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WASTE MANAGEMENT IN BROILER INDUSTRY, BULGARIA

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Abstract

Under the current global policies for sustainable development, agriculture and animal husbandry are among the sectors which need to shift their production concepts towards more efficient, eco-friendly and smart technologies. Poultry farming is currently the most rapidly growing agricultural industry. This sector aims at stable economic growth combined with environmental safety which is an opportunity to introduce a transition of the business from the traditional linear model to circular economy. The present study focuses on the aspects of poultry waste management which sees waste as a resource for utilization. We discuss the main principles of circular economy in the view of a real-life example from one of the intensive poultry-breeding industries in Bulgaria which had implemented practices for waste-to-energy solutions.

Key words**:** *poultry, waste, circular economy*

INTRODUCTION

The current development of global economy encourages processes related to adding value to waste, by-products and resource flows. The recycling of materials is strongly integrated in the initiatives along the entire life cycle of products and promoted by the European Green Deal and the Circular Economy Action Plan [29] with the aim to offer innovative solutions to an improved resource management. As one of the primary goals of EU is to be a climate-neutral and resource-efficient economy by 2050, member states are expected to develop more sustainable practices using the raw materials and energy potential of waste in ways that are economical and environmentally acceptable [2].

Local societies are encouraged to introduce systems where "the value of products, materials and resources is retained in the economy for as long as possible and the generation of waste is minimized" [6]. In order to implement the circular economy principles into practice, the waste management should change the understanding of wastes and see them as resources utilized through innovative recycling and treatment techniques [10].

The perceived benefits from such development could result in cost savings, resource conservation, brand reputation of the operators, business sustainability [30]. Agriculture and animal husbandry are among the sectors that generate waste at a large scale, thus these sectors are in urgent need to form strategies and implement circular economy in order to solve the environmental, social and economic concerns of unsustainable waste management. As [14] proposed agricultural waste could be used as a source of fertilizers for crop production and biogas production as renewable energy. Biogas installations offer the farmers a viable waste treatment solution for conversion of organic waste into energy [6], beneficial not only for the rural communities but for the industrial enterprises as well. Although the current legislation promotes implementation of such methods in the agricultural business that generates most of the livestock waste like poultry industry, some operators continue to work in linear economy mode [16]. However, some prospective poultry enterprises had partially turned to circular practices [24] and joint biofuel projects with other stakeholders [2, 28]. Better understanding and exploration of the model offered by circular economy for the purpose of waste pollution management from livestock and poultry could be enhanced further through digitalization and simulation among the stakeholders [32].

In this context, the study aimed to analyze the aspects of poultry waste management so that waste to be reutilized as a resource for producing renewable energy.

MATERIALS AND METHODS

The study focused on the operation and performance of one of the large-scale industrial poultry enterprises established in Bulgaria. After collection of raw data on the outputs from the production chain in 2023, we processed the data and analysed them with regard to the current development of poultry production in the country and abroad, in particular poultry waste management. Several main categories of waste were defined and their rates for 2023 were presented in one table and two diagrams. The techniques introduced by the enterprise for recycling or re-use of some of the poultry waste were discussed in the light of the principles of circular economy. In order to gain insights into the main directions of the circular economy we studied the relevant legislative framework and official reports from the European Commission.

RESULTS AND DISCUSSIONS

According to the data available there is an increase in the poultry meat production in the EU estimated to 15.2 million tons in total in 2018 which is approximately a quarter higher than the production in 2010 [8]. The increasing demand and level of production in the rapidly developing poultry sector [3] at global level is fully reflected in the poultry production in Bulgaria as well, evident from the data reported by the Ministry of Agriculture – from 71,138 tons meat in 2015 to 113,094.2 tons in 2020 and 120,000 tons in 2022 [17, 18]. This increase in the poultry meat production in the country accounted for about 59% rise for the period 2015-2022 and respectively led to increase of the waste that is a big share in the intensive poultry breeding. In the poultry enterprise that appeared as an object of our study in 2023, the broiler production accounted for 9,631,087.704 kg (carcass weight) from which 6,934,383.147 kg were poultry meat and 2,696,704.557 kg were slaughterhouse waste or 28% of the production (Table 1).

There was another category of waste produced related to broilers that died during transportation to the slaughterhouse – 2,450.296 kg or 0.025% if compared to the carcass weight.

