Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 21, Issue 2, 2021
PRINT ISSN 2284-7995, E-ISSN 2285-3952

HONEY PRODUCTION IN THE EUROPEAN UNION IN THE PERIOD 2008-2019- A STATISTICAL APPROACH

Agatha POPESCU[1,2,3], Toma Adrian DINU[1], Elena STOIAN[1], Valentin ȘERBAN[1]

[1]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, District 1, 011464, Bucharest Romania, Phone: +40213182564, Fax: +40213182888, Email: agatha_popescu@yahoo.com, tomadinu@yahoo.fr, stoian_ie@yahoo.com, srbn.valentin@yahoo.com
[2]Academy of Agricultural and Forestry Sciences "Gheorghe Ionescu-Sisesti", 61 Marasti Boulevard, District 1, 011464, Bucharest Romania, Email: agatha_popescu@yahoo.com
[3]Academy of the Romanian Scientists, 1 Ilfov Street, Bucharest, 030167, Romania, Email: agatha_popescu@yahoo.com

Corresponding author: agatha_popescu@yahoo.com

Abstract

The paper analyzed honey production in the EU-28 in the period 2008-2019 using the data provided by FAOstat. Regression equations and average annual growth rate have pointed out a general increasing trend in honey production both at the EU level and in almost all member states. In 2019, the EU produced 280 thousand tonnes honey, of which 76.44% was carried out by the largest producing countries: Spain, Romania, Hungary, Germany, Greece, Poland, France, Italy, Bulgaria with over 10, 000 tonnes per year. Other countries like Portugal, United Kingdom, Czechia, Croatia, Austria had a moderate production ranging between 5 and 10 tonnes per year, and their share accounted for 12.07%. The remaining of 11.49% was assured by the other 12 countries. The average growth rate of honey production was 3.07 at the EU-28 level, but the highest growth of over 6% was registered in the Baltic countries, Croatia and Italy, and a moderate growth rate varying between 4 and 6% was recorded in the main producing countries and also by Czechia. Spain, France and Bulgaria had growth rates below 2%. In Denmark production stagnated, and in Austria, Ireland and Slovakia declined. Important EU funds are destined for the implementation of the national apiculture programmes 2020-2022 for sustainable beekeeping development, enhancing technical endowment, improving apiculturists' education level, sustaining young apiculturists, increasing the number of beehives and honey production level and quality and for assuring healthy and strong bee colonies. Bees have to continue to support agricultural production by pollination, rural areas development, a clean environment, balanced ecosystems and biodiversity preservation.

Key words**:** *honey, production, EU, member states, trends, problems, support*

INTRODUCTION

Honey is an important food and medicine due to its high nutritional value which per 100 g consists of: carbohydrates (38% fructose, 31% glucose, 8% dissacharides, 2% other sugars) assuring 300kcal energy, proteins 0.5 g, vitamins (Phyllochinon 0.025 mg, Thiamin 0.01 mg, Riboflavin 0.01 - 0.02 mg, Pyridoxin 0.01 - 0.32 mg, Niacin 0.10 - 0.20 mg, Panthothenic acid 0.02 - 0.11 mg), Ascorbic acid 2.2 - 2.5 mg, minerals (Potassium 40 - 3,500 mg, Calcium 3 - 31 mg, Sodium 1.6 - 17 mg, Phosphorus 2 - 15 mg, Magnesium 0.7 - 13 mg, Iron 0.03 - 4 mg, Manganesium 0.02 - 2 mg, Zinc 0.05 - 2 mg, Copper 0.02 - 0.06 mg, Chromium 0.01 - 0.3 mg, Selenium 0.002 - 0.01 mg) and other substances 4% [8].

The importance of honey and other apiary products in human life has determined a continuous growth of consumption which accounts at present for 250-300 g in average per capita at the global level [36].

In consequence, world honey production has continuously raised and in 2019 reached 1.72 million tonnes. The highest growth rate was in the Asian countries, where China is the leader with a share of 25.81% in the global honey production, followed by India, both of them being able to produce over 10 thousand tonnes per year. In contrast, Europe and the Americas showed limited increases.

As a result, the international trade with honey, especially the export flows have been intensified during the last decades [19, 25, 26].
In the EU agriculture, beekeeping occupies a very important place. First of all because honey demand has been showing a constant increase [39].
Europe is the top consumer of honey, accounting for more than 20% of the total global consumption. The EU is among the largest consumer of honey, but the amount differs from a member state to another. In 2019, the top honey consumers were Germany (69 k tonns), France (52 k tonnes) and United Kingdom (45 k tonnes), representing 38% of the EU-28 consumption. Also, other countries including Spain, Poland, Italy, Greece, Romania, Netherlands, Portugal, Czechia and Croatia, all together had a weight of 47% in the total consumption at the EU level.
Regarding the average consumption of honey per inhabitant and year, three EU countries are in the top: Croatia (2.50 kg), Greece (2.47 kg), and Romania (1.13 kg) [14].
Besides honey and other apiary products (pollen, royal jelly, propolis etc), bee colonies have a special role in pollination together with other insects, also in maintaining biodiversity and landscapes beauty, in environment preservation, and rural areas development, beekeeping being a pleasant job outdoors and also an income source, which could reduce migration of rural population to the cities [17, 33].
The honey production in the EU is one of the priorities in its Policy Common Agriculture, as the main source for covering the consumption need and also for increasing agricultural production by pollination and for maintaining biodiversity and ecosystems.
Honey production increased in general, but it is still not sufficient to cover the internal market requirements, and that it is why the EU is the top importer of honey in the world accounting for more than 38% of the global imports [5].
In this context, the paper aimed to analyze the dynamics of honey production in the EU in the period 2008-2019 both at the EU level and by member state in order to establish in what measure production has been developed, which is the position occupied by each member state based on production performance, which are the top producing countries and which is their market share, how countries could be grouped based on their performance, and which was the average annual growth rate of production in the studied interval, which are the critical problems in the EU beekeeping and how the EU found solutions to sustain this sector of high importance in its agriculture.

