

MARKET TRENDS IN MEAT AND MEAT PRODUCT PRICES: ANALYZING THE COST PRICE OF ENERGY VALUE IN MEAT PRODUCTS

TRENDОВИ ПРОМЕНА ТРЖИШНИХ ЦЕНА МЕСА I ПРОИЗВОДА OD МЕСА: ISPITIVANJE CENE KOŠTANJA ENERGETSKE VREDNOSTI PROIZVOVA OD МЕСА

Tamara Stamenić, research assistant ^{1*}

Maja Petričević, research associate ²

Tanja Keškić, research associate ³

Boris Pisinov, research associate ⁴

Ljiljana Samolovac, senior research associate ⁵

Zoran Sekulić, PhD - environmental protection engineer ⁶

Andrijana Milošević Georgiev, Assistant Professor ⁷

Abstract: *This study provides an overview of food prices in the Republic of Serbia from 2016 to 2023 amidst the challenges faced by the meat processing industry. Household spending trends reveal a notable shift, marking an increase since 2016. The study explores meat products' affordability and nutrient density, challenging conventional assumptions. Mortadella emerges as the most nutrient-dense despite its lower calorie content due to high protein content, while pâté commands a higher market price despite its lower nutrient quality.*

Key words: price trends, meat processing industry, nutrient density, energy density

Apstrakt: *Studijom je obuhvaćen pregled cena hrane u Republici Srbiji od 2016. do 2023. godine i uticaj izazova sa kojima se suočava mesna industrija. Trendovi potrošnje domaćinstava otkrivaju promenu, označavajući porast u odnosu na 2016. Studija istražuje pristupačnost mesnih proizvoda i gustinu nutrijenata, dovodeći u pitanje konvencionalne pretpostavke. Mortadela se izdvaja kao namirnica sa najboljim odnosom cene u odnosu na nutrijente uprkos nižem sadržaju kalorija usled visokog sadržaja proteina, dok pašteta ima višu tržišnu cenu uprkos nižem kvalitetu hranljivih materija.*

Ključne reči: trendovi cena, industrija prerade mesa, gustina hranljivih materija, gustina energije

¹ Institute for Animal Husbandry, Autoput Beograd – Zagreb 16, 11080 Belgrade, Serbia, e-mail: tstamenic@istocar.bg.ac.rs, (*Corresponding author)

² Institute for Animal Husbandry, Autoput Beograd – Zagreb 16, 11080 Belgrade, Serbia, e-mail: mpetricevic@istocar.bg.ac.rs

³ Institute for Animal Husbandry, Autoput Beograd – Zagreb 16, 11080 Belgrade, Serbia, e-mail: tkeskic@istocar.bg.ac.rs

⁴ Institute for Plant Protection and Environment, Teodora Drajzera 9, 11040 Belgrade, Serbia, e-mail: boriss752002@yahoo.com

⁵ Institute for Animal Husbandry, Autoput Beograd – Zagreb 16, 11080 Belgrade, Serbia, e-mail: ljsamolovac@istocar.bg.ac.rs

⁶ Institute of Public Health of Belgrade, Bulevar Despota Stefana 54a, 11108 Belgrade, Serbia, e-mail: zoran.sekulic@zdravlje.org.rs

⁷ Faculty of Pharmacy, University of Belgrade, Vojvode Stepe 450, 11221 Belgrade, Serbia, e-mail: andrijana.milosevic@pharmacy.bg.ac.rs

1. INTRODUCTION

While the global community is in the process of recovering from the impact of the recent pandemic COVID-19, this rebound is taking place unevenly both among and within countries. Compounding these challenges, the world is currently contending with the ramifications of the ongoing conflict in Ukraine, causing significant disruptions in food price markets. Agricultural and food systems continue to be highly susceptible to shocks and disturbances stemming from conflicts, on and off going animal diseases, and economic downturns [1]. As urbanization and incomes continue to rise, households typically consume larger and more varied amounts of food. This includes dairy, fish, meat, legumes, fresh fruits and vegetables, along with an uptick in the consumption of processed foods [2,3]. This, coupled with population growth, signals significant escalations in the production and supply of specific food types to meet the heightened demand.

