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Waste Recovery Potentials of Solid Waste Generated by Animals at Zoological Garden of a Tertiary Institution in Nigeria

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Abstract

Lack of proper management of litters generated by zoo animals can escalate into very serious environmental health hazards and reduce touristic sight attraction to the visitors and picnickers. This paper assessed the number of animals and, amounts of organic wastes produced and their disposal methods in a zoo located on the campus of University of Ibadan, Nigeria, with a view of recommending resource recovery option. Samples of waste generated by 17 varieties and a total of 112 live animals and birds in the zoo were collected each day for seven days in a week for physical and chemical characterisation. Physical characterisation was carried out by spreading them on a work bench before taking their volumes and weight using a calibrated drum and weighing scale, respectively. The chemical analyses were carried out on volatile substances, non-volatile substances, total Kjeldahl nitrogen, total phosphorous and empirical carbon using analytical methods. A participatory observation checklist was also used to monitor feeding practices and method of waste disposal in the zoo. The total waste (fresh weight) generated per week was 3.28 ± 0.8kg, ranging between 0.03±0.00kg and 3.4±0.08 kg per day with the least from tortoise and highest from gorilla. The wastes had high levels of organic matters (78.7%),volatile substances (54.9%), non-volatile substances (45.1%), total Kjeldahl nitrogen (2.4%) and total phosphorous (2.0%). Zoo wastes were very rich in valuable mineral nutrients and hygienic disposal with resource recovery is recommended to prevent environmental health hazards.

Potentiel de récupération des déchets solides générés par les animaux au jardin zoologique d'une institution tertiaire au Nigeria

Résumé

Le manque de gestion appropriée des 'wastes' générées par les animaux de zoo peut dégénérer en dangers de l'environnement très graves et réduire l'attrait touristique pour les visiteurs et les pique-niqueurs. Ce document évalue le nombre d'animaux et la quantité de déchets organiques produits et leurs méthodes d'élimination dans un zoo situé sur le campus d'Ibadan, au Nigeria, en vue de recommander une option de récupération des ressources. Des échantillons de déchets produits par 17 variétés et un total de 112 animaux vivants et oiseaux au zoo ont été collectés chaque jour pendant sept jours par semaine pour une

caractérisation physique et chimique. La caractérisation physique a été réalisée en les étalant sur un banc de travail avant de prendre leurs volumes et leur poids en utilisant un tambour calibré et une balance. Des analyses chimiques ont été effectuées sur des substances volatiles, des substances non volatiles, du phosphore total et du carbone empirique à l'aide de méthodes analytiques. Une liste de contrôle d'observation participative a également été utilisée pour surveiller les pratiques d'alimentation et les méthodes d'élimination des déchets au zoo. Le poids frais total moyen généré par semaine était de 3,28 ± 0,8 kg, compris entre 0,03 ± 0,00 kg et 3,4 ± 0,08 kg par jour, avec un minimum de tortues et plus élevé chez les gorilles. Les déchets ont un niveau élevé de matières organiques (78,7%), les substances volatiles (54,9%), les substances non volatiles (45,1%), (2,4%) et de phosphore total (2,0%). Les déchets de zoo étaient très riches en nutriments minéraux précieux et une élimination hygiénique est recommandée pour prévenir les risques pour la santé environnementale.

Introduction

A zoo is a facility in which animals are housed within enclosures, displayed to the public, and in which they may also breed. According to Adams and Salome (2014), people visit zoological gardens for different purposes like educational, recreational, research, economic and cultural values. Throughout the world, published studies on zoological gardens and wild animals focus on epidemiology of gastrointestinal parasites in zoo animals (Olayide and Adekunle 2008; Yabsley, 2009; Ajibade *et al.* 2010; Akinboye, *et al.,* 2010; Khan *et al.,* 2010; Wang *et al.,* 2011; Papini *et al.,* 2012; Otegbade and Morenikeji 2014).