MATERIALS AND METHODS

This research is based on the data provided by FAOStat and Reports of the EU Commission on honey market and literature in the field.
The indicator analyzed in this study is honey production at the EU-28 level and also in 26 member states, specifying that for Malta and Netherlands there were no available data.
Honey production was studied in its dynamics in the period 2008-2019 and also in the year 2019 compared to the year 2008, both at the EU level and also at the level of each member state.
The methodology applied to process the data included the well known procedures and techniques such as:
-Fixed basis index, $I_{FB\%} = (y_n/y_1)$ x100;
-Average annual growth rate, $\overline{R} = (\bar{I}$ x 100) - 100, where: $\bar{I} = \sqrt[n-1]{\frac{y_n}{y_1}}$
- Regression equation of various types depending on the dispersion of the variables in the chart. In the regression analysis, there were used both linear regression and polynomial regression of different degrees: regression of the 2nd degree (parabolic regression) $Y = ax^2 + bx + c$, of the 3rd degree (cubic polynomial regression) $Y = ax^3 + bx^2 + cx + d$ and also the polynomial regression of the 4th degree, $Y= ax^4 + bx^3 + cx^2 + dx + e$.
- Coefficient of determination, R^2, was also used for reflecting in which measure the variation of production was influenced by time variation.
-Spearman test "ρ" of rank differences for honey production and for average annual

growth rate was also applied according to the formula: $\rho = 1 - \frac{6 \sum D^2}{N(N^2-1)}$.

Based on honey production level, the EU member states were divided into three groups: (i)HighProd countries with a honey production over 10 tonnes, (ii) ModerateProd countries having the level of production between 5 and 10 tonnes and (iii) LowProd countries whose production was smaller than 5 tonnes.

Also, the EU member states were grouped based on the average annual growth rate of honey production into the following categories:

(i)High Growth rate countries with over 6% average annual growth rate,

(ii) Moderate Growth rate countries whose growth rate varied between 3% and 6 %,

(iii) Low Growth rate countries, having the rate ranging between 0% and 3 %,

(iv)Stagnating rate countries (0%) and

(v) Declining rate (a negative rate).

The obtained results were illustrated in charts and tables, accompanied by the corresponding comments.

At the end of the study, the main ideas resulting from this research work have been drawn.

RESULTS AND DISCUSSIONS

Dynamics of honey production in the EU-28

The EU is among the largest honey producers in the world, coming on the 2nd position after China. In the year 2019, it produced 280,000 tonnes honey, representing 16.27% of the 1.72 million tonnes global honey production [5, 16].

Honey production in the EU had a continuous increasing trend since 200,600 tonnes in the year 2008 to 280,000 tonnes in 2019, meaning +39.58% in the period of the last 12 years. The general trend pattern remained relatively stable reflecting a continuous increasing, but in certain years there were some fluctuations. The highest growth rate was registered in the year 2014 when production increased by 17.73% compared to the level of 2013. Also, in 2016 versus 2015, production raised by 12.8%. The year with a deep decline was 2012, when production decreased by 14% compared to the previous year. The last year registered slight increases, but in 2019 it was noticed a slight decline (-1%) versus 2018 (Fig. 1).

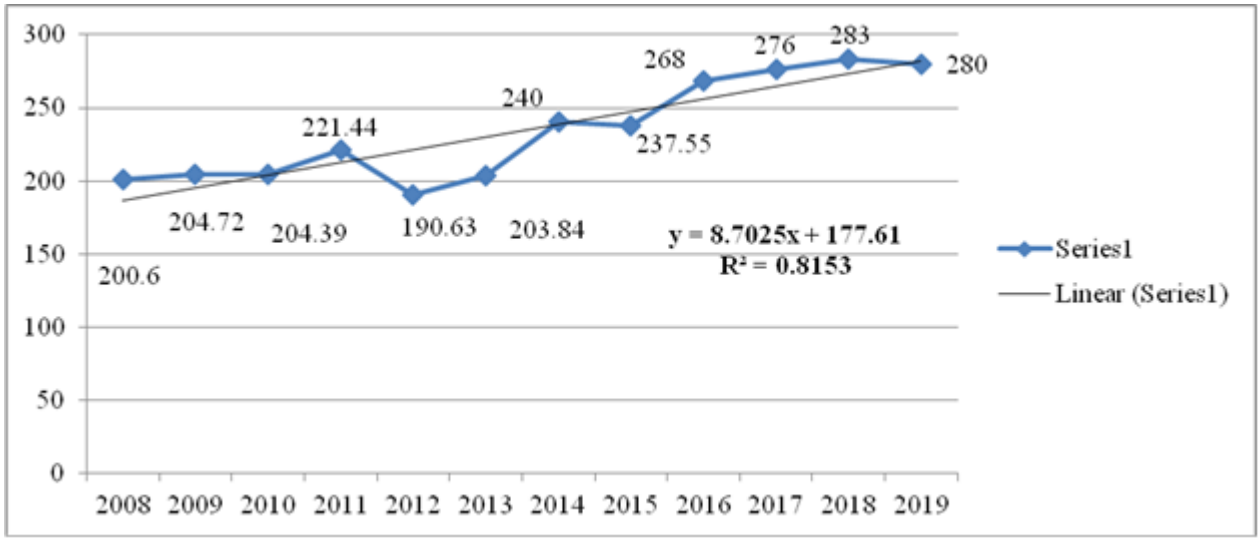

Fig. 1. Dynamics of honey production in the EU-28 in the period 2008-2019 (Thousand tonnes)
Source: Own design and processing based on FAOStat Data, 2021 [10].

The EU-28 honey production accounts for 70% of Europe's honey production in 2019, compared to only 57% in the year 2008 [9, 16].

The growth of production is justified by the fact that in the EU honey demand is high, bee colonies play an important role in the pollination of the agricultural crops, fruit trees and wild flora, also for maintaining biodiversity, the indirect role in "shaping" the landscapes, the functioning of the ecosystems and human health and life [15, 23, 35, 38].

The EU sustains beekeeping by implementing the EU apiculture programmes, because apiculture is essential for agriculture and biodiversity [3].