A confluence of factors, including elevated feed prices, diseases, and surging global demand, has led to unprecedented increases in the prices of beef and pork, thereby impacting the prices of meat and meat products in the Republic of Serbia's market as well.

Researchers exploring the relationship between nutrient density and the monetary cost of foods require access to comprehensive data on both nutrient composition and pricing. Dietary energy density [4] has also been employed as a metric for assessing diet quality. An analysis that linked fifty food prices to dietary survey data from the Val de Marne study [4,5] demonstrated that higher-quality diets were linked to increased energy-adjusted diet costs [4].

Several studies have consistently shown that specific food and nutrient intakes are inversely correlated with energy-adjusted diet costs. Diets rich in energy-dense foods (kcal/100 g), often characterized by higher sugar and fat content (typically considered more affordable raw materials), tend to have lower diet costs per 100 kcal. This pattern is often a result of compensating for the lack of nutrient-rich components such as animal-source proteins, vegetables, or fruits [4,6].

This research aimed to provide an overview of the present condition of food prices on the market of the Republic of Serbia, particularly those related to meat and meat products, concerning consumer income and inflation levels spanning from 2016 to 2023. Additionally, the study sought to reassess the current market prices of chosen meat products through comparative metrics for food costs. It also aimed to examine cost-to-energy ratios and protein-to-fat ratios to ascertain whether nutrient-dense meat products are appropriately priced.

2. MATERIAL AND METHODS

The paper is divided into two sections: the first involves data collection and subsequent discussion, focusing on average household budgets, yearly net salary growth, and expenditures on food and beverages. Special attention is given to meat and meat products, along with tracking the inflation rate of these products in relation to the average net salary growth. The second section utilizes surveys to delve into the prices of commonly available processed meat products in the market. It involves calculating their average price, as well as their average energy, protein, and fat content. Ratios of different nutrients, such as protein and fat, compared to overall energy, are also computed. Additionally, in the paper we calculated the price (in EUR) compared to the energy content of these products.

We conducted a literature search using data from the Statistical Office of the Republic of Serbia, including Household Budget Surveys spanning 2016 to 2023. Additionally, direct communication with support services was utilized. Our aim was to gather information on average household size, net income (excluding non-monetary income), prices of selected meat varieties and processed meat

products, and meat consumption per household for the period of 2016-2022, considering both urban and rural regions.

A formal inquiry was made to the Statistical Office of the Republic of Serbia to obtain data on the inflation rate of meat and processed meat products. Calculations for meat and meat product consumption per capita were derived from the average household size and the household consumption data. Monthly household income and budgets allocated for food and beverages, meat (poultry, pork, beef), and processed meat products were converted to euros using a conversion rate of 1 EUR = 118 RSD (Serbian Dinar).

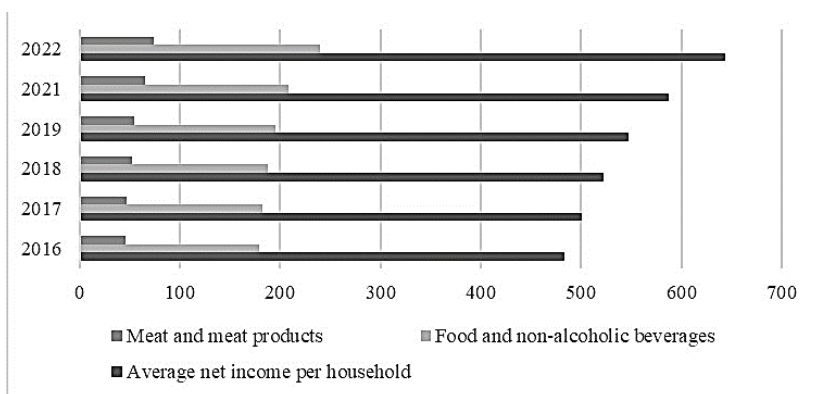
Meat product retail prices and nutrient composition information were sourced from supermarkets and the Internet. Researchers adhered to a pricing protocol, obtaining prices from at least two supermarket or hypermarket chains (or their websites) and calculating the average price for each item. Family-sized packaging was prioritized when making selections. In cases where prices were sourced from a food cost survey conducted from the market, the average price (weighted mean by quantities bought) was determined. The prices of the products were selected to accurately reflect the current pricing landscape (data was collected over a 7-day period at the beginning of January 2024, considering only the full prices of the products).

