided into two main groups. These are agglomerative hierarchical clustering methods and divisive hierarchical clustering methods. The distance criteria used in cluster analysis include Euclidean distance, squared Euclidean distance, Manhattan distance, Pearson distance, Mahalanobis distance, Minkowski distance, squared Pearson distance, Hotelling T^2 distance, and Canberra criterion. The decision on which distance measure to use is made based on whether the variables are discrete or continuous, or whether the variables are nominal, ordinal, interval, or ratio scale (Dinler 2014).

In this study, data related to the number of beekeepers, the amount of honey produced, and the trade balances of countries were evaluated to classify countries using the hierarchical clustering method. In this study, which uses the agglomerative clustering method and the squared Euclidean distance was used as the distance criterion. Furthermore, the dendrogram obtained by the average linkage method. The average linkage method calculates the average distance between all points of the two clusters. This means the distance between the clusters is determined by averaging the distances between all individual points (Yim and Ramdeen 2015). The average linkage method has been chosen because it represents the general relationships and similarities between clusters in a more balanced way and reduces the impact of outliers. The classification process was performed in four stages, ranging from binary groups to five groups, and the results obtained were used for comparisons between countries.

RESULTS

In the research, using multidimensional scaling analysis, the similarities and differences between 28 countries in terms of the amount of honey produced, the number of beekeepers, and trade balance in value have been revealed based on the distances in the perceptual map. Initially, the model included the amount of honey produced, the number of beekeepers, the number of beehives, and the trade balance in value. However, after conducting the VIF (Variance Inflation Factor) test, it was found that the amount of honey produced and the number of beehives were causing multicollinearity problems. Therefore, the number of beehives was removed from the model. Thus, the multicollinearity problem in the model was resolved. However, the number of beehives has been presented in the table to facilitate comparisons between countries. Variable data for the countries are provided in Table 3. Accordingly, Türkiye has the highest amount of honey produced and the number of beehives, while Germany has the highest number of beekeepers and a negative trade balance in value.

As a result of the analysis, for n=28 (number of units), p=3 (number of variables), and k=2 (two-dimensional solution), iterations were continued until the improvement in the stress statistic value was less than 0.001, and at the 8th iteration, an improvement value of 0.00075 was reached, leading to the termination of the iterations (Table 4). The stress statistic value, which is close to zero, indicates that the obtained solution is appropriate.

Table 3. The amount of honey produced, the number of beekeepers, the number of beehives, and trade balance in value by country (2021)[1]

Country	The amount of honey produced (kg)	The number of beekeepers	The number of beehives	Trade balance in value (US Dollar thousand)
Türkiye	96344200	89197	8179085	30770
Romania	30875000	23161	2353000	42442
Spain	29393200	28786	2953000	45222
Germany	28651066	129048	982000	-166278
Italy	23000000	56059	1717000	-70681
Poland	22300000	74302	2013000	-28031
France	19788000	53953	1808000	-86364
Greece	15000000	9266	2183000	13074
Hungary	14000000	22447	1207000	86342
Bulgaria	11807269	12260	838000	34968
Portugal	10800000	11301	758000	-1148
Czechia	10113340	61572	695000	-13399
Croatia	7440000	7283	460000	-3857
Austria	5000000	29745	456000	-17470
Slovakia	4112580	18586	344000	15347
Lithuania	4000000	8950	209000	5577
Sweden	3500000	16000	179000	-17113
Denmark	2500000	7000	140000	-8024
Finland	2059000	3200	86000	-10116
Latvia	1998000	3341	104000	1360
Belgium	1840000	8223	82000	-1773
Netherlands	1792700	9345	78000	-32786
Slovenia	1700000	11349	213000	-1743
Estonia	1252900	5215	50000	-448
Cyprus	584144	676	55000	-2640
Ireland	257000	3300	27040	-12824
Malta	60000	234	6000	-966
Luxembourg	48200	456	3000	-1764

[1] The data was obtained from the FAO, ITC, and TURKSTAT databases, and EC (2023).