As a consequence, in 2019, the EU-28 had 18,214 thousand behives, by +5.1% more than in 2018, also it had 612,000 beekeepers and their number is continuously increasing and the apiary size accounts in average for 21 beehives [4].

The EU measures for funding beekeeping are destined to assure "technical endowment in apiaries, beekeepers' training, young beekeepers' business, beehives movement in the pastoral pickings helping the pollination of the agricultural crops, fruit trees and the wild flora, for combating the beehive invaders, product analysis and improvement, market monitoring and applied research" [6, 7].

As self-sufficiency in the EU domestic market is only 60%, the honey requirements are covered by imports. And the EU is the top importer of honey in the world, its share in the global import of honey being 38.3% [20, 25, 29].

In 2019, the EU imported 162,172 tonnes, the main suppliers being China, Ukraine, Argentina, Mexico and other countries [35].

The EU is not among the top honey exporting countries, but it accounts for 5.2% in the global exports and its honey is of the highest quality. As import exceeds export, the EU has a negative trade balance [14, 40].

Therefore, the EU is deeply oriented towards honey import due o the high demand on the internal market and production which is not able alone to meet the requirements. Regarding exports, the EU is not very competitive [18].

Dynamics of honey production in the EU member states was in general a positive one with a few exceptions during the last 12 years.

The performance in honey production differs from a country to another in close relationship with many factors among which the most important ones are: geographical position, soil and climate conditions, wild flora, structure of agricultural crops and fruit trees orchards, tradition in beekeeping.

Also, other factors influencing production of honey and economic efficiency in beekeeping sector are: the number of bee colonies and the apiary size being known that from at least 150 bee families we can discuss about profitability [21, 22, 27, 30].

In 2019, in the EU, there were 612,000 beekeepers having 18.2 million beehives, meaning 29.7 beehives per beekeeper. The countries where the beekeepers have the highest number of beehives per apiary are: Greece (147), Spain (103) and Romania (80) [5, 7].

The performance in honey production depends on the power of bee families, the breeding value of the queen bee, the picking availability in the stationary and also in the pastoral movement during the flowering season, bee colonies health, beekeepers' training level and experience.

The apiculturists with a higher education are interested in the adoption of new technology and create value added to beehive products [39].

Honey is the main product achieved by bees and which is commercialized by apiculturists assuring them a good gross margin, and bringing them income and profit [24, 27, 28, 32].

The structure of agricultural crops and hybrids has a deep influence on picking and honey production, the chemical treatments applied for crop protection and the use of the new hybrids have affected pollination and nectar picking by bees and other insects. The colony collapse disorder has become a more common phenomenon.

Therefore, in the EU there are disparities regarding beekeeping, honey production and

quality among the member states which have a deep impact on their contribution to the whole performance at the community level.

The situation of honey production by member state in the EU-28 in the year 2019 compared to the year 2008 is presented in Table 1 and Fig. 2.

Table 1. Honey production in the EU member states and their position in the year 2019 compared to 2008 (Thousand tonnes)

	2008		2019	
	Honey production	Position	Honey production	Position
EU-28	**200.6**	**-**	**280**	**-**
Spain	30.36	1	37.00	1
Hungary	22.39	2	29.00	3
Romania	20.04	3	31.00	2
Germany	15.73	4	26.00	4
France	14.86	5	15.75	8
Greece	14.11	6	22.84	5
Poland	14.00	7	19.03	7
Italy	11.58	8	22.00	6
Bulgaria	11.38	9	11.52	9
United Kindom	7.19	10	9.92	11
Portugal	6.65	11	10.10	10
Czechia	6.08	12	8.26	12
Austria	5.30	13	4.00	15
Slovakia	4.24	14	4.00	15
Croatia	2.71	15	7.44	13
Sweden	2.65	16	3.00	17
Lithuania	1.91	17	5.28	14
Belgium	1/69	18	2.00	20
Slovenia	1.58	19	1.75	21
Finland	1.50	20	3.30	16
Denmark	1.50	20	1.50	22
Latvia	0.69	21	2.15	19
Cyprus	0.63	22	0.66	24
Estonia	0.50	23	1.29	23
Ireland	0.24	24	0.21	25
Luxemburg	0.11	25	0.15	26

Source: Own calculation based on FAOStat data, 2021 [10].
Note: Malta and Netherlands- No available data.

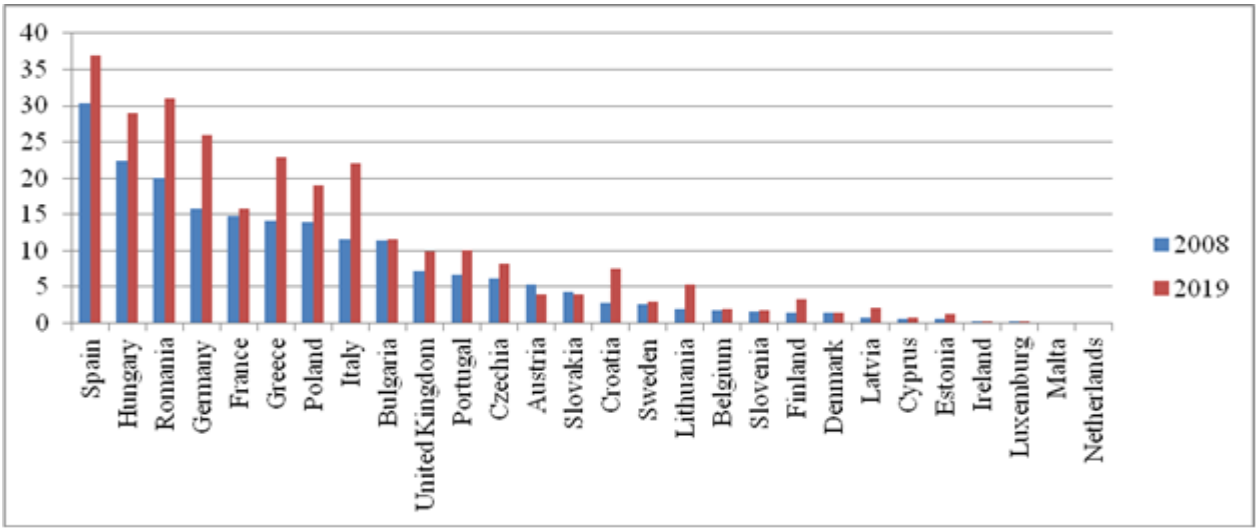

Fig.2. Honey production in the EU-28 member states in the year 2019 compared to 2018 (Thousand tonnes)
Source: Own design based on FAOStat data, 2021 [10].