Nutrient composition data provided by manufacturers allowed us to calculate each item's energy value (kcal/100g) [7]. The energy value, protein-fat ratio, the purchase price (converted to euros from the domestic currency), and the energy cost for selected items were then expressed for the chosen meat products [6].

3. RESULTS AND DISCUSSION

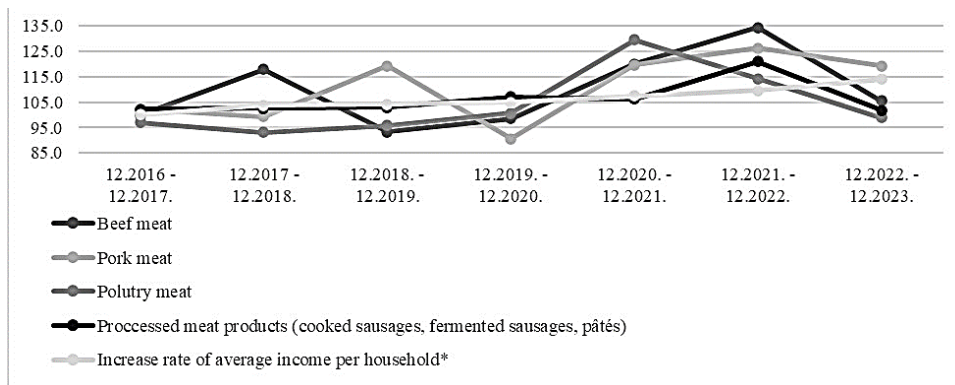
Household Spending on Meat Products and the Impact of Global Dynamics on the Meat Processing Industry

In order to gain a better insight into average annual expenditure on food and beverages, particularly the allocation of meat and processed meat products concerning the annual average wage, we searched through the existing datasets offered by the Statistical Office of the Republic of Serbia. While many studies on household expenditure patterns tend to concentrate on broader categories of goods [6,8,9], often treating food and beverages as a single aggregate class marked at a status of necessary goods, a limited number of studies have undertaken a more detailed examination of food consumption. Graph 1 presents the average monthly spending per household compared to net income (EUR). The data used are the 2016-2023 Household Budget Survey for the Republic of Serbia, covering 37645 households over a 7-year period (except for 2020, which was skipped due to the COVID-19 pandemic). The primary benefit of utilizing these methods over individual diet and nutritional data lies in the fact that individuals are queried about their purchases rather than directly about their eating habits. This approach makes the interview process feel less intrusive, reducing the likelihood of individuals providing inaccurate information intentionally [10].



Graph 1. Average monthly spending per household compared to average net income (EUR)

We displayed the price trends, represented as the inflation rate (% change/year) from 2016 to 2023 for meat and processed meat products (we considered the cumulative price trend for all processed meat products, encompassing fermented and cooked sausages, as well as pâtés), concerning the annual growth in income (refer to Graph 2). Additionally, our analysis incorporated the prices of poultry, pork, and beef meat, given their significance as primary components of the meat processing industry. In the Republic of Serbia, households allocated more than a third of their disposable income (36%) to food and beverages in the past year, marking an increase compared to 2016, when this expenditure was almost 2% lower.



Graph 2. Inflation rate of the goods compared to income net growth

Our analysis showed that in the years preceding pandemic, specifically from 2016 to 2019, the average monthly consumption per household (inclusive of both urban and rural areas) showed a 2% decrease when compared to the post-COVID-19 period.

As reported by FAO [11], the outbreak of African swine fever began affecting Asian countries in late 2018 and persisted through 2019 and 2020. This significantly contributed to a substantial decline in global pig meat production between 2018 and 2019, particularly impacting China, and continued to impede production in 2020 and 2021 across Europe. However, there was a resurgence in pig meat production in late 2021, leading to a robust increase in global meat production.