Table 4. Young's S-stress statistic results

Iteration	S - stress	Improvement	Iteration	S - stress	Improvement
0	0.47618	-	5	0.19506	0.00448
1	0.31409	-	6	0.19242	0.00264
2	0.22751	0.08658	7	0.19105	0.00137
3	0.20801	0.01950	8	0.19029	0.00075
4	0.19954	0.00847			

The stress value calculated according to Kruskal's formula is 0.149, which, according to the table of stress values and goodness of fit, indicates a fair fit. As a result of the analysis, the R^2 (coefficient of determination) expected to be above 60% has been calculated as 0.952. Therefore, for k=2 dimensions, the stress value explains the data by 95.2%.

The two-dimensional geometric representation of the data has shown compatibility, and a linear relationship between observational distances and disparities has been observed (Figure 2).

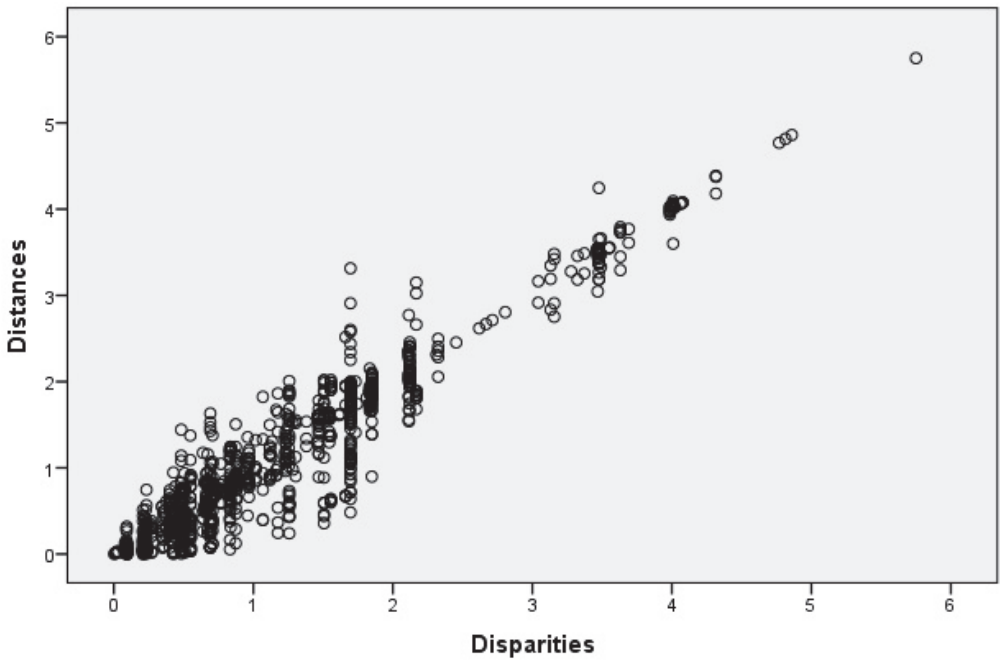

Figure 2. Scatterplot of relationship between distances and disparities

When examining the coordinate values underlying the two-dimensional geometric representation, it was determined that some countries are significantly differentiated from others in terms of beekeeping. In the first dimension, Türkiye (-3.2421) stands out distinctly from other countries, having the most extreme value, while in the second dimension, Germany (-3.8437) differs significantly from others with the most extreme value. Romania and Spain have similar values in both dimensions, indicating that these countries display similar profiles in terms of beekeeping. Hungary, which has the highest value (1.9272) in the second dimension, stands out from the others as the country with the highest trade balance. Furthermore, in the first dimension, Malta (0.8862) and Luxembourg (0.8841) are the countries closest to a positive value of 1. Malta has the fewest beekeepers, and Luxembourg has the lowest honey production, which confirms this result. When the first and second dimensions are evaluated together, the most similar countries to each other are Spain and Romania (Table 5).

In the study, the differences matrix, which shows the proximity and distance between the examined countries, was also evaluated. Countries with values close to zero in the differences matrix are considered to be similar in terms of the examined characteristics, while countries with values above two are considered distant from each other, indicating that these countries are less similar (Gevrekçi et al. 2011). The results indicate that among the examined countries, Türkiye and Germany are the countries with a distance of more than two from the others, and these countries stand out as significantly distinct.

Figure 3 illustrates the relationships between countries in a two-dimensional space. In this coordinate system, countries with similar honey production quantity, number of beekeepers, and trade balance are grouped around the origin, while Türkiye and Germany are located far from the origin. Indeed, Türkiye ranks first among the examined countries in terms of honey production quantity (96344200 kg), while Germany is at the top in terms of the number of beekeepers (129048) and trade balance (166.28 million US Dollars).