The figures from Table 1 show that the top honey producers in 2019, in the decreasing order, were: Spain, Romania, Hungary, Germany, Greece, Italy, Poland, France and Bulgaria.

All the nine countries exceeded the EU average of 7.71 thousand tonnes in 2008 and of 10.77 thousand tonnes in 2019 in various amounts.

In 2008, the first three positions were occupied by Spain, Hungary and Romania, all together accounting for 36.28% of the EU honey production. In 2019, Spain registered 13.21% market share, followed by Romania with 11.07% and Hungary with 10.35%, all together accounting for 34.63% of the EU honey production.

In 2008, these three leaders were followed by Germany, France, Greece, Poland, Italy and Bulgaria, summing 40.49% of the EU honey production. In 2019, the decreasing order in this group of countries was: Germany, Greece, Italy, Poland, France and Bulgaria, all together accounting for a market share of 41.81%.

Relatively similar affirmations were made by IndexBox in 2020 [14].

Taking into consideration the market share of the top nine EU countries in honey production, they contributed by 76.97% in 2018 and by 76.44% in 2019 to the EU total honey output (Table 2).

Table 2. Honey production surplus over the EU average and the market share of the EU top 9 honey producing member states in 2019 versus 2008

	Changes over the EU-28 average (Thousand tonnes)		**Market share (%)**	
	2008	2019	2008	2019
EU Average	**7.71**	**10.77**	-	-
Spain	+22.65	+26.23	15.13	13.21
Romania	+12.33	+23.23	9.99	11.07
Hungary	+14.68	+18.23	11.16	10.35
Germany	+8.02	+15.23	7.84	9.28
Greece	+6.40	+12.07	7.03	8.16
Italy	+3.87	+11.23	5.77	7.85
Poland	+6.29	+8.26	6.97	6.79
France	+7.15	+4.98	7.41	5.62
Bulgaria	+3.67	+0.75	5.67	4.11
Total	-	-	76.97	76.44

Source: Own calculation based on FAOStat Data, 2021[10].

However, taking into account the whole honey production achieved in 2019 compared to 2008, there were noticed some changes in the hierarchy of the EU countries.

First of all, the top nine countries producing honey are the same, but their position changed with a few exception.

For the whole production of honey in 2019, the leaders in the decreasing order were: Spain, Romania, Hungary, Germany, Greece, Poland, France, Italy and Bulgaria. Therefore, compared to the positions occupied in 2008, Spain maintained its first position, Hungary passed from the 2nd position to the 3rd one, Romania raised its position to the 2nd place, Germany maintained its 4th position, Greece climbed one step from the 6th to the 5th position, Poland passed from the 7th position to the 6th place, France lost its 5th position and passed on the 7th position, Italy maintained its 8th place and Bulgaria its 9th position.

Making a comparison between the position occupied in 2019 for honey production achieved in this year and the position for the whole production in the last 12 years, we may notice that Spain, Romania, Hungary, Germany, Greece and Bulgaria maintained their positions, France went up one position from the 8th position to the 7th one, Poland went up from the 7th position to the 6th, Italy went down from the 6th position to the 8th (Table 3).

We have to point out the high development of beekeeping in Romania which has a long tradition and continues to increase the number of bee hives, apiary size, honey production and intensify its export with honey of the highest quality [1, 20, 33, 34, 35].

For the whole honey production carried out in the period 2008-2019, other changes took place in the following countries: Portugal, United Kingdom, Czechia, Croatia and Slovakia remained on their positions: the 10th, the 11th, the 12th and the 13th and, respectively, the 15th.

Table 3. Mean, standard deviation and coefficient of variation for honey production in each EU member state in the period 2008-2019

	Mean	St. Dev.	CV (%)
EU-28	234.18	34.74	14.83
1 Spain	32.63	2.56	7.87
2 Romania	24.61	4.59	18.67
3 Hungary	24.25	5.15	21.24
4 Germany	21.58	3.93	18.23
5 Greece	18.50	3.17	17.13
6 Poland	15.98	3.51	21.96
7 France	14.37	2.56	17.81
8 Italy	12.47	4.94	39.66
9 Bulgaria	10.41	0.93	8.94
10 Portugal	9.50	2.44	25.77
11 United Kingdom	8.62	0.91	10.60
12 Czechia	8.35	1.49	17.91
13 Croatia	6.32	3.02	47.81
14 Austria	4.95	0.70	14.24
15 Slovakia	3.97	0.56	14.15
16 Sweden	3.27	0.36	11.07
17 Lithuania	2.51	1.12	44.94
18 Finland	1.84	0.67	36.73
19 Denmark	1.58	0.288	18.22
20 Slovenia	1.56	0.61	39.23
21 Latvia	1.40	0.57	41.00
22 Estonia	0.95	0.27	28.84
23 Cyprus	0.46	0.13	29.13
24 Ireland	0.25	0.02	8.40
25 Luxemburg	0.18	0.16	92.77
26 Belgium	0.12	0.04	34.16

Source: Own results based on FAOStat data, 2021 [10].

The countries which passed to a superior position were as follows: countries going up one position Austria, Slovenia, Estonia, Cyprus, Ireland, Luxemburg; Finland climbed two positions; countries which went up three positions: Lithuania and Denmark; countries which lost their positions: Sweden -1 position, Latvia -2 positions, and Belgium - 6 positions (Table 3).

At the EU level, the value of the variation coefficient of honey production in the period 2008-2019 was 14.83% reflecting a relative heterogeneous series of data, depending on the performance carried out in each member state.

