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APPRAISING THE ENTREPRENEURIAL PROSPECTS FROM ABATTOIR NON-EDIBLE BY-PRODUCTS IN PORT HARCOURT METROPOLIS, RIVERS STATE

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Abstract

This study appraises the entrepreneurial prospects of abattoir non-edible by-products in Port Harcourt Metropolis, Rivers State. The study adopted the quasi-experimental design. Four (4) abattoirs, namely Iwofe, Eagle Island, Eliozu, and Woji were randomly selected for the collection of non-edible by-products over 12 months between May 2021 and April 2022. The collected samples were analyzed using tables. The study revealed that the composition of the non-edible abattoir by-products in both wet and dry seasons includes: blood, intestines, bones, trimming, fats, horns, hoofs, and skin/hide. In addition, the result indicated that the entrepreneurial prospects of these non-edible abattoir wastes are producing animal feed, operating musical instruments, producing calcium pills, producing fashion accessories, making soap, producing a fashionable chair, producing foot oils, and producing leather. The study recommended, among others, that the government should embark on adequate enlightenment on the entrepreneurial prospects and economic importance of recycling, recovering, and converting abattoir waste into excellent options that would prevent the imminent pollution from the poor management and disposal of wastes into landfills, drainages, and groundwater sources adjacent to abattoirs.

Introduction

An abattoir or slaughterhouse is generally a place where the business and activities related to the slaughtering of animals are carried out. Similarly, the slaughtering or killing of animals such as cattle, sheep, goat, etc. results in the production of edibles like liver, kidney, tongue, etc. that can be consumed and sold as well as non-edible by-products like carcass, blood, horn, fat, etc. that can be recycled and sold for income purposes (Amaechi-Onyerimma, 2022). In particular, abattoir activities such as skinning, trimming, cleaning, and processing are expected to be ethically undertaken during the slaughtering of cattle, sheep, goat, etc., to produce hygienic meat with the right protein and income needed for the teeming merchants, consumers, and governments.

In Nigeria, most abattoirs are characterized by poor designs, inefficient locations, especially in residential suburbs, and non-existent drainage, among other issues that give rise to poorly managed and disposed of by-products with their safety and quality concerns (Orunoye, 2015). Durotoye et al. (2018) pointed out that the practice wherein many abattoirs in Nigeria incinerate and dispose of their untreated effluents directly into landfills, streams, rivers, and other water sources with which the slaughtered animals are washed, triggers a serious cycle of pollution. So, an appraisal of certain parameters in the environmental components adjoining abattoirs could be quite revealing of an impending doom from improperly disposed of non-edible by-products.

In specificity, the chemicals or substances that are added during the processing of meat, together with the blood, fat, organic and inorganic materials from the slaughtered animals, result in the generation of non-edible abattoir by-products considered in this study. These non-edible abattoir by-products come with different dimensions of pollutants that are detrimental to the health of both humans and the environment. This underscores the essence of veterinarians inspecting and sanctioning the livestock to be slaughtered as being healthy and free from any animal disease (Nouri et al., 2008; Amaechi-Onyerimma, 2022). However, Onugha (2022) observed that inefficient meat inspection service, as well as the evidently poor state of the majority of abattoirs, indicates that the operations of abattoirs would be highly susceptible to the production and consumption of unwholesome meat that can accentuate public health and environmental issues.

Abattoir operations cover activities (like skinning, trimming, cleaning, paunch handling, and processing) during butchering, generation of non-edible by-products, and utilization of by-products or waste (Onugha, 2022). This implies that the several operations or procedures carried out in abattoirs lead to the production of waste that can be discharged into the land and water bodies, incinerated, or renewed and used for other viable options. Given this, Irshad and Sharma (2015) stated that abattoir by-products are rich in nitrogen content that can be utilized as fertilizer and high-value products as well as economically beneficial biomaterials with attendant benefits.

Elemile et al. (2019) observed that the various processes and operations adopted during the slaughtering of animals could result in the release of high intensity of nitrogen, phosphorus and total solids among other noxious substances that are eventually discharged into the land and groundwater sources (like well, lake, rivers, etc.) nearby abattoirs. Consequently, Ojekunle and Lateef (2017) reported that animals that graze on contaminated plants and drink from polluted waters, as well as marine life that breed in heavy metal-polluted waters, also accumulate such metals in their tissues and milk if lactating. When such animals are killed, these

metals are released into the soil as a natural sink but subsequently leached out into nearby streams or water bodies.