Table 5. Coordinates of countries

Country	Dimension 1	Dimension 2
Türkiye	-3.2421	0.3476
Germany	-1.5570	-3.8437
Poland	-1.2276	-0.5763
Czechia	-0.3735	-0.3852
Italy	-1.0439	-1.3781
France	-0.7582	-1.6870
Austria	0.1275	-0.0753
Spain	-1.2777	1.0363
Romania	-1.2831	0.9901
Hungary	-0.2904	1.9272
Slovakia	0.2765	0.5548
Sweden	0.4121	-0.0467
Bulgaria	-0.0112	0.9402
Slovenia	0.7419	0.2147
Portugal	0.1444	0.2616
Greece	-0.0392	0.5435
Lithuania	0.5746	0.2293
Netherlands	0.7699	-0.3588
Belgium	0.7836	0.1984
Croatia	0.4652	0.2212
Denmark	0.7979	0.1582
Estonia	0.8297	0.1967
Ireland	0.8731	-0.1183
Finland	0.8374	-0.1073
Latvia	0.8289	0.1883
Cyprus	0.8709	0.1903
Luxembourg	0.8841	0.1898
Malta	0.8862	0.1886

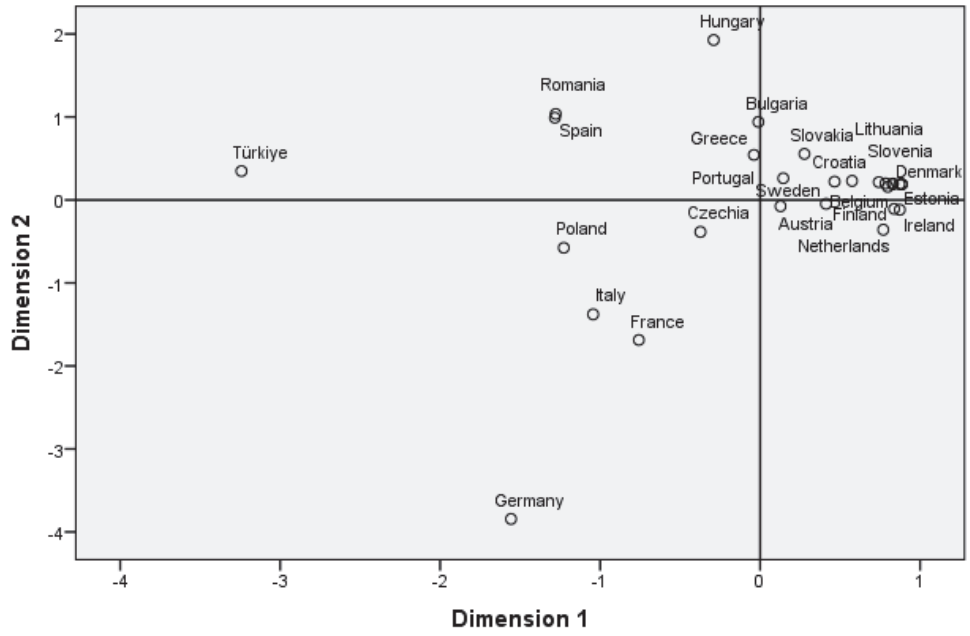

Figure 3. Two-dimensional space representation of countries

The results of the multidimensional scaling analysis are supported by cluster analysis. According to the cluster analysis results, which were evaluated in seven different groups, Germany and Türkiye were placed in a different group in each clustering (Figure 4). The results of the multidimensional scaling analysis are consistent with the cluster analysis.

In the grouping of seven, Germany constitutes the 1st group, Türkiye the 2nd group, Poland, and Czechia the 3rd group, Italy and France the 4th group, Hungary the 5th group, and Spain and Romania the 6th group, while the other EU countries form the 7th group. Poland and the Czechia, both of which are in the 3rd group, are similar in terms of the number of beekeepers and also have a negative trade balance. Within the 4th group, Italy and France are closely matched in terms of honey production quantity and the number of beekeepers. Hungary, which has the highest positive trade balance, forms a separate group within the grouping of seven. Spain and Romania in the 6th group have similar values in terms of the variables considered (honey production, the number of beekeepers, and trade balance).