Table 1. Poultry production in the studied intensive breeding industrial enterprise in Bulgaria, 2023

Premises	Broilers unfit or died during transportation		Broiler production (carcass weight)		Slaughterhouse waste, kg	Poultry meat, kg
	kg	Number	kg	Number		
1	375.454	171	1,495,390.546	708,396	418,709.3529	1,076,681.193
2	376.653	176	1,502,107.347	720,912	420,590.0572	1,081,517.29
3	405.803	197	1,464,299.197	717,917	410,003.7752	1,054,295.422
4	392.727	185	1,743,280.273	847,803	488,118.4764	1,255,161.797
5	486.689	223	2,066,096.311	997,573	578,506.9671	1,487,589.344
6	412.97	191	1,359,914.03	645,588	380,775.9284	979,138.1016
Total	**2,450.296**	**967**	**9,631,087.704**	**3,920,272**	**2,696,704.557**	**6,934,383.147**

Source: Authors` data from the survey.

The intensive production provided poultry meat on the market which compared to the all other meat (carcass weight) was over 50% in Bulgaria and at the same time chicken accounted for the highest share of poultry meat [9]. There were deviations in the poultry production in the last years, mostly due to the constant outbreaks of Highly Pathogenic Avian Influenza (HPAI) leading to killing and destroying the birds for disease control purposes, but in 2023 the EU poultry production quickly recovered [7].

In the common linear economy, the take-make-dispose approach [23] maintained a constant outflow of output at the end of the production chain, thus materials seen as waste were usually disposed. Currently, a new legal framework is in place within the European

Union that regulates waste management and encourages transition to circular economy with using the waste as secondary raw materials for recycling [31]. In agriculture, "livestock waste" as defined includes animal excrement, bedding, water, soil, hair, feathers or other waste resulting from the processing of animal products [22]. In our study, the abattoir waste together with the broilers died during transportation (mortality waste) fall into this category and were subjected to further inclusion in activities that lead to partial transition to circular practices. The mentioned waste after slaughtering was collected and delivered to another facility for processing as raw materials and food for other animal species. This practice appeared in line with the parts of the 6R concept of reducing, reusing, recycling, repurposing, remanufacturing and rethinking [23] which for the studied poultry enterprise led to sustainable performance, lessening the negative effect on the environment and economic profits. Abattoir waste was studied profoundly for the risk it posed to the public and animal health being a hub of pathogens and the solid waste exposure in terms of air, water, and soil pollution and the associated health challenges that could arise due to improper solid waste management practices [20].

Poultry waste appeared to be a major problem to the poultry industry due to its large-scale accumulation [3]. In fact, poultry waste could be divided into several categories in order to find more efficient and sustainable ways of its management - litter and manure waste, feather waste, mortality waste, abattoir waste, and hatchery waste [33]. In our study, the amount of litter and manure waste for 2023 was 3,975,660 kg in total and the amount varied through the months and seasons (Fig. 1). The reasons for the variations were predominantly related to the production process planning as a whole and issues like density of bird population (capacity, disease control measures and depopulation, biosecurity, etc.).

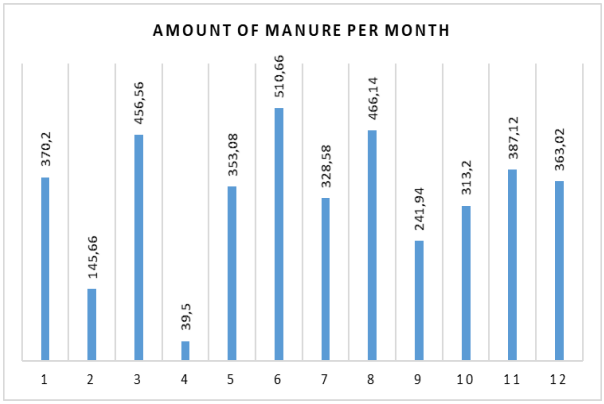

Fig. 1. Monthly produced litter and manure waste in kg from the studied industrial poultry enterprise, 2023
Source: Authors` data from the survey

Techniques for waste management were found to be dependent on many factors and as [15] stated the specialization in one or few industries of an administrative region in the country usually defined the type of waste there – industrial, municipal, agricultural and the common waste management issues like accumulation of large quantities of waste. Poultry industry, generating "livestock waste" in great amounts, usually implements several techniques for its disposal - composting of poultry manure to obtain fertilizers and soil improvers, anaerobic digestion of poultry manure for energy recovery [12], and also pyrolysis of poultry manure into different types of biochar that can be applied in agriculture, horticulture and industry [5]. Some of the mentioned common techniques were proven to be useful for sustainable poultry waste management with focus on the carbon, nitrogen and phosphorus cycles and subsequent "matter recovery" [11]. The poultry enterprise in our study had previously fully operated into linear economy model and used to subject the manure to composting. With its partial transition to circular economy practices, the enterprise currently included the manure into a production line for biofuel, thus contributing to energy recovery. Such practices, according to [33] should be further encouraged among the stakeholders with the support of the policymakers through waste-to-wealth projects in the regions. Biofuel production appeared as one of the highly environmental and economic sustainable projects with this regard [2] to produce value-added products from agricultural residues and

food processing side streams through integrated approach [11].