In the Republic of Serbia, despite the initial detection of African swine fever in late 2019 along the borders with Romania and Bulgaria within the wild boar population, a substantial 1637 outbreaks in domestic pigs were reported from September 2020 to August 2021 [12]. This situation triggered widespread slaughters across the county, significantly impacting the overall prices of pork meat. Notably, there was a significant surge in prices of pork, with inflation rates reaching 119.7% and 126.3% in mid-2020 and 2022, respectively. Given that pork meat is a primary raw material used in the meat processing industry (along with poultry meat), the prices of meat products followed this spike with a +121% inflation rate within the period of December 2021 to December 2022. This marks a notable increase compared to the previous year when the inflation rate stood at 106% (Graph 2).

Meanwhile, the beef industry in the EU faced mounting challenges related to campaigns advocating for a reduction in red meat consumption, linking red/beef meat with environmental protection, and highlighting its negative impact on climate change. Over the past two decades, there has been a noticeable trend of a continuous decline in the number of cattle [13], reaching its lowest level in 2021 [14]. In contrast, chicken meat production experienced the most significant growth since 2000 and became the most produced type of meat in 2021, according to FAO [11].

The FAO Food Price Index, which monitors monthly fluctuations in the international prices of globally-traded food commodities, recorded its highest value ever between May 2020 and March 2022 [15]. This surge was attributed to a combination of factors, including the repercussions of the COVID-19 pandemic on supply chains, the resurgence in activity and demand experienced in 2021, and disruptions to exports from the Russian Federation and Ukraine (major suppliers of crops used for animal feed) [11]. These global shifts have significantly influenced the meat processing industry, as the prices of meat products continue to mirror the fluctuations in prices in relation to the accessibility of meat (Graph 2).

Coalescing meat product prices with nutrient composition data – the current state of the market

The data on expenditure of food purchased for 256 meat products was recorded (Table 1). We estimated the affordability of processed meat products by energy density and nutrient quality. Assessing the financial impact of meat products based on retail prices, whether local or national, may not always paint dietary trends or health implications. For instance, the decrease in particular food prices in Brazil [8] and Mexico [9] has been associated with an increase in obesity rates and different cardiometabolic diseases. However, a decline has mainly been observed in the prices of energy-dense, less healthy, items such as sweetened beverages and sweetened grains [9]. In contrast, the prices of fresh meat continue to rise [8, 9]. In France, vegetable prices have surged, while dietary fat prices have declined [6]. Conversely, our research in Serbia revealed a significant spike in meat prices, while the average cost of animal fat remained stagnant over the study period, accompanied by a minimal inflation rate (+100.8%) compared to 2016 (data not presented in this paper).

Comparative metrics for food costs have been established based on energy and nutrient content per 100g of the edible portion. Table 1 illustrates the energy density (in kcal/100g), the price (EUR/100g), and the energy cost (EUR/100kcal) of selected meat products commonly available in Serbian retail stores. Given the economic significance of achieving 2000 kcal/ day at a reasonable cost, the preferred strategy for comparing food prices is per calorie rather than per serving or unit weight [6].

Generally, studies have shown that the average price per 100 kcal for ultra-processed foods such as some grains, fats, and sweets are linked to lower per-calorie food costs, whereas animal-sourced

proteins, some meat products, fruits, and vegetables (processed foods and unprocessed/minimally processed foods) tend to have higher per-calorie food costs [6, 16].

Table 1. Analysis of average energy content, protein to fat ratio, fat to energy and protein to energy value ratio, purchase price, and cost of energy for selected meat products in the Serbian market.

