

A study on enhancement of red meat production and consumption estimation methods in Türkiye

F.Ş. Özbek* 

Turkish Statistical Institute, Ankara, Türkiye

ORIGINAL RESEARCH PAPER

Received: July 18, 2022 • Accepted: December 14, 2022

Published online: February 6, 2023

© 2022 Akadémiai Kiadó, Budapest



ABSTRACT

It is necessary to estimate the number of animals slaughtered outside slaughterhouses in countries like Türkiye, where slaughterings in non-slaughterhouses are relatively high. This paper presents the estimation of red meat production including all slaughterings both in slaughterhouses and in non-slaughterhouses by using a re-established model based on change in the inventory of animals including imported and exported animals, slaughtering rate for the slaughtered animals raised domestically in Türkiye, and total red meat consumption per capita per year in Türkiye. Total red meat production in Türkiye was estimated as 1 million 952 thousand 38 tonnes, bovine meat production was estimated as 1 million 471 thousand 550 tonnes, sheep and goats meat production was estimated as 480 thousand 488 tonnes in 2021. Total red meat human consumption per capita in Türkiye was estimated as 23 kg carcass weight per capita per year and 17 kg retail weight per capita per year. 17 kg of total red meat human consumption came from bovine meat, and 6 kg came from sheep and goats meat. According to the result of cluster analysis of European countries, Türkiye was clustered in the group of lowest total red meat consumption with Albania, Ukraine, Bosnia and Herzegovina, Republic of Moldova, North Macedonia, Czech Republic, and Serbia.

KEYWORDS

red meat, meat consumption, meat production, Türkiye

* Corresponding author. E-mail: fethiozbek@tuik.gov.tr

1. INTRODUCTION

It is necessary to estimate the number of animals slaughtered outside slaughterhouses and, therefore, the total amount of red meat production including slaughterings both in slaughterhouses and in non-slaughterhouses in countries like Türkiye, where slaughterings in non-slaughterhouses (with slaughterings in the feast of sacrifice) are relatively high (TurkStat, 2022a).

Officially, two methods were used to estimate total red meat production of Türkiye in the past. Total red meat production statistics of Türkiye were estimated by considering the slaughterings in slaughterhouses and the hides that were collected by Turkish Aeronautical Association in the feast of sacrifice until 2010. After 2010, the amount of total red meat production was estimated based on the number of raw hides processed by tanneries, in order to cover all the slaughterings both in slaughterhouses and in non-slaughterhouses. In this method, it was assumed that the amount of leather processed by the tanneries was equal to the number of animals slaughtered in the reference period. However, some factors caused deviations in the estimations on red meat production in this method, such as not all the hides of slaughtered animals are processed in tanneries (especially sheep and goats), storable product feature of hides, and effects of market demand on the amount of leather to be processed in tanneries. So, re-estimation of total red meat production of Türkiye became essential (TurkStat, 2022a).

For the estimation of slaughtered animals a new approach, using change in the inventory of animals including imported and exported animals and the number of born/dead animals, was used by Yavuz and Zulauf (2004). They used the number of milking animals and the proportions of animals (i) that give birth to twins and (ii) that are born dead in order to estimate born animals. The model established by Turkmenoglu (2010) was estimated slaughtered animals by adding unregistered slaughterings to registered slaughterings. Unregistered slaughterings were estimated as residual number by using change in the inventory and demographic ratios (ratios of viviparous, live birth, vitality up to cutting age, death in old animals). The numbers of imported and exported animals were not considered in this model. Even though there were no imported animals and low number of exported animals in Türkiye before 2010, a model estimating red meat production should theoretically reflect the imported and exported animals.

After 2010, the number of imported animals for slaughtering/fattening sharply raised in Türkiye. Also, it was not possible to estimate unregistered slaughterings separately from registered one because of the fact that registered slaughterings processed also imported animals. So, there became a need for improving the model established by Turkmenoglu (2010). It was improved within this study (i) by considering imported slaughtering/fattening animals and exported animals, and (ii) by estimating total number of slaughtered animals without separating registered and unregistered slaughterings.

Slaughtering rate was estimated as the ratio of slaughtered animals to the total number of animals in the herd. Slaughtering rates were estimated for the years of 2020 and 2021 according to model results within this study. Total red meat consumption per capita per year in Türkiye and the comparisons with European countries were also given.



The aim of this study was to estimate (i) total red meat production of Türkiye by using a re-established model, (ii) slaughtering rate for the slaughtered animals raised domestically in Türkiye, and (iii) total red meat consumption per capita per year in Türkiye.