Another category of poultry waste that should be strictly regulated is the share of birds that died during the process of their growing on the farm (Fig. 2). The mortality waste generated in the poultry enterprise in the study accounted to 159,030.7 kg for 2023. As the enterprise had not fully made its transition to circular economy, the approach to dispose the mortality waste was through incineration. It was considered a valid approach as this method was also used to prevent environmental contamination and public and animal health threats due to bacteria and viruses [1].

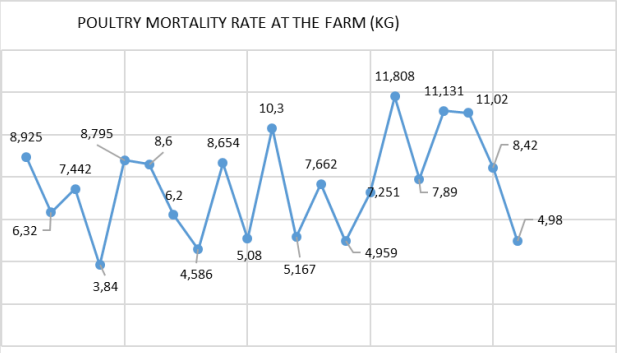

Fig. 2. Mortality waste in kg produced at the studied industrial poultry enterprise, 2023 (carcasses were collected more than once a month)
Source: Authors` data from the survey.

However, carcass incineration in animal husbandry was considered potentially harmful as many pollutants from poultry incineration caused environmental issues [19] contamination of air, soil and water; social concerns related to odor; economic constraints related to the alarming increase in the costs of raw materials like: kerosene, diesel and wood for burning and the labor cost [1]. Moreover, a lot of research had documented detrimental effects of incinerators on the public health resulting in cancer, cardio-cerebrovascular diseases and respiratory diseases, pregnancy outcomes and congenital anomalies [25, 21]. While [26] argued that newer incinerator technologies might reduce exposure of pollutants to public health, there were other traditional techniques of carcass disposal like composting that could overcome some of the concerns [4], especially the infectious threats and environmental contamination. The poultry enterprise in the study had previously applied the composting method regarding waste management but temporarily, only in cases of HPAI outbreaks. A way to turn towards more sustainable practices was offered by [13] through hydrothermal treatment of carcasses and processing of chicken bones into valuable by-products rich in calcium and phosphorus and later re-used.

CONCLUSIONS

The production of poultry meat worldwide had increased in the last decade and with this the amount of waste from the poultry industry had multiplied. The traditional techniques for waste management in linear economy include composting of poultry manure to obtain fertilizers and soil improvers, anaerobic digestion and also pyrolysis. In these models the waste is usually disposed and a lot of environmental, health and economic issues arise.

In order to improve and maintain sustainability, one of the industrial poultry enterprises in Bulgaria had adopted some practices that view waste as a resource for reusing, recycling, repurposing and rethinking in the production cycle. The studied enterprise had partially introduced circular economy techniques with regard to the manure waste management and abattoir waste management that showed good results across economic, social and ecological dimensions. Further transition to circular economy is needed with the support of policymakers, governmental bodies and other stakeholders in order to create incentives to operators who produce value-added products from agricultural waste.

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REFERENCES

[1]Baba, I.A., Banday, M.T., Khan, A.A., Khan, H.M., Nighat, N., 2017, Traditional methods of carcass

disposal: a review. J Dairy Vet Anim Res. 5(1):21-27. DOI: 10.15406/jdvar.2017.05.00128

[2]Bandh, S. A., Malla, F. A. (eds.)., 2024, Waste Management in the Circular Economy. Springer International Publishing.

[3]Bolan, N.S., Szogi, A.A., Chuasavathi,T., Seshadri, B., Rothrock Jr., M.J., Panneerselvam, P., 2010, Uses and management of poultry litter, World's Poultry Science Journal, 66:4, 673-698, DOI: 10.1017/S0043933910000656)

[4]Costa, T., Akdeniz, N., 2019, A review of the animal disease outbreaks and biosecure animal mortality composting systems. Waste Management, Vol. 90, pp. 121-131,https://doi.org/10.1016/j.wasman.2019.04.047.