In Spain, Bulgaria and Ireland, the value of the variation coefficient was below 10% reflecting that the performance in honey production was homogeneous from a year to another and as a result the mean is representative.

In case of Romania, Germany, Greece, France, United Kingdom, Czechia, Austria, Slovakia, Sweden, and Denmark, the value of the variation coefficient ranged between 10% and 205 showing that the levels of production were relatively heterogeneous and the average is less representative.

Also, in case of Hungary, Poland, Italy, Portugal, Croatia, Lithuania, Finland, Slovenia, Latvia, Estonia, Cyprus, Belgium and Luxemburg, the data regarding production were very different from a year o another for many reasons and in this case the average is not representative.

Therefore, the means and the variation coefficients attest the large differences existing among the EU countries regarding their performance in honey production, the causes and factors of influence being multiple and having an impact of various intensity in beekeeping (Table 3).

Grouping the EU countries based on the whole honey production in the period 2008-2019

Based on the whole performance in the analyzed interval, the EU member states were divided into three categories as follows: (i) HighProd group, having a higher production than 10 tonnes; (ii) ModerateProd group, with a production ranging between 5 and 10 tonnes, and (iii) LowProd group, including the countries producing less than 5 tonnes (Table

4). The HighProd group registered in average 277.59 tonnes honey, and the variation coefficient showed a high heterogeneity among the data. The ModerateProd grup produced in average 91.01 tonnes honey, and the variation was a little bit lower compared to the HighProd group. In case of the LowProd group, the average was more than four times lower than in the ModerateProd group, and 11.18 times lowers compared to the HighProd group of countries (Table 4).

Table 4. Mean, standard deviation and variation coefficient by country group according to honey production, 2008-2019

Group	Countries	Mean	St. Dev.	CV%
HighProd (over 10 tonnes)	**Group total honey production = 2,048.32 tonnes**			
	Spain, Romania, Hungary, Germany, Greece, Poland, France, Italy, Bulgaria	227.59	85.31	37.48
ModerateProd (5-10 tonnes)	**Group total honey production = 455.06 tonnes**			
	Portugal, United Kingdom, Czechia, Croatia, Austria	91.01	22.09	24.27
LowProd (below 5 tonnes)	**Group total honey production = 306.78 tonnes**			
	The remaining EU countries	20.34	14.20	69.81

Source: Own conception and results.

Table 5. Grouping the EU countries based on the average annual growth rate of honey production in the period 2008-2019 (%)

	Country	Average annual growth rate (%)
	EU-28	**3.07**
High growth rate (Over 6%)	1 Latvia	10.88
	2 Lithuania	9.68
	3 Croatia	9.61
	4 Estonia	8.99
	5 Finland	7.43
	6 Italy	6.00
Moderate growth rate (3%-6%)	7 Germany	4.67
	8 Greece	4.47
	9 Romania	4.04
	10 Portugal	3.87
	11 United Kingdom	2.96
	12 Luxemburg	2.85
	13 Czechia	2.82
	14 Poland	2.82
	15 Hungary	2.37
Low growth rate (0-3%)	16 Spain	1.81
	17 Belgium	1.54
	18 Sweden	1.13
	19 Bulgaria	1.11
	20 Slovenia	0.93
	21 France	0.53
	22 Cyprus	0.42
Stagnating production	23 Denmark	0.00
Decline rate	24 Slovakia	-0.01
	25 Ireland	-1.21
	26 Austria	-2.53

Source: Own conception and results.

We have to specify that the classification of the countries in these three groups based on honey production is different than the hierarchy established by FAO and Eurostat in 2008, as mentioned by Formato and Smulders (2011). Their classification consisted of five groups of countries as follows:

(i)countries with honey production between 21.9-31.8 thousand tonnes including only Spain and Germany;

(ii) countries with production between 10.9 and 21.8 thousand tonnes, including: Hungary, Romania, Greece, France and Poland;

(iii) countries with production between 4.6 and 10.8 thousand tonnes, including: Italy, Bulgaria, Portugal, Austria and Czechia;

(iv) countries with production ranging between 1.2-4.5 thousand tonnes including: United Kingdom. Slovakia, Sweden, Finland, Denmark;

(v) countries with the lowest production varying between zero and 1.1 thousand tonnes, including: Lithuania, Latvia, Estonia and Ireland [13].

Average annual growth rate of honey production in the interval 2008-2019

At the EU level, the average growth rate was 3.07 %. From a country to another, the average growth rate varied having either higher values, lower values, or stagnating or even negative values.

A high growth rate was noticed in six countries: Latvia, Lithuania, Croatia, Estonia, Finland and Italy, varying between 6% in Italy and 10.88% in Latvia.

A moderate growth rate ranging between 2.37% to 4.67% was registered in Germany, Greece, Romania, Portugal, United Kingdom, Luxemburg, Czechia, Poland and Hungary.

A low growth rate between 0.42% and 1.81 % was achieved in Spain, Belgium, Sweden, Bulgaria, Slovenia, France and Cyprus.

In Denmark, honey production stagnated at 1.5 tonnes almost every year, therefore there was no growth or decline.

In Slovakia, Ireland and Austria, honey production registered a decline rate varying between -0.01% in Slovakia and -2.53% in Austria (Table 5).

Spearman test of the rank differences for honey production and for average annual growth rate

The result of Spearman rank correlation was ρ = 0.140, a very weak correlation, and consulting the tabled ρ for the degrees of freedom in Thornton table, it was noticed that the calculated ρ is smaller. Therefore, there is not a significant correlation between the two variables: honey production and average annual growth rate, or, in other words, the average annual growth rate has no influence on honey production level.

Honey production trend line by EU member state

The trend in honey production in the analyzed period 2008-2019 was represented in corresponding equations and R^2 as well for each member state as presented in Table 6.

A linear increasing trend of honey production was noticed at the EU-28 level, Y = 8.7025x + 177.61, reflecting that for one more year, production will increase by 8.70 units. The R^2 = 0.8153 explains that 81.53% of the variation in honey production is caused by time and the difference of 18.47% depends on other factors.