Information on solid waste management at zoological gardens located in some of the urban centres in the country is very scanty and not well documented. Otegbade and Morenikeji (2014) carried out a study to establish the gastrointestinal parasite profile of birds kept in zoological gardens in the University of Ibadan, Obafemi Awolowo University, University of Ilorin, University of Lagos and Federal University of Agriculture Abeokuta, all in south-west Nigeria. Olayide and Adekunle (2008) investigated zookeepers at the University of Ibadan Zoological Garden for helminthic ova and protozoan cysts and affirms the possibility of transmission of parasites infection from animals to man and *vice-versa* in the zoological garden. In a similar study, Ajibade *et al.,* (2010) took an inventory of the wild animal population and surveyed for helminth parasites in animals at the Obafemi Awolowo University and University of Ibadan zoological gardens.

Several other documented researches in the country that are related to the present study include: those of Yager *et al.,* (2015) who assessed the recreational potentials of Makurdi Zoological garden, Nigeria and Akinyemi (2015) that carried out survey on the impacts of feeding wild animals by visitors in ex-situ conservation and measures to minimize such practices. Though not at a zoological garden, Fafioye and John-Dewole (2012) investigated the effect of open dumping of animal wastes on the farm workers' health and the environment and concluded that the open dumping of animal wastes as a method of disposal has significant effects on health of the workers and the environment. Similarly, Olusola and Olaogun (2016) evaluated livestock waste management methods in Oyo State and revealed that commercial poultry and livestock keepers in Oyo State practice open lands waste disposal method which is not environmental friendly, culminating in widespread air, water and land pollution.

Solid waste disposal is a very serious problem in Nigeria as no government has been able to solve it to the satisfaction of the communities. These wastes pose serious problem of disposal as they are usually disposed of together with other solid wastes in the sites (Hammed *et al.,* 2012; Hammed *et al.,* 2016). Recently, there has been

more awareness in the utilisation of organic wastes for organic fertilizer production (Sridhar and Hammed, 2014) and efforts are being put into taking inventory of all the available organic wastes in the country. As such, lack of proper management of litters generated by zoo animals can escalate into very serious environmental health problems and reduce touristic sight attraction to the visitors and picnickers. This paper assessed the number of animals and management practices including the process of feeding, cleaning practices and amounts of organic wastes produced in a zoo located on the campus of University of Ibadan in South-West Nigeria, with a view of recommending proper management of the waste through a resource recovery option.

Materials and Methods

Study Area

The University of Ibadan is the oldest Nigerian university, and is located five miles from the centre of the major city of Ibadan in Western Nigeria (Longitude $3^{0}53^{'}$ East of Greenwich meridian and Latitude $7^{0}34^{'}$ North of the Equator). The University was established 68 years ago and it is popularly known as Unibadan or UI. Until 1962 when it became a full-fledged independent University, it was a College of the University of London in a special relationship scheme. The University, which took off with academic programmes in Arts, Sciences and Medicine is now a comprehensive citadel of learning with academic programmes in thirteen Faculties. The Zoological Garden of the University of Ibadan (Figures 1 and 2) came into existence over six decades ago and became a full-fledged zoo in 1974. It is mainly for conservation, education and entertainment purposes. In the last four years, the zoo had undergone tremendous transformation in the drive towards international standards. The garden has now been stocked with more and new species of animals. The zoo animals are grouped in different sections, including the avian, herbivore, carnivore, reptile, primate and small animal sections.