[5]Dróżdż, D., Wystalska, K., Malińska, K., Grosser, A., Grobelak, A., Kacprzak, M., 2020, Management of poultry manure in Poland – Current state and future perspectives. Journal of Environmental Management, 264(5):110327.
https://doi.org/10.1016/j.jenvman.2020.110327.

[6]European Commission, Directorate-General for Agriculture and Rural Development. Di Federico, E.(editor). 2019, Bioeconomy and environmental sustainability. In: Bioeconomy, p 20. Publications Office of the European Union, 2019, https://data.europa.eu/doi/10.2762/830078, Accessed on 25 Feb. 2024.

[7]European Commission-EC, DG Agriculture and Rural Development, 2023, Short-term outlook Autumn 2023 – Meat Products. https://agriculture.ec.europa.eu/system/files/2023-10/short-term-outlook-autumn-2023-chapter-meat-products_en.pdf, Accessed on 25th Feb 2024

[8]Eurostat, 2019, Poultry meat production in EU at new high in 2018. https://ec.europa.eu/eurostat/en/web/products-eurostat-news/-/ddn-20190325-1 Accessed on 24th Feb 2024

[9]Eurostat, 2021, Poultry Statistics. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Poultry_statistics#Poultryme Accessed on 25th Feb 2024

[10]Guman, O., Wegner-Kozlova, E., 2020, Waste management based on circular economy principles. E3S Web of Conferences 177, 04014. https://doi.org/10.1051/e3sconf/202017704014

[11]Kacprzak, M. J., Sobik-Szołtysek, J., 2022, The poka-rock in N and P of poultry manure management according to circular economy. Journal of Environmental Management, 316(14):115262

[12]Kacprzak, M., Malińska, K., Grosser, A., Sobik-Szołtysek, J., Wystalska, K., Dróżdż, D., Jasińska, A., Meers, E., 2023, Cycles of carbon, nitrogen and phosphorus in poultry manure management technologies – environmental aspects. Critical Reviews in Environmental Science and Technology, 53:8, 914-938, DOI: 10.1080/10643389.2022.2096983

[13]Keerthika, P., Kevin, F., Lakshmi Sruthi, L., Lavanya, M., Bhavadharani, M, Baskaran, N., Vignesh, S., 2023, Emerging Food and Bioscience Research on Human Health: Safety, Security and Sustainable Aspects. In S. Vignesh, Baskaran, N., Loganthan, M (Ed.), A Review on Valorisation of Food Scraps and Derivatives: Skyfox Publishing Group. https://doi.org/10.22573/spg.023.978-93-90357-85-7/7

[14]Kononenko, L., Sysolina, I., Sysolina, N., 2023, Formation of a strategy by Agricultural Enterprises in a Circular Economy. Economic Scope, (184), 91-94. https://doi.org/10.32782/2224-6282/184-15

[15]Kononenko, O., Molodyka, V., 2019, The typification of the regions of Ukraine by possibilities for sustainable waste management. Visnyk Kyivskogo nacionalnogo universytetu imeni Tarasa Shevchenka, Geografiya [Bulletin of Taras Shevchenko National University of Kyiv, Geography], 2 (75), 28-34 (in Ukranian, abstr. in English), doi: 10.17721/1728-2721.2019.75.5

[16]Mezones-Santana, J. J., Köhler, S., Acevedo-Urquiaga, A. J., 2022, Assessment of the circular economy philosophy in a poultry production in Ecuador. Ingeniería Industrial, Vol. XLIII/No.2/abril-junio/4314.

[17]Ministry of Agriculture and Food-MAF, Bulgaria, 2016, Agrostatistical Reference Book 2000-2015. MAF, Agrostatistics Department, Survey "Activities of the slaughterhouses for poultry meat", p 216. (In Bulgarian).
https://www.mzh.government.bg/MZH/Libraries/%D0%A1%D0%BF%D0%B8%D1%81%D1%8A%D0%BA_%D0%BD%D0%B0_%D0%BE%D0%B4%D0%BE%D0%B1%D1%80_%D1%80%D0%B0%D0%B7%D0%B2%D1%8A%D0%B4%D0%BD%D0%B8_%D0%BE%D1%80%D0%B3/AgrostatisticalReferenceBookMAF-2000-2015.sflb.ashx Accessed on 24th Feb 2024

[18]Ministry of Agriculture and Food-MAF, Bulgaria, 2023, Poultry Production in Bulgaria in 2022. MAF, Agrostatistics Department (In Bulgarian). https://www.mzh.government.bg/media/filer_public/2023/04/07/publication_422_poultry_2022.pdf Accessed on 24th Feb 2024.