Table 6. Trend line regression equations and coefficient of determination for honey production by member state in the period 2008-2019

	Trend line regression equation	**R^2**
EU-28	**$Y = 8.7025x + 177.61$**	**0.8153**
Austria	$Y = 0.0025x^4 + 0.06x^3 - 0.4796x^2 + 1.3316x + 4.331$	0.3853
Belgium	$Y = -0.00x^4 + 0.00x^3 - 0.03x^2 + 0.10x + 0.05$	0.2000
Bulgaria	$Y = 0.0097x^3 + 0.2321x^2 - 1.4833x + 12.418$	0.4901
Croatia	$Y = -0.109x^2 + 2.0313x - 0.985$	0.6956
Cyprus	$Y = 0.0086x^2 - 0.108x + 0.6952$	0.5126
Czechia	$Y = -0.006x^4 + 0.1583x^3 - 1.4411x^2 + 5.3373x + 1.6069$	0.4590
Denmark	$Y = -0.004x^3 + 0.0138x^2 - 0.0907x + 1,6212$	0.2132
Estonia	$Y = 0.0729x + 0.4797$	0.9191
Finland	$Y = 0.0056x^3 - 0.0842x^2 + 0.3714x + 1.1285$	0.6151
France	$Y = 0.0112x^3 - 0.0823x^2 - 0.4921x + 16.364$	0.3772
Germany	$Y = 0.0426x^3 - 0.8097x^2 + 4.9365x + 11.761$	0.5549
Greece	$Y = 0.0222x^2 + 0.5437x + 13.767$	0.9030
Hungary	$Y = -0.0526x^3 + 1.136x^2 - 5.989x + 28.332$	0.6430
Ireland	$Y = -0.0003x^3 + 0.0052x^2 - 0.0215x + 0.2624$	0.4045
Italy	$Y = 0.2925x^2 - 2.8886x + 15.405$	0.8675
Latvia	$Y = -0.0074x^2 + 0.2416x + 0.2348$	0.8527
Lithuania	$Y = 0.0515x^2 - 0.4132x + 2.407$	0.9252
Luxemburg	$Y = -0.00x^4 + 0.00x^3 - 0.03x^2 + 0.09x + 0.05$	0.2000
Poland	$Y = -0.0269x^3 + 0.6096x^2 - 3.178x + 17.269$	0.7467
Portugal	$Y = -0.032x^3 + 0.5617x^2 - 2.0516x + 8.634$	0.8327
Romania	$Y = 0.0264x^3 - 0.4352x^2 + 2.685x + 17.353$	0.6040
Slovakia	$Y = -0.0009x^4 + 0.0158x^3 - 0.0286x^2 - 0.4265x + 4.9625$	0.3714
Slovenia	$Y = 0.003x^4 - 0.0015x^3 - 0.0441x^2 + 0.3123x + 1.3625$	0.1780
Spain	$Y = -0.0029x^4 + 0.118x^3 - 1.3864x^2 + 5.628x + 26.128$	0.5377
Sweden	$Y = -0.0005x^4 + 0.0122x^3 - 0.1211x^2 + 0.6029x + 2.1623$	0.5235
United Kingdom	$Y = 0.2525x + 6.9764$	0.0991

Source: Own results.

Among the countries, the dispersion of the points reflecting production in the chart varied from a country to another and from a year to another depending on the specific local conditions and determinant factors.

A linear trend line of honey production was recorded in Estonia with $R^2 = 0.919$, reflecting the continuous development of beekeeping. In United Kingdom, it was also recorded an increasing trend as proved by the linear regression and $R^2 = 0.991$.

In the other countries, the most suitable trend equation was the polynomial of various degrees as follows:

- a polynomial equation of the 2nd degree in case of Lithuania ($R^2 = 0.925$), Greece ($R^2 = 0.903$), Italy ($R^2 = 0.867$), Latvia ($R^2 = 0.853$), Croatia ($R^2 = 0.696$) and Cyprus ($R^2 = 0.513$);
- a polynomial equation of the 3rd degree in case of Portugal ($R^2 = 0.832$), Poland ($R^2 = 0.746$), Hungary ($R^2 = 0.643$), Finland ($R^2 = 0.615$), Germany ($R^2 = 0.554$), Bulgaria ($R^2 = 0.490$), Ireland ($R^2 = 0.404$), France ($R^2 = 0.377$) and Denmark ($R^2 = 0.2132$);
- a polynomial equation of the 4th degree in case of Spain ($R^2 = 0.538$), Sweden ($R^2 = 0.532$), Czechia ($R^2 = 0.459$), Austria ($R^2 = 0.385$), Slovakia ($R^2 = 0.317$), Luxemburg ($R^2 = 0.20$), Belgium ($R^2 = 0.20$) and Slovenia ($R^2 = 0.178$)(Table 6).

The problems the EU beekeeping is facing

The main challenges the EU beekeeping is facing to maintain the number of beehives and production are the following ones:

- the continuous increase of the apiary input prices and of production costs;
- the honey cheap imports from the third countries making the EU beekeepers' honey to become uncompetitive and the apiculturists to register huge income losses [11];
- the loss of bee colonies due to the increased frequency of the bee collapse disorder and the incidence of diseases, the increase of the number of beehives invaders, the attack of various predators;
- climate change has a more a more impact on bee colonies and honey production, as the weather extreme phenomena produce disturbances in pickings during flowering season, as it happened in Hungary, Portugal, Italy, France, which registered important production losses [2, 12];
- the more and more limited access to pickings in the agricultural crops due to the use of new hybrids especially for sun flower which do not allow the bees to collect the nectar;
- the intensification of agriculture using pesticides reduces the pickings availability and implicitly creates a loss of bees and production,
- the intensification of urbanization which affects bees habitat [3, 37, 38];
- honey price volatility varying from a country to another in close relationship with honey type and quality and also with demand/offer ratio [31];
- the low export capacity, the EU being able to export only 8% of its total honey production.
-the lack of international import standards and regulations regarding honey quality has lead to the commercialization of a honey whose quality is susceptible. In the EU there are some regulations regarding honey labeling, but they are extremely low, because they do not indicate exactly how much honey of various origins is in the blended honey [11, 19].
- the fake or counterfeit honey has appeared on the EU market as a consequence of cheap imports and because the use of weak tests for honey quality, which imposes a more severe regulation regarding the checking of honey authenticity and the improvement of the traceability standards [37];
-the decline in bees colonies could affect the whole food chain in the EU and also at the global level, being known that bees pollinate between 5 and 8% of global food production [11].