2. MATERIALS AND METHODS

Total red meat production was estimated based on the multiplication of total number of slaughtered animals with the average carcass weight (C) (Yavuz and Zulauf, 2004; Turkmenoglu, 2010). The average carcass weight was obtained from the "Survey of Slaughterhouse Statistics" conducted by the Turkish Statistical Institute (TurkStat) monthly. The imported animals for fattening and slaughtering were also added into red meat production. Estimation of total number of slaughtered animals needs to take into account stock change in the population of animals, net foreign trade, the number of viviparous animals, and the death loss in old animals (Yavuz and Zulauf, 2004).

Total number of slaughtered animals was estimated within two parts: (i) from the slaughtered animals raised domestically in Türkiye (S_d) and (ii) from the slaughtered animals imported for slaughtering and fattening (S_i) (Equation (1)).

$$(MP)_t = [(S_d)_t + (S_i)_t] * C_t \quad (1)$$

The number of slaughtered animals raised domestically (S_d) in Türkiye was estimated as follows (Equation (2)):

$$(S_d)_t = (B_t * [(v * lb * vca) - d - pc]_t) \quad (2)$$

where

B : beginning inventory of animals
 v : the ratio of viviparous,
 lb : live birth rate
 vca : the ratio of vitality up to cutting age
 d : death rate in old animals
 pc : change of population rate

The definitions of variables in the equation as follows:

- the ratio of viviparous: the proportion of the number of viviparous animals to the beginning inventory of animals
- live birth rate: the proportion of the number of animals born alive to the number of viviparous animals
- the ratio of vitality up to cutting age: $1 -$ (the proportion of death animals before one age to the number of animals born alive)
- death rate in old animals: the proportion of death animals after one age to the beginning inventory of animals
- change of population rate: the proportion of (total number of animals at the end - (total number of animals in the beginning - exported animals)) to the beginning inventory of animals



Slaughtering rate (SR) was estimated as the ratio of being slaughtered animals to the total number of animals in the herd and derived from Eq. (2) as follows (Equation (3)).

$$SR = [(v * lb * vca) - d - pc] \quad (3)$$

The number of slaughtered animals imported for slaughtering and fattening (S_i) for year t was estimated as follows (Equation (4)):

$$(S_i)_t = (S_{is})_t + (S_{if})_t + (S_{if})_{t-1} \quad (4)$$

where

$(S_{is})_t$: The number of slaughtered animals imported for slaughtering in year t

$(S_{if})_t$: The number of slaughtered animals imported for fattening in year t before eighth month

$(S_{if})_{t-1}$: The number of slaughtered animals imported for fattening in year $t-1$ after eighth month

The following assumptions were applied in the calculations (Turkmenoglu, 2010; TurkStat, 2022a):

- Reaching ideal slaughtering live weight (or carcass weight) for animals is normally three years for bovine animals and two years for sheep and goats. Meanwhile, average slaughtering rates of three years for bovine and two years for sheep & goats were used because of losses due to diseases, epizootic, etc., and for other data fluctuation.
- Stock change in the population in the calculations based on the data compiled by the Ministry of Agriculture and Forestry (MoAF) and published by TurkStat. Exported animals were extracted from the number of animals in the beginning inventory of animals in the calculation of stock change in the population.
- Some imported animals are for breeding, and some are used for fattening or slaughtering. Imported bovine animals and sheep and goats were classified by the types of Harmonized Commodity Description and Coding System (HS) codes as fattening or slaughtering animals. It was assumed that imported live animals for fattening were slaughtered at the end of fifth month entering the country (because of the fact that they cannot be slaughtered or sold according to the related legislation). So, it was assumed that live animals imported for fattening were slaughtered after eighth month in the following year. In order to calculate stock change in the population, these animals were extracted from the end of current year and the beginning of the following year. Imported live animals for slaughtering were assumed to be slaughtered in the year they were imported.
- Stillborn animals, twins, triplets, etc. were included in live birth rate. E.g., the ratio of 1.05 means that 105 live animals were born from 100 viviparous animals.

The demographic ratios used in Eq. (2) were compiled by Animal Production Survey in Agricultural Holdings conducted by TurkStat every year. This survey was conducted on the agricultural holdings registered in Animal Registry System (TURKVET), established by MoAF, in order to register animals. All agricultural holdings in sampling frame having bovine animals with higher than 500 animals, and sheep and goats with higher than 1,000 animals were included to the sample. Other samples were selected from the rest of the frame through stratified simple random sampling. According to this design, the sample size of the survey was 40,565



agricultural holdings in 2020 and 41,944 agricultural holdings in 2021. The sample size was determined as follows (Equation (5)):

$$n = \frac{z^2 s^2}{d^2} \quad (5)$$

where n is sample size, z is the level of confidence according to the standard normal distribution, d is the tolerated margin of error.