On the other hand, certain abattoir waste contains noxious substances, potential pathogens, biodegradable organic compounds, and odour-producing elements that could become the source for environmental pollution and health hazards that may threaten animal and human health around the vicinity of the abattoirs (Alfonso-Muniozguren et al., 2018; Eryuruk et al., 2018; Ozdemir et al., 2018). Ojekunle and Lateef (2017) stated that the effect of toxic contaminants could disrupt the livelihood and amenity of legitimate biodiversity and organisms in the environment. Against this backdrop, Ware et al. (2016) emphasized that the adoption of an integrated biorefinery technique for converting abattoir waste into biomaterial, biofuel, biogas, and biochemicals suffices as an excellent option for tackling the environmental and health problems from abattoir waste. Hence, Limeneh et al. (2022) asserted that an integrated biorefinery approach provides opportunities for the appropriate utilization of abattoir by-products, to reduce the associated pollution as well as create job opportunities and open other entrepreneurship prospects. Given this, Tseghai and Wangatia (2015) and Zeller et al. (2016) reiterated that the conversion of abattoir wastes to high-value-added trendy products with economic benefits would immensely benefit merchants, customers, government, and the environment at large in contemporary times.

Problem Specification

The activities, processes, programmes, and operations engaged in abattoirs heighten the generation of non-edible by-products or wastes with the propensity to directly or indirectly stir a series of pollution to the environmental components, especially land and water adjoining abattoirs. In specificity, activities in abattoirs, like butchering, removal of the hide, intestine management, trimming, cleaning activities, etc., and chemicals added during handling operations lead to the generation of by-products comprising blood, oil, salts, organic solids, and toxic substances.

The imminent environmental and health threats from the hitherto discharge of toxic abattoir by-products into landfills, groundwater and drainages necessitates the adoption of an integrated biorefinery technique that would enhance the conversion of by-products into high value-added products in such a fashionable manner that it would reduce the environment pollution and at same time create job opportunities and improve income for merchants, customers and governments. This, therefore, emerges as the current emphasis towards efficiently managing and sustainably utilizing abattoir wastes. It is based on this backdrop that this study appraised the entrepreneurial prospects from abattoir non-edible by-products in Port Harcourt metropolis, Rivers State.

Specifically, the objectives of the study were to:

1. ascertain the composition of the non-edible by-products during the wet season in the selected abattoirs in the study area.
2. identify the composition of the non-edible by-products during the dry season in the selected abattoirs in the study area.
3. determine the entrepreneurial prospects of the non-edible by-products from the selected abattoirs in the study area.

Materials and Methods

Study Area: This study was conducted in Port Harcourt metropolis, which spans over two local government areas (LGAs), namely, Port

Harcourt and Obio/Akpor. Port Harcourt metropolis is located between Latitude 4°45'N and Latitude 4°55'N, and Longitude 6°55'E and Longitude 7°05'E in Rivers State. Also, the study area lies at an average altitude of about 12 m above mean sea level, as well as being located at about 25 km from the Atlantic Ocean and is situated between the Dockyard Creek/Bonny River and the Amadi Creek (Chiadikobi et al., 2011). Furthermore, Port Harcourt metropolis is bounded by Emohua, Ikwerre, Eleme, Oyigbo, and Okrika LGAs, including the Atlantic Ocean. Similarly, Port Harcourt metropolis experiences two seasons, that is, dry and rainy seasons. Temperatures over Port Harcourt metropolis are constantly high, with a mean maximum of about 34°C and a mean minimum of about 21°C.

Location of Sample Sites: Four (4) abattoirs were selected using three-phase sampling techniques. In the first phase, the cluster sampling technique was used to delineate the study area (i.e., Port Harcourt metropolis) into 12 clusters for the collection of abattoir by-products. The 12-cluster classification include: (1) May, (2) June, (3) July, (4) August, (5) September, (6) October, (7) November, (8) December, (9) January, (10) February, (11) March, and (12) April.