[19]Minnesota Pollution Control Agency. Air Emission Permit No. 15100038-004. Issue date February 9, 2005; Alternative Resources, Inc. "A Review of the Expected Air Emissions for the Proposed FibroShore 40-MW Power Plant to Be Fueled with Poultry Litter and Wood." February 2001 at 14 to 15.

[20]Mozhiarasi, V., Natarajan, T.S., 2022, Slaughterhouse and poultry wastes: management practices, feedstocks for renewable energy production, and recovery of value added products. Biomass Conv. Bioref. https://doi.org/10.1007/s13399-022-02352-0

[21]Negri, E., Bravi, F., Catalani, S., Guercio, V., Metruccio, F., Moretto, A., La Vecchia, C., Apostoli, P., 2020, Health effects of living near an incinerator: A systematic review of epidemiological studies, with focus on last generation plants. Environmental Research, 184, p 109305, https://doi.org/10.1016/j.envres.2020.109305.

[22]Parihar, S.S., Saini, K.P.S., Lakhani, G.P., Jain, A., Roy, B., Ghosh, S., Aharwal, B., 2019, Livestock waste management: A review. J Entomol Zool Stud;7(3):384-393.)

[23]Rashid, S., Malik, S.H., 2023, Transition from a Linear to a Circular Economy. In: Bandh, S.A., Malla, F.A., Hoang, A.T. (eds) Renewable Energy in Circular Economy. Circular Economy and Sustainability. Springer, Cham. https://doi.org/10.1007/978-3-031-42220-1_1
[24]Rauw, W. M., Gomez-Raya, L., Star, L., Øverland, M., Delezie, E., Grivins, M., Karen T., H., Marco, P., Klaassen, M. T., Klemetsdal, G., Gil, M. L. G., Torres, O., Dvergedal, H., Formato, G., 2022, Sustainable development in circular agriculture: An illustrative beeↃlegumeↃpoultry example. Sustainable Development 31(2). DOI: 10.1002/sd.2435
[25]Sharma, R., Sharma, M., Sharma, R., Sharma, V., 2013, The impact of incinerators on human health and environment. Reviews on Environmental Health, Vol. 2891), 67-72. https://doi.org/10.1515/reveh-2012-0035
[26]Tait, P. W., Brew, J., Che, A., Costanzo, A., Danyluk, A., Davis, M., Khalaf, A., McMahon, K., Watson, A., Rowcliff, K., Bowles, D., 2020, The health impacts of waste incineration: a systematic review. Australian and New Zealand Journal of Public Health, volume 44, Issue 1, pp 40-48, https://doi.org/10.1111/1753-6405.12939.
[27]Tauš, P., Šimková, Z., Cehlár, M., Krajňáková, I., Drozda, J., 2023, Fulfillment of EU Goals in the Field of Waste Management through Energy Recovery from Waste. Energies, 16, 1913. https://doi.org/10.3390/en16041913
[28]Tavera, C. G., Raab, T., Trujillo, L. H., 2023, Valorization of biogas digestate as organic fertilizer for closing the loop on the economic viability to develop biogas projects in Colombia. Cleaner and Circular Bioeconomy, Vol. 4, 100035. https://doi.org/10.1016/j.clcb.2022.100035
[29]Thormann, L., Neuling, U., Kaltschmitt, M., 2023, Opportunities and challenges of the European Green Deal for the chemical industry: An approach measuring circularity. Cleaner and Circular Bioeconomy, volume 5, 100044, https://doi.org/10.1016/j.clcb.2023.100044.
[30]Toni, M., 2023, Conceptualization Of Circular Economy And Sustainability At The Business Level. Circular Economy And Sustainable Development. International Journal Of Empirical Research Methods, 1(2), 81-89. https://doi.org/10.59762/ijerm20527579122023120514 0635
[31]Wala, M., Nowakowski, P., 2020, Investigating The Economic Efficiency Of Waste Collection And Transportation – Case Study For Urban And Rural Municipalities In Poland. Transport Problems, 15(2), 93-105.
[32]Yunan, X., Weixin, L., Yujie, Y., Hui, W., 2021, Evolutionary game for the stakeholders in livestock pollution control based on circular economy. Journal of Cleaner Production, volume 282, 125403, https://doi.org/10.1016/j.jclepro.2020.125403.
[33]Zhang, L., Ren, J., Bai, W., 2023, A Review of Poultry Waste-to-Wealth: Technological Progress, Modeling and Simulation Studies, and Economic-Environmental and Social Sustainability. Sustainability; 15(7):5620. https://doi.org/10.3390/su15075620