Total red meat consumption per capita in Türkiye in carcass weight equivalent was estimated by dividing total red meat supply ready for human consumption by the related data on the population. Total red meat supply was calculated by adding total imported meat in carcass weight equivalent to red meat production. The meat supply ready for human consumption was calculated by extracting total exported quantity from total red meat supply (FAOSTAT, 2022). Imported and exported quantity of meat was calculated by using technical conversion factors used in the EU (EC, 2009). Stock change and losses was assumed as negligible (EU, 2022; OECD, 2022; STATBEL, 2022). Carcass weight to retail weight conversion factors were taken as 0.7 for bovine meat and 0.88 for both sheep and goat meat (OECD, 2022).

The method selected for clustering European Countries by meat consumption is the average, which bases clustering decisions on the average distance (linkage) between points or clusters (SAS, 2022a). In this method, the distance between two clusters is the average distance between pairs of observations, one in each cluster. Average linkage tends to join clusters with small variances, and it is slightly biased toward producing clusters with the same variance (SAS, 2022b). The analysis was carried out using SAS software package. The null hypotheses (H_0), the median red meat consumption across the groups are equal, were stated for the red meat consumption groups of total, bovine, and sheep and goats separately. The Kruskal-Wallis test, a non-parametric version of the One-Way Anova, was used to test null hypotheses.

3. RESULTS AND DISCUSSION

3.1. Total red meat production estimation of Türkiye

Total red meat production in Türkiye was calculated using the re-established model and assumptions presented in the “Method” section. According to the model results, total red meat production was estimated as 1 million 952 thousand 38 tonnes, bovine meat production was estimated as 1 million 471 thousand 550 tonnes, sheep and goats meat production was estimated as 480 thousand 488 tonnes in 2021. Total red meat production was estimated as 1 million 785 thousand 952 tonnes in 2020 (Table 1).

Total red meat production comprised of 74.8% cattle meat, 0.6% buffalo meat, 19.8% sheep meat, and 4.8% goat meat in 2021 (Fig. 1).

3.2. Total red meat human consumption per capita estimation of Türkiye

Total red meat human consumption per capita in Türkiye was estimated as 23 kg carcass weight per capita per year and 17 kg retail weight per capita per year in 2021. 17 kg of total red



Table 1. Production of red meat (tonnes), 2020–2021

	2020	2021
Total red meat	1,785,952	1,952,038
Bovine meat	1,349,870	1,471,550
Cattle meat	1,341,446	1,460,719
Buffalo meat	8,424	10,831
Sheep and goats meat	436,082	480,488
Sheep meat	345,639	385,933
Goats meat	90,443	94,555

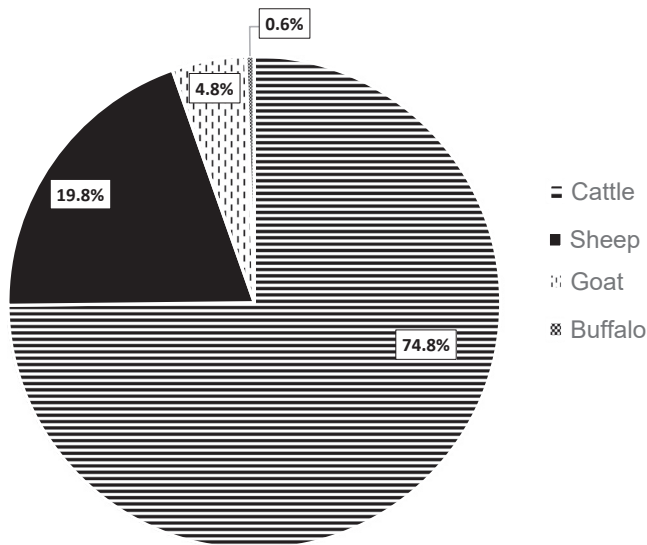


Fig. 1. The distribution of total red meat production by animal types, 2021

meat human consumption belonged to bovine meat, and 6 kg belonged to sheep and goats meat. Self-sufficiency ratio was estimated as 100% for both total red meat and subgroups of it (Table 2).

Human consumption per capita by retail weight was estimated by using technical conversion coefficients to transform carcass weight into retail weight as 0.7 for bovine meat and 0.88 for sheep and goat meat (OECD, 2022). Retail weight means the weight of meat as it is sold at the retail level. So, it does not include the losses until retail and associated inedible parts, which cannot be sold at the retail level.