Secondly, a random sampling technique (using a blind) was used to select four (4) out of the 20 abattoirs in Port Harcourt metropolis. Thus, the consecutive pick of 4 numbers (from a pot of 20 numbers) led to the picking or selection of Eagle Island, Eliozu, Iwofe, and Woji abattoirs in the study area. In the third and final phase, purposive sampling was used in the collection of effluents or by-products from each of the 4 selected abattoirs during each cluster or monthly. This constituted a sample of twelve (12) streams of by-products or effluents that were selected from the four selected abattoirs in the study area (See Figure 1 for the validation of coordinates of the selected abattoirs in Port Harcourt metropolis).

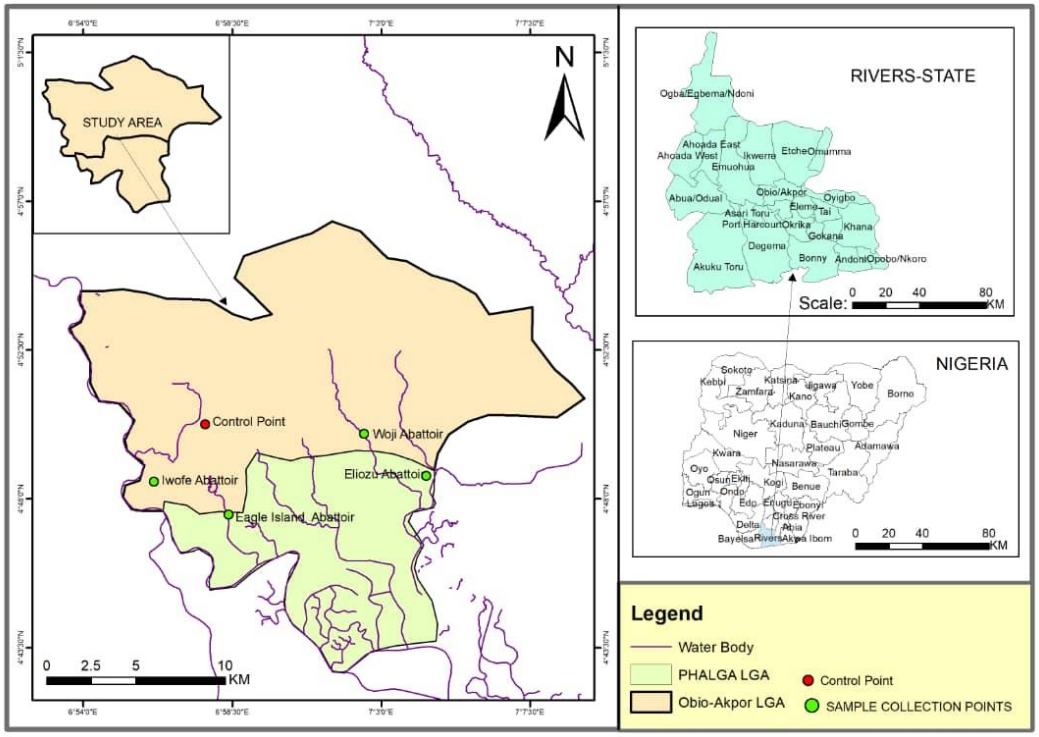

Figure 1: Validation Coordinates of the Sample Points of the Selected Abattoirs in Port Harcourt Metropolis

Research Design: This study adopted the quasi-experimental design. The quasi-experimental design is applied in a study that is not purely experimental and where all the threats to validity cannot be controlled by human intervention in the research (Nwankwo, 2016).

Instrumentation and Method of Data Collection: The GPS was used to determine the coordinates of the selected sampling points at Eagle Island, Eliozu, Rumuolumeni, and Woji abattoirs. Also, the plastic container and cooler were instruments that were used for the collection of abattoir by-products over 12 months from May to October 2021 (representing wet season) and November 2021-April 2022 (representing dry season). This began with the opening of the plastic bottle for about five (5) minutes before the collection of the abattoir by-products. At the end of each of the 12 periods, the collected by-products were put into the cooler in the course of their movement to the laboratory for the identification of the abattoir by-products.

Data Analysis: Tables were utilized to determine the objectives stated in this study.