Name of the product (sample size, N)	Energy value (kcal/100g)	Protein/Fat ratio	Fat to energy value ratio	Protein to energy value ratio	Purchase price (EUR/100 g)	Cost of energy (EUR/100 kcal)
Dry-fermented sausages						
Čajna sausage, N=10	430	6.78	76.1	20.6	1.64	0.42
Kulen sausage, N=11	432	6.66	78.6	20.9	1.57	0.48
Sucuk sausage, N=4	394	8.16	73.1	23.9	2.05	0.52
Salami sausage*, N=27	422	6.93	77.5	21.5	1.90	0.45
Emulsion-type cooked sausages						
Hot dogs*, N=46	286	5.55	79.7	17.7	0.75	0.26
Mortadella, N=11	241	7.89	71.0	22.4	1.20	0.50
Parizer*, N=39	201	6.50	87.4	22.7	0.56	0.28
Alpska sausage*, N=18	236	7.28	73.9	21.5	0.65	0.27
Grill sausage*, N=43	284	6.49	76.6	19.9	0.99	0.35
Boiled sausages						
Pâté (* all categories) N=47	290	4.16	82.4	13.7	1.12	0.39

Products labeled with * correspond to categories categorized as "under a different name" according to the Rulebook [17].

Studies on the relative cost of energy-dense versus nutrient-dense foods heavily rely on accurate metrics of nutrient density. Recent advances in nutrient profiling techniques have allowed for a more objective assessment of the nutritional value of different foods [6, 18, 19]. Foods can be ranked or rated based on their nutrient content relative to calories. Numerous studies based on databases have consistently shown that higher nutrient density scores are directly associated with higher per-calorie costs. In essence, more nutrient-rich foods tend to be more expensive per kcal than foods with lower nutritional value [6, 18].

Similarly, our research has identified consistent patterns—specifically, the cost of energy (EUR/100 kcal) aligning with trends observed in the calculated protein-to-fat ratio and the energy value (kcal/100g) of meat products. Dry-fermented sausages, in particular, exhibited a higher cost of energy, nearly doubling the energy value compared to other groups, except for Mortadella. Despite its lower calorie content per 100 g, Mortadella exhibited a higher cost of energy, potentially attributable to its elevated protein-to-fat ratio—ranking highest among all the groups. Hence, it could be regarded as the most nutrient-dense food among the groups under study. Furthermore, the purchase price followed a similar trend, with one notable exception and irregularity observed in the pâté category. The cost of energy and, consequently, the purchase price per 100 g were assessed as exceptionally high for pâté based on its energy value and the protein-to-fat ratio, which was the

lowest among the groups. This irregularity in pricing may be attributed to the cost of packaging (typically canned, as opposed to other meat products considered in this research, which are usually packaged in natural or plastic casings that are more cost-effective), a factor not accounted for when calculating the final price-to-energy ratio.

4. CONCLUSION

The findings underscore the complex interplay between global events and market dynamics. This study elucidates the nuanced landscape of food prices in the Republic of Serbia from 2016 to 2023, as well as intricate challenges for the meat processing industry. Navigating the impacts of the uneven recovery from pandemic and the ongoing conflict in Ukraine on global food markets, environmental concerns, and African swine fever outbreak that has led to surging meat prices with rise of inflation rates. Household spending patterns reveal a notable shift, with 36% of disposable income directed toward food and beverages in the past year, signaling a significant increase since 2016.

Moreover, the study delved into meat products' affordability and nutrient density, utilizing metrics such as energy density, protein-to-fat ratio, and cost-to-energy ratios. Findings challenge conventional assumptions, and raise some questions about pricing of certain meat products on the market.

As we navigate these complexities, understanding the nuanced relationship between nutrient density and the cost of food becomes pivotal for informed policy decisions and consumer education. According to the authors' knowledge, surveys on consumers' motivations for purchasing meat and meat products, along with insights into the factors influencing their food choices in the Republic of Serbia, are yet to be conducted. Therefore, this research offers a foundation for future studies and policy considerations in the ever-evolving meat processing industry.

5. ACKNOWLEDGMENT

This research was funded by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, on the basis of the Agreement on the realization and financing of scientific research work of SRO No. 451-03-47/2023- 01/200022.