3.3. Comparison of the red meat human consumption in Türkiye with European countries

According to the data of red meat human consumption (including bovine, sheep and goat, and pig meat) by carcass weight in European countries for 2019 (FAOSTAT, 2022), the maximum

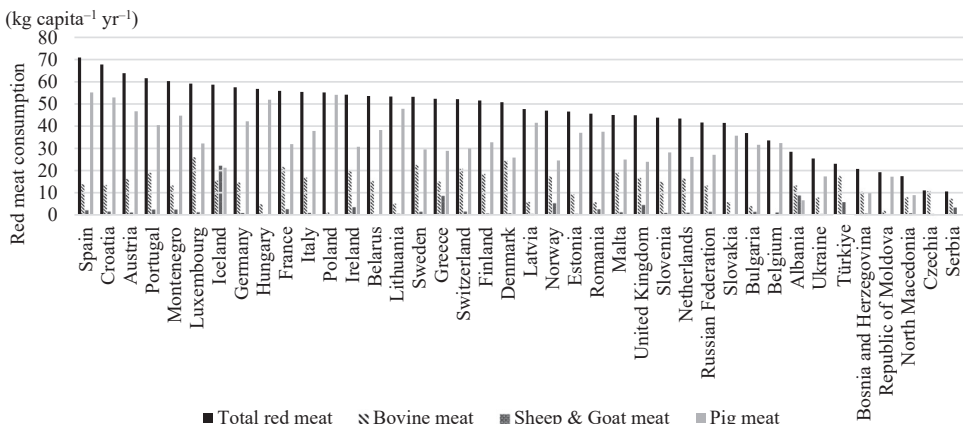


Table 2. Supply balance sheet for red meat production in Türkiye (2021)

	Bovine meat	Sheep and goats meat	Total red meat
Production (tonnes)	1,471,550	480,488	1,952,038
Import (tonnes)	1,566	0	1,566
Supply = Use (tonnes)	1,473,116	480,488	1,953,604
Export (tonnes)	1,105	439	1,544
Supply ready for consumption (tonnes)	1,472,012	480,049	1,952,061
Population	84,680,273	84,680,273	84,680,273
Human consumption per capita (by carcass weight) (kg capita ⁻¹ year ⁻¹)	17	6	23
Human consumption per capita (by retail weight) (kg capita ⁻¹ year ⁻¹)	12	5	17
Self-sufficiency ratio (%)	100	100	100

red meat consumption value was observed in Spain with 71.0 kg capita⁻¹ yr⁻¹, and the minimum value was obtained in Serbia with 10.6 kg capita⁻¹ yr⁻¹ (Fig. 2). Total red meat human consumption of Türkiye for 2021 (23.1 kg capita⁻¹ yr⁻¹) was lower than the weighted average value of European countries (49.6 kg capita⁻¹ yr⁻¹). Bovine and sheep and goats meat human consumptions of Türkiye for 2021 (17.4 and 5.7 kg capita⁻¹ yr⁻¹, respectively) were lower than the weighted average values of European countries (13.7 and 1.7 kg capita⁻¹ yr⁻¹, respectively).

When we clustered red meat human consumptions of European countries by FAO area classification by using average linkage cluster model, we observed that European countries can be classified into four clusters with the values of R-square as 0.92, 0.92, and 0.95 for total red meat consumption, bovine meat consumption, and sheep and goats meat consumption, respectively. The average total red meat consumptions of the countries varied from the group of lowest

Fig. 2. Red meat human consumption per capita per year in European countries (kg capita⁻¹ year⁻¹)

total red meat consumption to the highest as 19.5, 43.1, 55.9 and 69.4 kg capita⁻¹ yr⁻¹ for these four clusters. These averages were 4.2, 10.4, 15.5, and 22.4 kg capita⁻¹ yr⁻¹ and 0.8, 2.7, 6.5, and 22.1 kg capita⁻¹ yr⁻¹ for bovine and sheep and goat meat, respectively.

In the cluster analysis, the null hypotheses were rejected since the *P*-values of the tests for all groups were less than 0.05, and it was decided that there were statistically significant differences between the medians across all groups. Türkiye is situated in the group of lowest total red meat consumption with Albania, Ukraine, Bosnia and Herzegovina, the Republic of Moldova, North Macedonia, Czechia and Serbia; in the group of second highest bovine meat consumption with Malta, Portugal, Finland, Norway, Italy, the United Kingdom, the Netherlands, Austria, Iceland, Belarus, Greece, Slovenia, Germany, Spain, Croatia, Albania, Montenegro, the Russian Federation and Belgium; and for sheep and goats meat consumption with Albania, Greece, Norway, and the United Kingdom (Fig. 2).