Results

Table 1: The composition of the non-edible by-products during the wet season in the selected abattoirs in the study area

S/N	Abattoir	Non-Edible By-Products Collected from each of the Abattoirs during the Wet Season					
		November	December	January	February	March	April
1	Eagle Island	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide
2	Eliozu	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide
3	Iwofe	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide
4	Woji	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide

Source: Researcher's Fieldwork, May 2021-October 2021.

Table 1 shows the composition of the non-edible by-products in the selected abattoirs (via Eagle Island, Eliozu, Rumuolumeni, and Woji) in Port Harcourt metropolis from May to October 2021. It further shows that the composition of the non-edible abattoir by-products during the wet season includes: blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide.

Table 2: The composition of the non-edible by-products during the dry season in the selected abattoirs in the study area

S/N	Abattoir	Non-Edible By-Products Collected from each of the Abattoirs during the Dry Season					
		November	December	January	February	March	April
1	Eagle Island	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide
2	Eliozu	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide
3	Iwofe	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide
4	Woji	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide	Blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide

Source: Researcher's Fieldwork, November 2021-April 2022.

Table 2 shows the composition of the non-edible by-products in the selected abattoirs (via Eagle Island, Eliozu, Rumuolumeni, and Woji) in Port Harcourt metropolis from November 2021 to May 2022. It further shows that the composition of the non-edible abattoir by-products during the dry season includes: blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide.

Table 3: The entrepreneurial prospects of the non-edible by-products from the selected abattoirs in the study area

S/N	Non-Edible Abattoir By-Products	Nature	Entrepreneurial Prospects
1	Blood	Liquid	Used as raw materials in the animal feed industry and for the production of bone meal and fish meal for chicken and fish, respectively
2	Intestines	Solid	Used in the operation of musical instruments
3	Bone	Solid	Producing bone meal for animal feed, including the production of calcium pills for human consumption. Also, crushed bones are used as dental therapy
4	Trimming	Solid	Production of fashion accessories
5	Fats	Solid	Used in soap making and animal feed
6	Horns	Solid	Raw materials in the meat processing industry and used to produce a fashionable chair
7	Hoofs	Solid	Producing foot oils used for shoe shining
8	Skin/hide	Solid	Used in the production of leather for the covering of chairs

Source: Researcher's Compilation, 2022.

Table 3 shows the entrepreneurial prospects of the non-edible by-products from the selected abattoirs (via Eagle Island, Eliozu, Rumuolumeni, and Woji) in Port Harcourt metropolis. It further shows that blood is used as raw material in the animal feed industry and for the production of bone meal and fish meal for chicken and fish, respectively. Intestines are used in the operation of musical instruments. The bones are used for producing bone meal for animal feed, including the production of calcium pills for human consumption, while crushed bones are used as dental therapy. The trimmed waste is used for the production of fashion accessories. Fats are used in soap making and animal feed. Horns are used as raw materials in the meat processing industries and for producing a fashionable chair. Hoofs are used for producing foot oils used for shoe shining. Skin/hide is used in the production of leather for the covering of chairs.

Discussion of Findings

The results in Tables 1 and 2 revealed that the composition of the non-edible abattoir by-products during the dry season includes: blood, intestines, bone, trimming, fats, horns, hoofs, and skin/hide. This finding is consistent with the position of Limeneh et al. (2022) that the non-edible abattoir wastes or by-products that are produced during slaughtering processes include blood, hoof, horns, gland, intestines, bones, fats, and skin/hide.

The result in Table 3 revealed that the entrepreneurial prospects of the non-edible by-products from the selected abattoirs in Port Harcourt metropolis include: blood used as raw materials in the animal feed industry and for the production of bone meal and fish meal for chicken and fish, respectively. This finding is in agreement with Adhikari et al. (2018) that the utilization of abattoir waste for value-added options has led to the mixture of blood with other abattoir wastes converted to blood, bone, and fish meals that are used in the feeding of chicken and fish. Also, the finding that intestines are used in the

operation of musical instruments while the trimming waste is used for the production of fashion accessories aligns with the previous findings by Lee (2008) and Mummed and Webb (2015) that the integration of modern operations, facilities and management in both public and private abattoirs has heightened the possibility of fashion accessories to be produced from trimming wastes as well as intestines often used in the application of a musical instrument.