Under these circumstances, it could be possible as the number of beehives not to increase, to remain stable or even to decline, and in consequence agriculture, horticulture and biodiversity in the EU to be affected due to the drift in pollination which threatens not only agriculture but also other sectors of the economy and could have a deep economic and social impact [11,37].

For sustaining beekeeping, the EU Commission established National Apiculture Programmes 2020-2022 which continues the measures taken before [7].

Taking into account all these aspects, the EU Commission approved a budget of Euro 240 million for the period 2020-2022, by 11% more than for the period 2017-2019, for the implementation of the national apiculture programmes. Each country could contribute by 50% and the rest of 50% funding will come from the EU for beekeeping development, the allocation being in close relationship with the number of bee hives exiting in each country.

CONCLUSIONS

The research led to the conclusion that the EU was and still is an important honey producer despite that the production potential is different from a country to another. The sector performance is sustained by Spain, Romania and Hungary, as the main producers, followed by Germany, Greece, Poland, France, Italy, Bulgaria and Portugal, whose contribution to the EU production is around 76%. The other EU countries will also continue to make efforts to increase their contribution to the honey production.

The increasing demand for honey will determine the EU to complete honey offer on the internal market by imports under the condition as imported honey to be of high quality attested by the authorized laboratories and the traceability of the final product to be assured.

The analysis of the evolution of the EU honey production proved that beekeeping must continue to be developed as being an important sector of agriculture.

Increasing production of honey, the EU could become less dependent on imports to cover the domestic market demand, and beekeepers will be sustained to perform and increase efficiency along the honey chain obtaining the expected and deserved returns.

Bees will continue to play an important role in the development of the sustainable agriculture, for maintaining balanced ecosystems and a healthy environment, for increasing agricultural production, creating jobs in the rural areas and reducing migration to cities and for preserving biodiversity and the beauty of the landscapes.

That is why this sector is strongly financed both from the EU and national budgets for the coming years.

The objectives of the national apiculture programmes are destined to assure beekeeping development by enhancing technical conditions, improving beekeepers training level, sustaining business of the young apiculturists, fighting against diseases and strengthening bee colonies, increasing the number of bee hives and honey production as well as its quality.

REFERENCES

[1]Bendre, G., 2017, Romania comes first in EU based on honey production, Business Review, Newsroom 16/01/2017, https://business-review.eu/news/romania-comes-first-in-eu-based-on-honey-production128402#:~:text=According%20to%20the%20European%20Commission,with%2020%2C000%20tonnes%20in%202014, Accessed on April 7, 2021.

[2]Euractiv, 2019, French beekeepers warn about 'catastrophic' honey harvest, 25 June 2019, https://www.euractiv.com/section/agriculture-food/news/french-beekeepers-warn-about-catastrophic-honey-harvest/

[3]European Commission, 2016, Brussels, 7.12.2016 COM(2016) 776 final Report from the Commission to the European Parliament and the Council on the implementation of the measures concerning the apiculture sector of Regulation (EU) No 1308/2013 of the European Parliament and of the Council establishing a common organisation of the markets in agricultural products, https://ec.europa.eu/transparency/regdoc/rep/1/2016/EN/COM-2016-776-F1-EN-MAIN-PART-1.PDF, Accessed on April 7, 2021.

[4]EU Commission, 2019, More beehives and beekeepers thanks to the EU support. 17 Dec.2019, https://ec.europa.eu/commission/presscorner/detail/en/IP_19_6777, Accessed on April 7, 2021.

[5]European Commission, 2021, Market presentation honey, Autumn 2020, https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/animals_and_animal_products/documents/market-presentation-honey_autumn2020_en.pdf, Accessed on April 7, 2021.

[6]EU Commission, 2021, Honey, Detailed information on honey production, national apiculture programmes, budget and legal bases, https://ec.europa.eu/info/food-