The raw milk-feed ratio, the amount of feed that can be purchased by selling a unit of raw milk, decreased to 1.5:1.56 in Türkiye in 2021 (Mat et al., 2021) because of the increase in the cost of feed, the most important input in the raw milk production. The raw milk-feed ratio should be 1.5:2 for ensuring sustainability in milk production (AERI, 2001; Mat et al., 2021). Unfavourable raw milk-feed ratio directly affecting the profitability of milk producing led to going out of dairy farming and slaughtering of milking cows. This resulted a 9.3% increase in total red meat production in 2021. Decrease in the number of milking cows will lead to a decrease in the number of cattle born and, thus, a decrease in the number of animals in the herd. This will lead to a decrease in the supply of red meat and, therefore, an increase in meat prices.

In this study, slaughtering rate was estimated as 0.25 and 0.27 for cattle for the years of 2020 and 2021, respectively. These values are compatible with the slaughtering rate estimations of the Agricultural Economics Research Institute and State Planning Organisation in Türkiye, which were 0.25 (Yavuz and Zulauf, 2004; Yavuz et al., 2006) and 0.30 (SPO, 2001), respectively. Turkmenoglu (2010) estimated the slaughtering rates between 0.38 and 0.41 for sheep and between 0.36 and 0.41 for ordinary goat; and SPO (2001) estimated 0.42 for sheep and 0.40 for ordinary goat. These values are compatible with the slaughtering rates estimated in this study as 0.42 and 0.41 for sheep and goats for the years of 2020 and 2021, respectively.

37.6% of total red meat production and 35.6% of bovine meat production was exported as meat and meat products in European countries in 2019, these percentages were 49.4% and 43.7% in Western Europe, respectively (FAOSTAT, 2022). However, the exported meat and meat products share of Türkiye in red meat production is very low, even negligible as 0.03% and 0.04% for total red meat and bovine meat, respectively. It is necessary to develop related policies to increase the amount of exported processed red meat, which can be achieved by increasing red meat production domestically, in order to increase added value to Türkiye's economy. In order to increase red meat production, it is necessary to increase the number of animals raised domestically by increasing the number of breeding animals.

Whereas FAO uses carcass weight equivalent for the country comparisons in meat human consumption, OECD uses retail weight equivalent. While retail weight better represents in-home consumption and provides advantages in comparisons with studies researching the behaviour of meat consumers, it may contain the margin of errors in the use of technical conversion coefficients to transform carcass weight into retail weight, because these coefficients are not



country specific and it varies in time due to the society's income, urbanisation, and economic growth (Chalak et al., 2016; Karwowska et al., 2021). Carcass weight estimations minimise this margin of error. So, both indicators were estimated in this study.

The red meat consumption is highly discussed by the general public and the political and scientific communities because of the possible effects of meat consumption on human health, environment, natural resources, and animal welfare in spite of the fact that meat is a good source of energy and essential nutrients, including protein and micronutrients such as iron, zinc, and vitamin B12 (Godfray et al., 2018; Springmann et al., 2018; Thies et al., 2022). Historically, there are conflicting results on associations between red meat consumption and health problems such as cardiovascular disease or cancer. While the International Agency for Research on Cancer of the World Health Organization announced that consumption of processed meat is “carcinogenic to humans” and that consumption of red meat is “probably carcinogenic to humans” (Bouvard et al., 2015), many studies contended no association between intakes of unprocessed red meat and negative consequences of human health (e.g. Binnie et al., 2014; Johnston et al., 2019; Leroy and Cofnas, 2020). Studies conducted in recent years have shown that it is important to distinguish between unprocessed meat such as beef, veal, pork, and lamb and processed meat such as bacon, bologna, sausages and salami, while examining the risks of red meat consumption in terms of health (Binnie et al., 2014; Godfray et al., 2018). Red meat consumption per capita in Türkiye (23.1 kg capita⁻¹ yr⁻¹) is lower than the average of the world (26.6 kg capita⁻¹ yr⁻¹) and the developed regions (Europe with 49.6 and America with 48.2 kg capita⁻¹ yr⁻¹). It is important to implement socio-economic measures to ensure adequate intake of red meat, which is an important nutritional source. However, while encouraging the consumption of red meat, the issues of encouraging the consumption of unprocessed red meat without the addition of carcinogenic substances, not applying methods causing carcinogenic substances, and eliminating/minimising the consumption of processed meat products that have been scientifically proven to be harmful to health should be taken into account.