REFERENCES

- [1] FAO, IFAD, UNICEF, WFP, and WHO, (2023), *The State of Food Security and Nutrition in the World 2023, Urbanization, agrifood systems transformation and healthy diets across the rural–urban continuum*, FAO, pp. 18-20
- [2] Abay, K. A., Tiberti, L., Woldemichael, A., Mezgebo, T. G., Endale, M., (2023), *Can Urbanisation Improve Household Welfare? Evidence From Ethiopia*, *Journal of African Economies*, 32(1), pp. 81-109.
- [3] van Zutphen, K. G., Barjolle, D., van den Berg, S., Gavin-Smith, B., Kraemer, K., Musard, C., Prytherch, H. Woltering, K., (2023), *Secondary cities as catalysts for nutritious diets in low-and middle-income countries*, *Science and Innovations for Food Systems Transformation*, pp. 305-316.
- [4] Darmon, N., Briend, A., Drewnowski, A., (2004), *Energy-dense diets are associated with lower diet costs: a community study of French adults*, *Public health nutrition*, 7(1), pp. 21-27.
- [5] Drewnowski, A., Darmon, N., Briend, A., (2004), *Replacing fats and sweets with vegetables and fruits—a question of cost*, *American journal of public health*, 94(9), pp. 1555-1559.
- [6] Darmon, N., Drewnowski, A., (2015), *Contribution of food prices and diet cost to*

- socioeconomic disparities in diet quality and health: a systematic review and analysis, *Nutrition reviews*, 73(10), pp. 643-660.
- [7] European Parliament and Council. Regulation (EU) No. 1169/2011 of the European Parliament and of the Council of 25 October 2011 on the provision of food information to consumers, *Official Journal of European Union*, 2011, L304, pp. 18–63.
- [8] Mello, A. V. D., Sarti, F. M., Fisberg, R. M. (2022), Associations among diet costs, food prices and income: Elasticities of risk and protection food groups for cardiometabolic diseases in Sao Paulo, Brazil (2003–2015), *Nutrition and Health*, 02601060221104579.
- [9] Batis, C., Gatica-Domínguez, G., Marrón-Ponce, J. A., Colchero, M. A., Rivera, J. A., Barquera, S., Stern, D., (2022), Price trends of healthy and less healthy foods and beverages in Mexico from 2011–2018, *Journal of the Academy of Nutrition and Dietetics*, 122(2), pp. 309-319.
- [10] De Agostini, P. (2014), The effect of food prices and household income on the British diet, *ISER Working Paper Series No. 2014-10*
- [11] FAO, (2023), *World Food and Agriculture-Statistical Yearbook 2023*, FAO, Rome, pp.16-17
- [12] Prodanov-Radulović, J., Mirčeta, J., Djurdjević, B., Lazić, S., Aleksić-Kovačević, S., Petrović, J., Polaček, V., (2023), African Swine Fever Outbreak in an Enclosed Wild Boar Hunting Ground in Serbia, *Pathogens*, 12(5), 691.
- [13] Kučević, D., Brka, M., Plavšić, M., Čobanović, K., Papović, T., Gantner, V., (2023), Organic beef production as a sustainable solution for the EU market: A case study of the Republic of Serbia, *Biotechnology in Animal Husbandry*, 39(1), pp. 1-14.
- [14] EUROSTAT (2021): *Organic Farming Statistics*. Available at: https://ec.europa.eu/eurostat/statisticsexplained/index.php?title=Organic_farming_statistics#Organic_production (assessed on 29.12.2023.)
- [15] FAO, (2023), *FAO Food Price Index*, FAO, Rome.
- [16] Vandevijvere, S., Pedroni, C., De Ridder, K., Castetbon, K., (2020), The cost of diets according to their caloric share of ultraprocessed and minimally processed foods in Belgium, *Nutrients*, 12(9), 2787.
- [17] Rulebook on minced meat, semi-finished, and meat products ("Official Gazette RS", No. 50/2019 and 34/2023).
- [18] Mailliot, M., Darmon, N., Darmon, M., Lafay, L., Drewnowski, A., (2007), Nutrient-dense food groups have high energy costs: an econometric approach to nutrient profiling, *The Journal of nutrition*, 137(7), pp.1815-1820.
- [19] Drewnowski, A., Dwyer, J., King, J. C., Weaver, C. M., (2019), A proposed nutrient density score that includes food groups and nutrients to better align with dietary guidance. *Nutrition reviews*, 77(6), pp. 404-416.