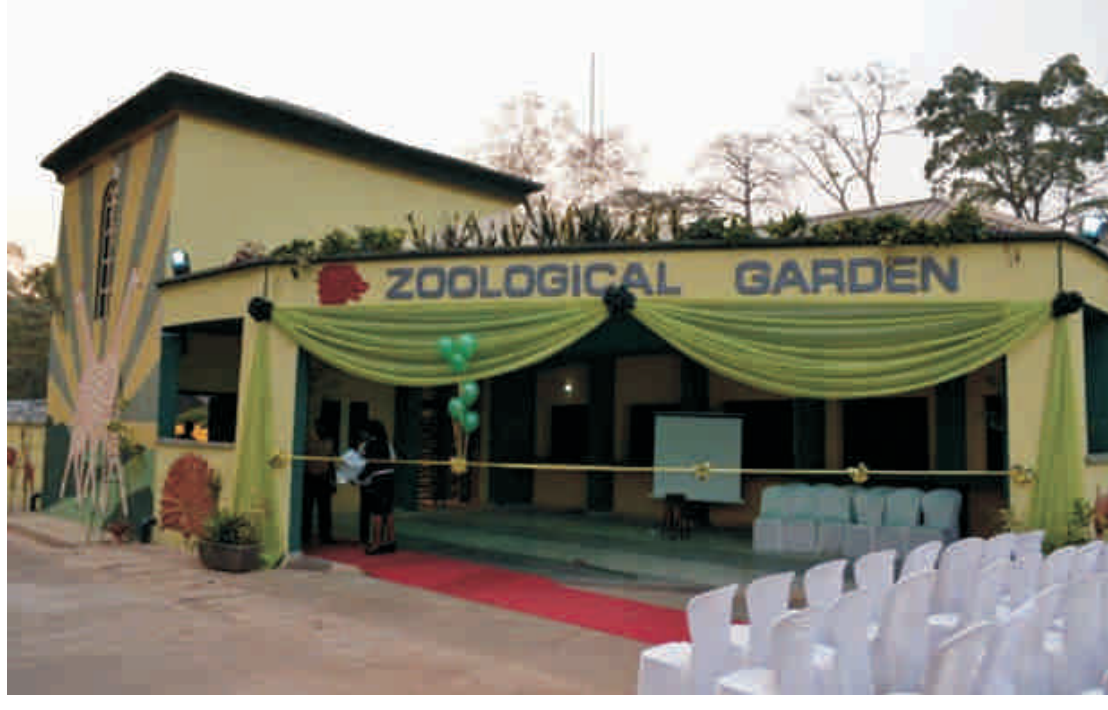

Figure 1: Front view of the Zoological Garden, University of Ibadan

Figure 2: Picnic arena inside the Zoological Garden of the University of Ibadan

Data Collection Procedure

Samples of waste generated by 17 varieties and a total of 112 animals and birds in the zoo were collected each day for seven days in a week for physical and chemical characterisation. Physical characterisation of the wastes was carried out by spreading them on a work bench before taking their volumes and weight using a calibrated drum and weighing scale, respectively. The moisture content was determined by taking fresh and unsorted of at least 1kg sample and dried in a ventilated drying oven kept at 105 ºC until the weight remained constant. For the chemical analyses, samples from each group of animal were prepared by drying the fresh samples and grinding in a mortar (initially of manual type and later of an electric type) to a fine powder. Parameters analysed were volatile substances and non-volatile substances (according to APHA, 2005), total Kjeldahl nitrogen, total phosphorous and empirical carbon using analytical methods as described by Motsar and Roy (2008).The moisture content and empirical carbon were calculated as shown in equation 1 and 2 respectively. In addition, a participatory observation checklist was also used to observe waste disposal methods in the garden.

$$Moisture\ content = \frac{Loss\ in\ weight}{Oven-dry\ weight\ of\ sample} \times 100 \quad \text{Eq. 1}$$

$$Carbon = \frac{(100 - \%ash)}{1.8} \quad \text{Eq. 2}$$

Results and Discussion

The type and number of animals in the zoo, their feeding practices and cleaning periodicity are given in Table 1. It was found that the feeds were given according to the specifications of the zoo and the wastage was minimal. A total of 111 animals were found in the zoo at the time of the study in the year 2000. This number is higher than what was observed ten years later by Ajibade *et al.,* (2010) who took an inventory and found a total of 95 wild animals in the University of Ibadan zoological garden. This is a clear indication that the animal population is reducing by death at the rate that may not be matched by natural replacement by birth. However, the animal population observed in this study is far

more than 38 animals found by Ajibade *et al.,* (2010) at the Obafemi Awolowo University Zoological Garden. Currently, the total population of animals in the University of Ibadan Zoological Garden has increased to a total of 230 as shown in Table 2. The increase was occasioned by the general rehabilitation that was carried out in the garden after a flooding incident that seriously affected the whole city of Ibadan in 2011.