Weighted average of red meat human consumption per capita per month was calculated as 1.42 kg retail weight capita⁻¹ month⁻¹ in this study. This value is compatible to the values estimated in previous studies when we consider high increase in income level in Türkiye (TurkStat, 2022b) from 2000 to 2021, which would increase red meat consumption (Uluat, 2002; Özbek, 2010). For example, Kızıloğlu and Kızıloğlu (2013) estimated the red meat human consumption as 1.18 kg capita⁻¹ month⁻¹, Mutlu (2007) estimated as 1.08 kg capita⁻¹ month⁻¹, Kara et al. (2004) estimated as 0.98 kg capita⁻¹ month⁻¹, Uluat (2002) estimated as 1.02 kg capita⁻¹ month⁻¹ and Gaytancıoğlu (1999) estimated as 0.6–1 kg capita⁻¹ month⁻¹.

According to the cluster analysis result (Fig. 3), EU countries can be classified into four groups by total red meat consumption. Türkiye is in the cluster of the countries with low red meat consumption. Özbek (2010) showed that meat consumption is low in low-income countries. Total red meat consumption per capita of Türkiye was lower than the values of many European countries and the weighted average of European countries due to lower income level of Türkiye compared to European countries. The human consumptions of bovine meat and sheep and goats meat in Türkiye were higher than the weighted average of European countries, because pig meat is consumed as a substitute for bovine meat and sheep and goats meat in Europe, and there is no pig meat consumption in Türkiye.



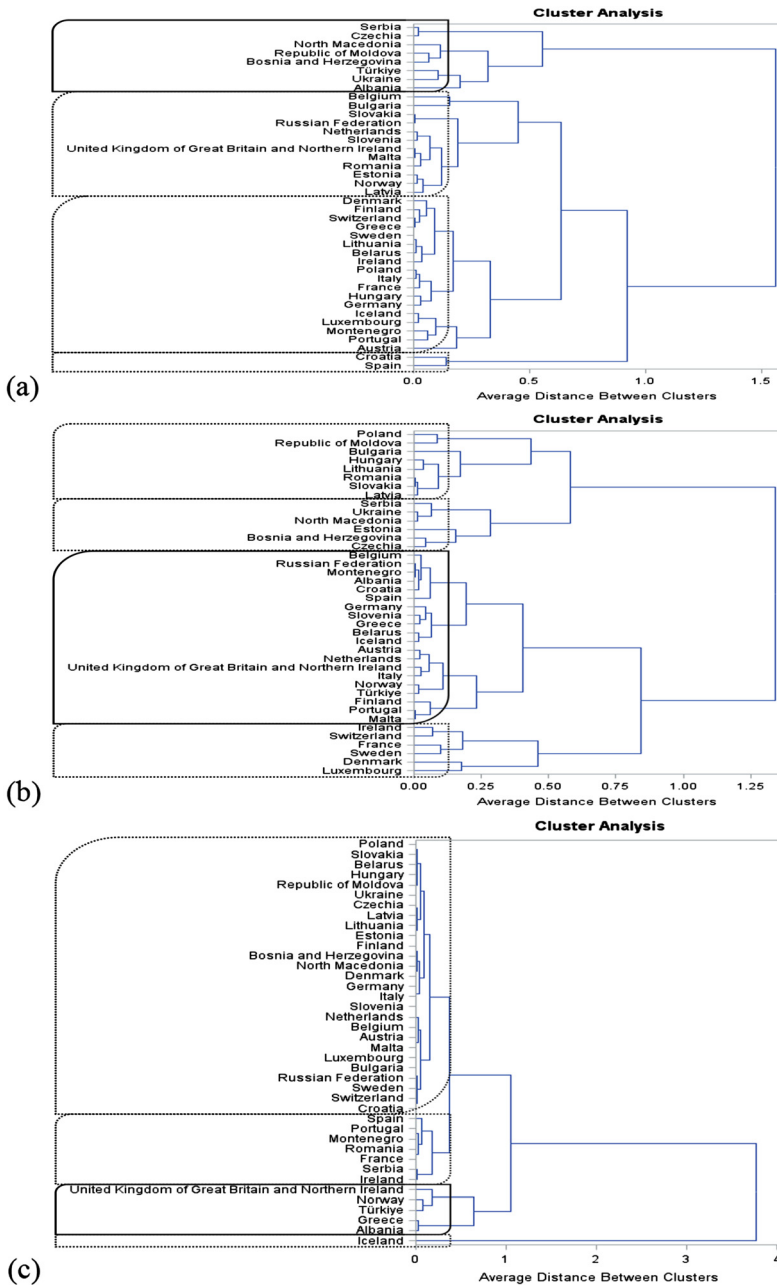


Fig. 3. Cluster analysis for European countries by (a) total red meat human consumption, (b) bovine meat human consumption, (c) sheep and goats meat human consumption



DISCLOSURE

This study was carried out at Turkish Statistical Institute, and the results of red meat production were published by Turkish Statistical Institute. The opinions and contents of the article remain the responsibility of the author, not of the Turkish Statistical Institute.