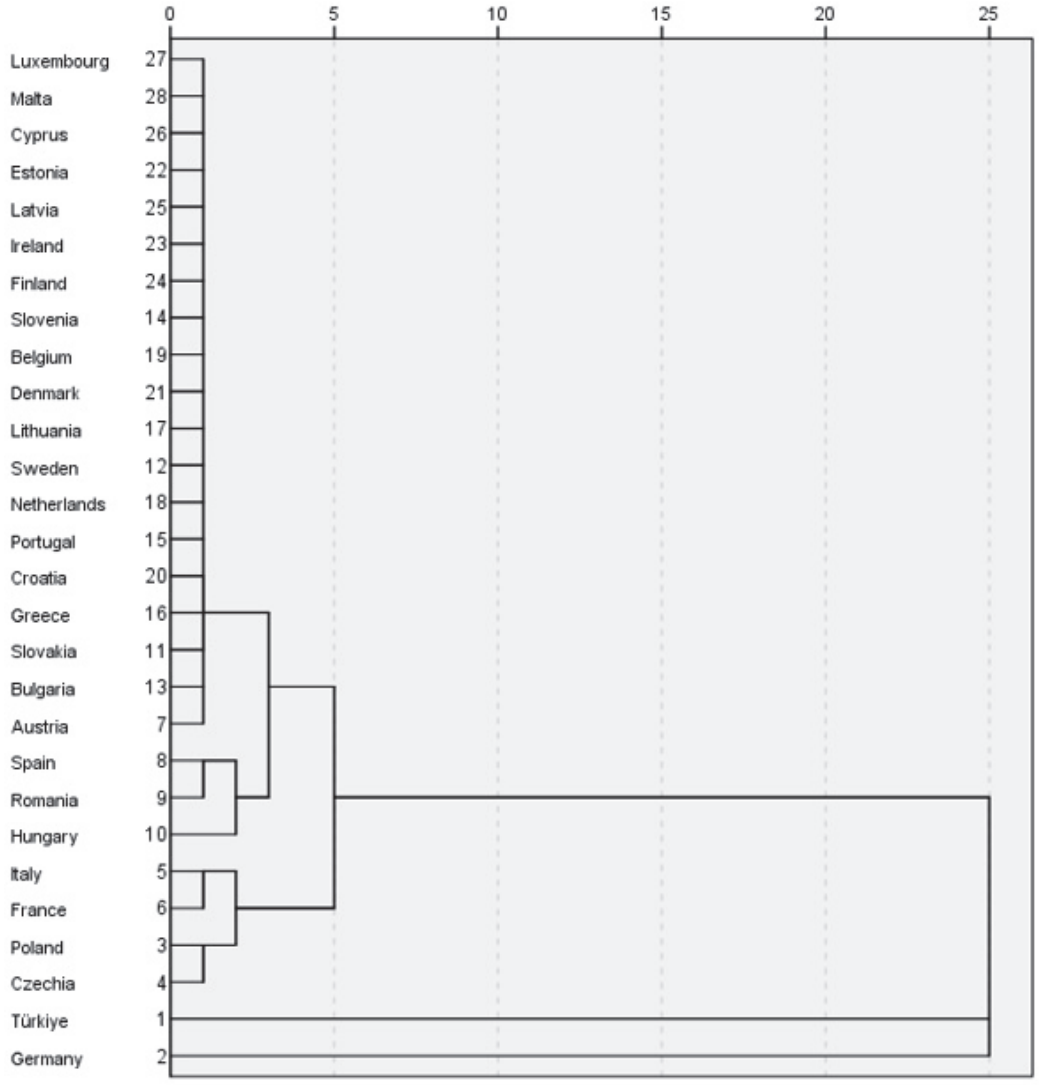

Figure 4. The dendrogram obtained by the average linkage method of beekeeping by country