The mean daily waste generation rates from different groups of animals range between 0.03kg and 3.4kg per day with least from tortoise and highest from gorilla and ape as shown in Table 3. The gross composition of the waste, depending on the animal species was vegetable, grasses, food wastes, excreta, manure or bones. The major component was organic matters, accounting for 76% of the total wastes produced followed by bones, gravels and leaves (Table 4).

Table 1: The Type and Number of Animal in the Zoo and the Feeding and the Cleansing Practices

Animal	No. of Animals	Feeds generally given	Periodicity of Cleaning
Antelope Duiker (India spotted, crowned Maxwell)	6	Green leaves, bread, water yam, corn/guinea corn (once daily)	Daily
Baboons	14	Meat, yam, coconut, garbage cucumber, fruits, vegetables (Twice daily)	Weekly
Cats (small) Civet Small-house	3	Meat, banana, pawpaw (Once daily)	Daily
Chimpanzee	4	Fruits, vegetables (Twice daily)	Daily
Dwarf Mongoose	1	Meat, banana (Once daily)	Daily
Donkeys	3	Guinea-corn, millet, grass (Once daily)	Daily
Elephant	1	Fruits, yam, leaves (Once daily)	Daily
Gorilla and Ape (Lowland)	2	Fruits, vegetables, tea, milk, raw eggs and vitamins (Twice daily)	Daily
Hippopotamus	1	Yam, beans, rice, green leaves (Twice daily)	Daily
Leopard	3	Meat (4 times weekly)	Daily
Lions	2	Meat (4 times weekly)	Daily
Small monkeys (Mona and Pats monkeys)	18	Cooked beans, rice, yam, fruits (Daily)	Daily
Owl and Eagles (Eagle and Frazer owl)	4	Meat	Daily
Python Snakes and Gabon Viper	5	Baby goats, chicken and white rats meat (Twice weekly)	Weekly
Rats colony	28	Chicken feed, horse cubes (Once daily)	Daily
Spotted hyena	3	Meat (Four times weekly)	Daily
Tortoise Bell hinged (8) and Dwarf Crocodiles (5)	13	Yam, oil, beans, meat, banana, rice and eggs (Once daily)	Daily
Total	**111**		

Table 2: Animal Inventory at Zoological Carding, University of Ibadan (2018)

S/N	Categories of animals	Number
1	Carnivores	15
2	Herbivores	18
3	Aves (Birds)	77
4	Omnivores	5
5	Primates (ape and monkeys)	25
6	Reptiles	70
7	Mollusc	20
Total		**230**

Table 3: Average Daily Generation of Wastes Per Animal in the Zoo

S/N	Animals	Mean±SD (kg/day)
1	Antelope Duiker	0.25±0.00
2	Baboons	0.20±0.01
3	Small cats	0.10±0.00
4	Chimpanzee	0.90±0.01
5	Dwarf Mongoose	0.23±0.01
6	Donkeys	1.43±0.02
7	Elephants	3.0±0.08
8	Gorilla and Ape	3.4±0.08
9	Hippopotamus	2.2±0.04
10	Leopard	0.95±0.01
11	Lion	2.2±0.05
12	Mona Monkey	0.42±0.00
13	Owl and Eagle	0.28±0.01
14	Python Snake	0.52±0.02
15	Rats Colony	0.04±0.00
16	Spotted Hyena	1.07±0.01
17	Tortoise	0.03±0.00