REFERENCES

- AERI (2001). Analyses of the impact of support policies and programs on animal resources development in Turkey. Agricultural Economics Research Institute, Project Report 2001–5, Publication Number: 53, 2001. 67 pages.
- Binnie, M.A., Barlow, K., Johnson V., and Harrison, C. (2014). Red meats: time for a paradigm shift in dietary advice. *Meat Science*, 98(3): 445–451.
- Bouvard, V., Loomis, D., Guyton, K.Z., Grosse, Y., Ghissassi, F.E., Benbrahim-Tallaa, L., Guha, N., Mattock, H., Straif, K., and the International Agency for Research on Cancer Monograph Working Group (2015). Carcinogenicity of consumption of red and processed meat. *Lancet Oncology*, 16: 1599–1600.
- Chalak, A., Abou-Daher, C., Chaaban, J., and Abiad, M.G. (2016). The global economic and regulatory determinants of household food waste generation: a cross-country analysis. *Waste Management*, 48: 418–422.
- EC (2009). *Working group on “Animal production statistics” of the Agricultural statistics committee*. Doc. ASA/TE/F/655, European Commission, Luxembourg.
- EU (2022). EU meat balance sheets, 2000–2019. Available at: https://agriculture.ec.europa.eu/document/download/61c30118-1667-4545-8b5e-b4014bad52c9_en?filename=agri-short-term-outlook-balance-sheets_en.xlsx (Accessed 14 December 2022).
- FAOSTAT (2022). Food balances. Available at: <https://www.fao.org/faostat/en/#data/FBS> (Accessed 30 May 2022).
- Gaytancıoğlu, S. (1999). *Tekirdağ Merkez ilçede kanath eti tüketim düzeyinin incelenmesi (The poultry meat consumption evaluation in Tekirdağ central)*. Trakya University Graduate School of Natural and Applied Sciences, Post Graduate Thesis, Tekirdağ. Available at: <https://tez.yok.gov.tr/UlusalTezMerkezi/TezGoster?key=weFMBHaUra8rsS5wi2bmHGuciONbkSDP1org5IItrnAlwyUrS2rIVk05r0BfTB> (Accessed 14 December 2022).
- Godfray, H.C.J., Aveyard, P., Garnett, T., Hall, J.W., Key, T.J., Lorimer, J., Pierrehumbert, R.T., Scarborough, P., Springmann, M., and Jebb, S.A. (2018). Meat consumption, health, and the environment. *Science*, 361(6399): eaam5324.
- Johnston, B.C., Zeraatkar, D., Han, M.A., Vernooij, R.W.M., Valli, C., El Dib, R., Marshall, C., Stover, P.J., Fairweather-Tait, S., Wójcik, G., Bhatia, F., de Souza, R., Brotans, C., Meerpohl, J.J., Patel, C.J., Djulbegovic, B., Alonso-Coello, P., Bala, M.M., and Guyatt, G.H. (2019). Unprocessed red meat and processed meat consumption: dietary guideline recommendations from the Nutritional Recommendations (NutriRECS) Consortium. *Annals of Internal Medicine*, 171(10): 756–764.
- Karwowska M., Łaba S., and Szczepański, K. (2021). Food loss and waste in meat sector – why the consumption stage generates the most losses? *Sustainability*, 13(11): 6227.
- Kara, M.K., Eyduran E., Özdemir T., and Zer, C. (2004). Van’da et ve ürünleri tüketim alışkanlıkları üzerine bir araştırma. (A study on consumption behaviours of meat and bee products in the province of Van). 4. National Zootechny Congress, 01-03 Eylül 2004, Isparta, pp. 661–664.