farming-fisheries/animals-and-animal-products/animal-products/honey_en, Accessed on April 7, 2021.
[7]European Commission, 2021, EU Beekeeping, National Apiculture Programmes, 2020-2022, https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/animals_and_animal_products/documents/honey-apiculture-programmes-overview-2020-2022.pdf, Accessed on April 7, 2021.
[8]FAO, 2019a, Honey, Food and Agriculture Organiztion of the United Nations, http://www.fao.org/resources/infographics/infographics-details/en/c/1202954/, Accessed on April 7, 2021
[9]FAO, 2019b, Largest consumers of honey, CA4657EN/1.05.19, http://www.fao.org/3/ca4657en/ca4657en.pdf, Accessed on April 7, 2021.
[10]FAOStat Data Base, 2021, www.fao.org, Accessed on April 7, 2021.
[11]Foote, N., 2020a, Struggling beekeepers undercut by cheap honey imports, says new report, Euractiv, 177 Feb 2020, https://www.euractiv.com/section/agriculture-food/news/struggling-beekeepers-undercut-by-cheap-honey-imports-says-new-report/, Accessed on April 7, 2021.
[12]Foote, N., 2020b, EU honey harvests feel the sting of climate change with record losses, Euractiv, No.10, 2020, https://www.euractiv.com/section/agriculture-food/news/eu-honey-harvests-feel-the-sting-of-climate-change-with-record-losses/, Accessed on April 7, 2021.
[13]Formato, G., Smulders, F., 2011, Risk management in primary apicultural production. Part 1: Bee health and disease prevention and associated best practices, 2011, Veterinary Quarterly 31(1):29-47, DOI: 10.1080/01652176.2011.565913, Accessed on April 7, 2021.
[14]IndexBox AI Platform, 2020, The EU Honey Market Slipped Back Slightly to $1.4B, https://www.globaltrademag.com/the-eu-honey-market-slipped-back-slightly-to-1-4b/#:~:text=In%202019%2C%20Germany%20(26K%20tonnes,achieving%2078%25%20of%20total%20export, Accessed on April 7, 2021.
[15]Majewski, J., Popa, D., Sobolewska, A., 2021, Economic value of pollination of orchards, Case of Moldova and Poland, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.21(1):479-485.
[16]Nation Master, 2020, Top Countries in Natural Honey Production, https://www.nationmaster.com/nmx/ranking/natural-honey-production, Accessed on April 7, 2021
[17]Panta, N.D., 2018, Honey market dynamics. The case of Romania, Management of Sustainable Development Sibiu, Romania, Vol. 10(2): 13-16.
[18]Pippinato, L., Di Vita, G., Brun, F., 2019, Trade and comparative advantage analysis of the EU honey sector with a focus on the Italian market, Quality - Access to Success 20(S2):485-492.
[19]Pippinato, L., Blanc, S., Mancuso, T., Brun, F., 2020, A Sustainable Niche Market: How Does Honey Behave?, Sustainability 2020, 12, 10678; doi:10.3390/su122410678, Accessed on April 7, 2021.
[20]Pirvutoiu, I, Popescu, Agatha, 2011, Analysis of Romania's Honey Market, International Symposium. "Bioengineering of Animal Productions", Timisoara, May 26-27, 2011, Lucrari stiintifice Zootehnie si Biotehnologii (Scientific Papers: Animal Science and Biotechnologies), Timisoara, Vol.44(2)/2011, pp.500-503.
[21]Popescu Agatha, 2005a, Researches concerning the increase of profitability in beekeeping by creating of commercial apiaries, Bulletin of the University of Agricultural Science and Veterinary Medicine, Vol 61, 188-191.
[22]Popescu Agatha, 2005b, Research on the possibility to increase profitability in an apiary of 50 bee families, Bulletin UASVM Cluj-Napoca, Romania, Seria Zootehnie si Biotehnologii si Medicina Veterinara, Vol.61, p.404-407.
[23]Popescu Agatha, 2006a, Study upon Honey Market in the EU Countries, Bulletin of UASVM Cluj-Napoca, Romania, Series Zootehnics, Biotechnologies and Veterinary Medicine, No.62, p.215.
[24]Popescu Agatha, 2006b, Gross margin - a barometer of profitability in agriculture. International symposium "Durable agriculture-agriculture for the future" Craiova, 23-24.
[25]Popescu, A., 2010a, Study upon the Economic Efficiency of Romania's Honey Foreign Trade, Scientific Papers Series D, Zootehnics, Faculty of Animal Science Bucharest, Vol. LIII, p.176-182.
[26]Popescu Agatha, 2010b, Home and foreign trade, Dominor Publishing House, Bucharest, 176-178.
[27]Popescu Agatha, 2012a, Research regarding Apiaries Structure and its Relationship with Honey Production, Bulletin of UASVM Cluj-Napoca, Romania, Animal Science and Biotechnology, Vol..69(1-2)/2012, p.332-334.
[28]Popescu Agatha, 2012b, Research on Beekeepers Income Estimation based on Honey Production. The 9th Bulletin of UASVM Cluj-Napoca, Romania, Animal Science and Biotechnology, Vol..69(1-2)/2012, pp.185-191.
[29]Popescu Agatha, 2013a, Study concerning the Trends in Romania's Honey Market, Scientific Papers-Series Zootechnics (Lucrari stiinifice-Seria Zootehnie) Iasi, Vol. 59, p.153-158.
[30]Popescu Agatha, 2013b, Research concerning Apiary Size, Honey Yield and Beekeepers' income in Teleorman County, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.13, Issue 1/2013, p.293-300
[31]Popescu Agatha, 2016a, Regression and Elasticity of the Average Delivery Price and Production of Honey in Romania, Proceedings of 28th IBIMA Conference Vision 2020: Innovation Management, Development Sustainability, and Competitive Economic Growth, Sevilla, Spain, November 9-10, 2016, pp.935-944.

[32]Popescu Agatha, 2016b, The effect of Honey Production on Beekeepers' Income. A Study Case in South Muntenia Development Region of Romania, Proceedings of 28th IBIMA Conference Vision 2020: Innovation Management, Development Sustainability, and Competitive Economic Growth, Sevilla, Spain, November 9-10, 2016, pp.919-934.

[33]Popescu Agatha, 2017, Bee Honey production in Romania, 2007-2015 and 2026-2020 forecast, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development,Vol.17(1):339-350.

[34]Popescu Agatha, 2018, Honey production and trade before and after Romania's accession into the European Union, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.18, Issue 4/2018, 229-248,

[35]Popescu Agatha, Toma, A.D., Stoian, E., Serban, V., 2021, Bee honey production concentration in Romania in the EU-28 and global context in the period 2009-2018, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.20(3):413-429.

[36]Root, A.I., 2019, 2018 Annual Honey Report, Bee Culture, https://www.beeculture.com/2018-annual-honey-report/#:~:text=While%20the%20per%20capita%20honey,to%202%20pounds%20per%20year, Accessed on April 7, 2021.

[37]Tamma, P., 2017, Honeygate: How Europe is being flooded with fake honey, Euractiv, 8 Sept. 2017, https://www.euractiv.com/section/agriculture-food/news/honey-gate-how-europe-is-being-flooded-with-fake-honey/, Accessed on April 7, 2021.

[38]UNESCO, 2020, World Bee Day - 20 May 2020, https://en.unesco.org/news/world-bee-day-20-may-2020, Accessed on April 7, 2021.

[39]Vapa-Tankosi, J., Miler-Jerkovi, V., Jeremi, D., Stanojevi, S., Radovi, G., Investment in Research and Development and New Technological Adoption for the Sustainable Beekeeping Sector, Sustainability 2020, 12, 5825; doi:10.3390/su12145825, Accessed on April 7, 2021.

[40]Workman, D., 2020, Natural Honey exports by country 2019, World's Top Exports, http://www.worldstopexports.com/natural-honey-exporters/, Accessed on April 7, 2021.