The chemical characteristics are given in Table 5. The wastes from Gorilla and Apes' houses contained the high level of volatile substances (83.9%), those from lions' house contained the highest phosphorous levels. In general, the wastes have high nitrogen contents. High volatile organic waste favours energy recovery from the waste in terms of methane production (Sridhar *et al.,* 2014) while phosphorus (as high as 4.4% and average of 2.00 ± 1.40) and total nitrogen (as high as 4.25% and average of 2.44 ± 0.98) levels make the waste good material for organic fertilizer production. The mean C: N ratio obtained from all animal's waste was 14.50 ± 7.54 which indicates that the zoo waste is highly nitrogenous. According to some researchers, a C: N ratio ranging between 25:1 and 30:1 is the optimum combination for rapid decomposition (Metcalf and Eddy, 2003; Sridhar *et al,* 2003; Parvaresh *et al.,* 2004). However, some researchers have successfully carried out composting at lower C: N ratios as low

Table 4: Gross Composition of Wastes from the Zoo Animals (on dry weight basis)

Animals	Total fresh weight (kg)	Leaves (%)	Organic matter (%)	Gravel (%)	Bones (%)	Water content (%)
Antelope Duikker	0.275	9.1	54.5	36.4	ND	80.0
Baboon	20.31	12.4	42.4	44.8	ND	18.0
Cat (Small)	0.31	ND	91.8	8.2	ND	45.0
Chimpanzee	3.6	ND	88.0	12.0	ND	62.7
Dwarf mongoose	0.125	20.0	80.0	ND	ND	20.0
Donkey	4.2	7.1	71.5	21.4	ND	65.6
Elephant	3.0	38.3	61.7	ND	ND	80.0
Gorilla	6.8	ND	96.0	ND	ND	80.0
Hippopotamus	2.2	ND	86.6	13.4	ND	56.7
Leopard	0.95	ND	84.2	15.8	ND	41.2
Lion	0.525	ND	85.3	ND	14.7	38.0
Mona monkey (small type)	7.6	ND	99.3	ND	ND	56.3
Owl and Eagle	1.1	4.5	16.0	79.5	ND	80.0
Python snake	0.345	ND	96.0	4.0	ND	50.0
Rat Colony	1.0	ND	92.0	8.0	ND	50.0
Spotted Hyena	3.2	ND	59.4	0.8	39.8	78.5
Tortoise	0.37	13.5	86.5	ND	ND	46.9
Mean ± S.D	3.28 ± 4.8	15 ± 10.6	76.0 ± 21.8	20.7 ± 21.8	27.3 ± 17.8	54.9± 18.8

ND = Not detectable

as 15 (Huang *et al.,* 2004), 18 (Gou *et al.,* 2012), 19.6 (Kumar *et al.,* 2010) and 20 (Zhu, 2006). If ratio is more than 30:1, heat production drops and decomposition slows down. A pile of leaves or wood chips may remain stagnant for a year or more without much apparent decay. Thus, zoo wastes with their high nitrogen contents may be effectively used for this purpose and in some areas with other waste management problems. The wastes may be mixed with other wastes that are rich in carbon such as saw dust, leaves or even municipal wastes for quality improvement.

In addition, it was observed that the zoo was well-kept and the collected wastes were dumped at two sites near a stream. There were two compartments for waste collection; the first one was 1.14m away from the stream that passes through the garden and measure 5.80m long, 3.05m wide and 1.20m high. The other was 4.57m away from the stream and measure 7.90 m long, 4.30m wide and 0.80m high. The leachates enter the stream which ultimately joins a lake about 200m away. This observation is very similar to a finding in the study carried out by Abiola and Olaogun (2016) on livestock waste management practices in Oyo State. They found out that 14% practiced flushing wastes into nearby streams and rivers as slurry. The leachate originating from the solid waste dumps have become major sources of pollution. A previous study by Sharma and Sridhar (1981) indicated that the leachate these zoo wastes have increase the BOD values of the stream nearly to about 94mg/1 which was a major source of water supply to University of Ibadan with over 20,000 residents and over 150,000 other floating populations.