- Kızıloğlu, S. and Kızıloğlu, R. (2013). Erzurum Merkez İlçede Et ve İthal Et Tüketme Durumunu İnceleyen Bir Araştırm. (A study of the status related to the meat and imported meat consumption in the Central District of Erzurum). *Iğdır University Journal of the Institute of Science and Technology*, 3(1): 61–68. In Turkish, with an English abstract.
- Leroy, F. and Cofnas, N. (2020). Should dietary guidelines recommend low red meat intake? *Critical Reviews in Food Science and Nutrition*, 60(16): 2763–2772.
- Mat, B., Arikan, M., Çevrimli, M., Akin, A., and Tekindal, M. (2021). Factors affecting the price of raw milk in Turkey using panel data analysis. *Ciência Rural*, 51. <https://doi.org/10.1590/0103-8478cr20200937>.
- Mutlu, S. (2007). Gıda güvenirliliği açısından tüketici davranışları (Adana kentsel kesimde kırmızı et tüketimi örneği). (Consumer behaviors on food safety (A case study on red meat consumption in urban areas of Adana)). Van Yüzüncü Yıl University Graduate School of Natural and Applied Sciences, Post Graduate Thesis, Van. 205 pages. In Turkish, with an English summary.
- OECD (2022). Meat consumption. Available at: <https://data.oecd.org/agroutput/meat-consumption.htm> (Accessed 20 May 2022).
- Özbek, F.Ş. (2010). Kişi başına düşen milli gelire ülkelerin gıda tüketim eğilimlerinin tespit edilmesi – Veri madenciliği uygulaması (The determination of food consumption patterns of the countries by national income per capita – data mining application.) *TurkStat Journal of Statistical Research*. 7(2): 66–76. In Turkish, with English abstract.
- SAS (2022a). SAS workshop - multivariate procedures. Available at: <https://webpages.uidaho.edu/CALS-StatProg/sas/workshops/multivariate/cluster.pdf> (Accessed 20 May 2022).
- SAS (2022b). The CLUSTER Procedure-average linkage Available at: https://documentation.sas.com/doc/en/pgmsascdc/9.4_3.3/statug/statug_cluster_details01.htm#statug_cluster001089 (Accessed 20 May 2022).
- SPO (2001). Sekizinci Beş Yıllık Kalkınma Planı Hayvancılık Özel İhtisas Komisyonu Raporu (Subcommission report for air transport prior to 6th five-years development plan), State Planning Organisation, 2547-ÖİK:587, Ankara. In Turkish.
- Springmann, M., Clark, M., Mason-D’croz, D., Wiebe, K., Bodirsky, B.L., Lassaletta, L., De Vries, W., Vermeulen, S.J., Herrero, M., Carlson, K.M., Jonell, M., Troell, M., Declerck, F., Gordon, L.J., Zurayk, R., Scarborough, P., Rayner, M., Loken, B., Fanzo, J., Godfray, H.C.J., Tilman, D., Rockström, J., and Willett, W. (2018). Options for keeping the food system within environmental limits. *Nature*, 562(7728): 519–525.
- STATBEL (2022). Supply balance sheets for meat. Available at: https://statbel.fgov.be/sites/default/files/files/documents/landbouw/8.8%20Bevoorradingbalansen/delmeat_en.xls (Accessed 10 May 2022).
- Thies, A.J., Efken, J., and Sönnichsen, M. (2022) How much meat do we eat? Estimating per capita meat consumption in Germany based on a market balance approach. *The German Journal of Agricultural Economics*. 71(2): 76–91.
- TurkStat (2022a). Methodological document of the revision for red meat production statistics. Available at: <https://data.tuik.gov.tr/Bulten/Index?p=Red-Meat-Production-Statistics-2020-2021-45671> (Accessed 31 May 2022).
- TurkStat (2022b). Gross domestic product per capita, 1998-2021, Available at: <https://data.tuik.gov.tr/Bulten/DownloadIstatistikselTablo?p=Jv6Z89yLDbfiU8akxk1vnstvligOmfx3zL8Gvcnk/yujODYR10jrTdlolHesMzEU> (Accessed 14 December 2022).
- Turkmenoglu, A. (2010). *Hayvansal üretim tahmin modeli geliştirilmesi ve idari kayıtlarla karşılaştırılması. (Development of animal production estimation models and comparison with administrative records)*, Turkish Statistical Institute Expertness Thesis. TurkStat, Ankara.



- Uluat, S. (2002). *Van ili Merkez ilçede hayvansal gıda tüketim yapısı. (Consumption pattern of animal products in Centre District of Van Province)*. Cukurova University Graduate School of Natural and Applied Sciences, Ph.D. Thesis, Adana. In Turkish.
- Yavuz, F. and Zulauf, C.R. (2004). Introducing a new approach to estimating red meat production in Turkey. *The Turkish Journal of Veterinary and Animal Sciences*, 28(4): 641–648.
- Yavuz, F., Keskin, A., and Aksoy, A. (2006). A comparative analysis of Turkey's red meat statistics and related research results. Proceedings of 15th Statistics Research Symposium, TurkStat, 11–12 May, Ankara.