DISCUSSION

According to the data for the year 2021, Germany ranks first among the EU countries both in terms of honey import value (314.76 million US Dollars) and honey export value (148.48 million US Dollars). This can be explained by Germany's strategy of adding value to imported honey and re-exporting it at a higher price. Türkiye's honey import value is 0.38 million US Dollars, and its export value is 31.15 million US Dollars. Furthermore, Germany accounts for 22.32% of Türkiye's honey exports by value, and Germany is at the top of Türkiye's honey exports among EU countries. However, Germany is the second-highest country in terms of honey import value in the world, following the United States. In Germany's honey imports, Mexico (38.11 million US Dollars), New Zealand (35.06 million US Dollars), and Argentina (30.17 million US Dollars) are at the forefront, while in honey exports, France (20.14 million US Dollars), Switzerland (15.60 million US Dollars), and the Netherlands (13.98 million US Dollars) are among the leading countries (ITC 2023). Germany's honey export strategy differs from both other EU countries and Türkiye. Germany's strategy involves importing honey at a fixed cost and then enhancing its value before exporting it at an elevated price.

The key indicators that distinguish Türkiye from other EU countries are honey production quantity and the number of beehives. From this perspective, Türkiye is in a significantly advantageous position compared to EU countries.

In terms of competitiveness between countries in beekeeping, increasing efficiency in beekeeping is of great importance. In a study conducted by Güler (2021) that examined beekeeping efficiency by provinces in Türkiye, it was found that beekeeping efficiency increased in provinces with large-scale enterprises and high honey yields. Previous studies have also supported this result (Abdul-Malik and Mohammed 2012, Aydın et al. 2020, Ceyhan 2017, Kaya 2020, Makri et al. 2015,). Güler's (2021) study revealed that beekeeping efficiency in Türkiye is low. Indeed, the average honey yield per hive in the EU (27) countries is 17.51 kg, while Türkiye's honey yield is 11.78 kg (FAO 2023). Achieving a high yield in beekeeping depends not only on colony efficiency but also on the diversity and quantity of nectar and pollen sources (Behçet and Yapar 2019). Furthermore, modern beekeeping practices also enhance honey yield and quality (Cabrera et al. 2019). Considering the current vegetation and climate type, it appears possible to increase Türkiye's honey yield average (Onuç et al. 2019).

When associating income from the honey trade with branding, it can be said that the number of registered geographical indications (GIs) for honey in countries is important. According to Güler and Saner's (2018) study, there were 34 types of honey registered as GI by the European Union in 2018, and all of these registrations belong to EU countries. Portugal had the most geographically indicated honey registrations among EU countries with 9 registered honeys. Following Portugal, Spain had 6 registrations, France had 5, Poland had 4, Italy had 3, and Slovenia had 3. Moreover, today there are a total of 51 types of honey across the EU, with 43 registered, 2 published, and 6 in application status. Among these, Türkiye's Bingöl Balı is registered, while Muğla Çam Balı and Sinop Kestane Balı are in the application status (EC 2024).

This study aims to reveal the similarities and differences between Türkiye and EU countries in terms of beekeeping and to classify similar countries. Data on honey production, the number of beekeepers, and the trade balance of each country were evaluated using multidimensional scaling analysis and clustering analysis. The research results showed distinctions among countries. Türkiye emerged as the most important differentiating country in terms of positive loads in the first dimension, while Germany was the most significant differentiating country in the second dimension. Specifically, Türkiye was differentiated from other countries by its high honey production. The key characteristics that differentiating Germany from other countries were the number of beekeepers and a high trade deficit. When the first and second dimensions were considered together, Spain and Romania were found to be the most similar countries.

Conclusion: The quantity and diversity of bee products produced in each country can vary depending on factors such as climate, flora, and production techniques. Additionally, the income generated from bee products in countries depends on factors such as branding, population density, and export quantity. The research results are guiding in evaluating the EU's (27) trade balance for honey. Developing strategic policies for honey exports to Germany, which stands out from other EU countries, is important. However, it is important to focus on

selling packaged honey with added value in both Germany and other countries in honey exports. It is also observed that the support provided by the EU to its member states is proportional to honey production quantities, and the support provided to Germany does not match its production volume. Türkiye also provides support for beekeeping.

This study has been limited to variables such as honey production quantity, the number of beekeepers, and trade balance. Future research can be expanded by incorporating additional bee product production data for countries, such as beeswax, royal jelly, pollen, propolis, etc., into the model. This broader dataset would provide a more comprehensive understanding of beekeeping in Türkiye and EU countries.

Data availability: All data and materials utilized and/or analyzed during the current study are accessible within this manuscript.

Ethical issue: Not applicable because this study does not involve animals or humans.

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