Similarly, the prospect of fats being used in soap making and animal feed aligns with the earlier finding by Irshad and Sharma (2015) that the effective utilization of abattoirs' by-products like fats for making soap and animal feed enhances the possibility of waste maximization and value-adding opportunities. The finding that bones are used for producing bone meal for animal meal including the production of calcium pills for human consumption while crushed bones are used as dental therapy; is in agreement with Limeneh et al. (2022) that the utilization of by-products in pharmaceutical, cosmetics, biofuels, textile and composite applications minimizes the waste disposal percentage as well as substantial reduction in soil degradation, water contamination and ecosystem depletion. In addition, the finding that horns are used as raw materials in meat processing industries and for producing a fashionable chair, hoofs are used for producing foot oils used for shoe shining, and skin/hide is used in the production of leather for the covering of chairs. These findings are consistent with Zwetsloot et al. (2014) that the recycling of abattoir waste aligns with what Shen et al. (2019) ascribe as the integration of novel technologies in the utilization of animal by-products such as horn, hoof, and skin/hide in food processing, foot oils, and leather respectively. Thus, this finding aligns with the positions of Toldrá et al. (2021) that the efficient management of meat by-products leads to improved meat processing and sustainable utilization of the non-edible abattoir by-products after removal of edible by-products from cattle. Including the position of Bharathy et al. (2012) that proper utilization of abattoir wastes aids in the attainment of a green economy as well as the sustainability of the environment, wherein abattoirs are located.

Conclusion

The study empirically ascertained that the composition of the non-edible abattoir by-products in both wet and dry seasons is: blood, intestines, bones, trimming, fats, horns, hoofs, and skin/hide. In addition, the present analysis specifically revealed the prospects of utilizing abattoir by-products such as blood, intestines, bones, and trimming for producing animal feed, operating musical instruments, producing calcium pills and dental therapy, as well as the production of fashion accessories, respectively. While abattoir by-products like fats, horns, hoofs, and skin/hide are potentially utilized for making soap, producing a fashionable chair, producing foot oils, and producing leather, respectively. Hence, the study concludes that the non-edible by-products of abattoirs in Port Harcourt metropolis have entrepreneurial prospects ranging from nutritional, industrial, medicinal, cosmetics, cleaning, textile, and entertainment benefits.

Recommendations

Based on the findings of the study, the following recommendations were proffered.

1. The regulators of abattoirs should ensure that their waste streams are disposed of with utmost regard to sound environmental management practices to

forestall harm to humans and other terrestrial and aquatic life.

2. The Ministry of Environment should enforce legislation against the incineration and indiscriminate disposal of abattoir wastes in water bodies, drainages, and dumpsites without treatment and segregation of wastes that would help in the avoidance of the attendant pollution, offensive odours, scavenging, and unaesthetic nature of the environment.
3. The government should embark on adequate enlightenment on the entrepreneurial prospects and economic importance of recycling, recovering, and converting abattoir waste into excellent options that would prevent the imminent pollution from the poor management and disposal of waste into landfills, drainage, and groundwater sources adjacent to abattoirs.
4. Further research should focus on exploring and developing localized and cost-effective options from abattoir by-products that would be rightly utilized to promote health, entrepreneurship, and environmental sustainability.

References

Adhikari, B. B., Chae, M., & Bressler, D. C. (2018). Utilization of slaughterhouse waste in value-added applications: Recent advances in the development of wood adhesives. *Polymers, 10*, 176.

Alfonso-Muniozguren, P., Lee, J., Bussemaker, M., Chadeesingh, R., Jones, C., Oakley, D., & Saroj, D. (2018). A combined activated sludge-filtration-ozonation process for abattoir wastewater treatment. *Journal of Water Process Engineering*, *25*(2), 157-163.

Amaechi-Onyerimma, C. N. (2022). *Impact of abattoir effluents on groundwater quality in Port Harcourt metropolis, Rivers State*. Unpublished PhD Thesis of Ignatius Ajuru University of Education Port Harcourt.

Bharathy, N., Sakthivadivu, R., Sivakumar, K., & Saravanakumar, V. R. (2012). Disposal and utilization of broiler slaughter waste by composting. *Vet. World, 5*, 359-368.

ChiadikobI, K. C., Omoboriowo, A. O., Chiaghanam, O. I., Opatola, A. O., & Oyebanji, O. (2011). Flood risk assessment of Port Harcourt, Rivers State, Nigeria. *Pelagia Research, 2*(6), 287-298.

Durotoye, T. O., Adeyemi, A. A., Omole, D. O., & Onakunle, O. (2018). Impact assessment of wastewater discharge from a textile industry in Lagos, Nigeria. *Cogent Engineering*, *5*(1), 1-11.

Elemile, O. O., Raphael, D. O., Omole, D. O., Oloruntoba, E. O., Ajayi, E. O., & Ohwavborua, N. A. (2019). Assessment of the impact of abattoir effluent the quality of groundwater in a residential area of Omu-Aran, Nigeria. *Environmental Science Europe*, *31*, 1-10.

Eryuruk, K., Tezcan Un, U., & Bakır-Ogutveren, U. (2018). Electrochemical treatment of wastewaters from poultry slaughtering and processing by using iron electrodes. *Journal of Cleaner Production*, *172*, 1089-1095.

Limeneh, D. Y., Tesfaye, T., Ayele, M., Husien, M. N., Ferede, E., Haile, A., Mengie, W., Abuhay, A., Gelebo, G. G., Gibril, M., & Komg, F. (2022). A comprehensive review on utilization of slaughterhouse by-product: Current status and prospect. *Sustainability*, *14*(11), 6469-6488.

Irshad, A., & Sharma, B. D. (2015). Abattoir by-product utilization for sustainable meat industry: A review. *J. Anim. Prod. Adv., 5*, 681-696.

Mummed, Y. Y., & Webb, E. C. (2015). Operation, facilities, and management in public and private abattoirs in Ethiopia. *African Journal of Agricultural Research*, *10*(7), 623-630.

Nouri, J., Karbassi, A. R., & Mirkia, S. (2008). Environmental management of coastal regions in the Caspian Sea. *International Journal of Environmental Science and Technology*, *5*(1), 43-52.

Nwankwo, O. C. (2016). *A practical guide to research writing for students in education and social sciences* (6th Edition). M & J Grand Orbit and Communication Ltd.

Ojekunle, O. Z., & Lateef, S. T. (2017). Environmental impact of abattoir waste discharge on the quality of surface water and ground water in Abeokuta. *Journal of Environmental Analytical Toxicology, 7*(5), 509-521.

Onugha, A. C. (2022). Sustainable use of abattoir waste and maximization of economic benefits among residence in Port Harcourt metropolis. *RIK International Journal, 16*(3), 248-256.

Oruonye, E. D. (2015). Challenges of abattoir waste management in Jalingo metropolis, Nigeria. *International Journal of Research in Geography (IJRG), 1*(2), 22-31.

Ozdemir, S., Yetilmezsoy, K., Nuhoglu, N. N., Dede, O. H., & Turp, S. M. (2018). Effects of poultry abattoir sludge amendment on feedstock composition, energy content, and combustion emissions of giant reed (Arundo donax L.). *Journal of King Saud University-Science*, *101*, 206-218.

Shen, X., Zhang, M., Bhandari, B., & Gao, Z. (2019). Novel technologies in utilization of byproducts of animal food processing: A review. *Crit. Rev. Food Sci. Nutr., 59*, 3420-3430.

Toldrá, F., Reig, M., & Mora, L. (2021). Management of meat by- and co-products for an improved meat processing sustainability. *Meat Sci., 181*, 1086-1098.

Tseghai, G. B., & Wangatia, L. M. (2015). Surface modification of cotton using slaughterhouse wastes. *Int. J. Mater. Text. Eng., 9*, 3011-3015.

Ware, A., & Power, N. (2016). Biogas from cattle slaughterhouse waste: Energy recovery towards an energy self-sufficient industry in Ireland. *Renew. Energy, 97*, 541-549.

Zeller, H., Zah, R., Gioacchini, M., & Faist, M. (2016). *Of the environmental impact valuation as base for a sustainable fashion strategy*. Available online: http://naturalcapitalcoalition.org/wp-content/uploads/2017/07/2nd_White_Paper_EIV.pdf (accessed on 15 February 2022).

Zwetsloot, M. J., Lehmann, J., & Solomon, D. (2014). Recycling slaughterhouse waste into fertilizer: How do pyrolysis temperature and biomass additions affect phosphorus availability and chemistry? *J Sci Food Agric., 95*, 281-288.