Conclusion

It is generally concluded that the animal population was reducing by death at the rate that might not be matched by natural replacement by birth. Gorilla had highest daily waste generation rate of all the different groups of animals in the zoo while tortoise had the least waste per day. The waste generated by the zoo animals was highly organic which may have good potentials for resource and energy recovery in terms of organic fertilizer and biogas (methane) generation. The litters and leachates were not properly managed and may contribute to organic

Table 5: Chemical Characteristics of Wastes from the Zoo Animals (Expressed on dry weight basis)

Animals	Volatile Substance (%)	Non-volatile Substance (%)	Empirical Carbon (%)	Total Kjeldah Nitrogen (g/100g)	C:N ratio	Phosphorous (%)
Antelope Duikker	38.34	61.62	21.3	2.03	10.49	0.8
Baboon	47.37	52.63	26.3	2.32	11.34	1.0
Cat (Small)	52.79	47.21	29.6	4.05	7.31	3.4
Chimpanzee	66.22	33.78	36.8	2.81	13.10	1.8
Dwarf mongoose	71.18	28.82	39.5	4.15	9.52	2.4
Donkey	68.94	31.06	38.1	2.16	17.64	1.6
Elephant	27.53	72.47	15.0	1.39	10.80	0.6
Gorilla and Ape	83.89	16.11	46.6	2.92	15.96	2.5
Hippopotamus	38.99	61.01	21.7	0.8	27.13	0.7
Leopard	32.45	67.55	18.5	2.41	7.68	3.5
Lion	53.56	46.44	29.7	4.02	7.39	4.4
Mona monkey	71.59	28.50	39.7	2.03	19.57	1.1
Owl and Eagle	48.58	54.42	25.3	2.68	9.44	0.4
Python snakes	81.37	18.63	45.2	2.1	21.52	3.8
Rat Colony	76.94	23.06	42.7	2.6	16.42	1.7
Spotted Hyena	24.58	75.42	13.7	2.11	6.49	4.2
Tortoise	52.63	47.37	29.2	0.84	34.76	0.4
MEAN± S.D	**54.94±18.96**	**45.06±18.95**	**30.45±10.19**	**2.44±0.98**	**14.50±7.54**	**2.00±1.40**

pollution of nearby stream. Thus, zoo wastes are found to be very rich in valuable mineral nutrients and hygienic disposal through resource recovery is recommended for their management to prevent environmental health hazards.

References

Abiola, J.O., and Olaogun, S.C. (2016). Livestock waste management practices in Oyo state. *Nigeria Journal of Environment and Waste Management* Vol. 3(2): 139-141.

Adams, A., and Salome, A.A. (2014). Impacts of Zoological Garden in Schools (A Case Study of Zoological Garden, Kano State Nigeria). *Open Journal of Ecology* 4: 612-618.

Ajibade, W.A., Adeyemo, O.K., Agbede, S.A. (2010). Coprological Survey and Inventory of Animals at Obafemi Awolowo University and University of Ibadan Zoological Gardens. *World Journal of Zoology* 5 (4): 266-271.

Akinboye, D.O., Ogunfeitimi, A.A., Fawole, O., Agbolade, O., Ayinde, O.O., Atulomah, N.O.S., Amosu, A.M., Livingstone, R. (2010).Control of parasitic infections among workers and inmates in a Nigerian zoo. *Nigeria Journal of Parasitology* 1:35-38.

Akinyemi, A.F. (2015). Tourist wildlife feeding for pleasure at the University of Ibadan Zoological Garden, Nigeria. *African Journal of Hospitality, Tourism and Leisure* 4 (2). Available at: http//: www.ajhtl.com accessed on 20/11/2017.

Fafioye, O.O. and John-Dewole, O.O. (2012). Problem of animal wastes disposal on the environment; a case study of S&D farms, Odeda, Nigeria. E3 *Journal of Environmental Research and Management* 3(4): 084-087.

Guo, R., Li, G., Jiang, T., Schuchardt, F., Chen, T., Zhao, Y. and Shen, Y. (2012). Effect of aeration rate, C/N ratio and moisture content on the stability and maturity of compost. *Bioresource Technol.* 112: 171-178.

Hammed, T.B., Sridhar, M.K.C., Olaseha, I.O., Oloruntoba E.O., Ana, G.R.E.E. (2012). Integrating a State Owned Waste Recycling Facility and Neighbourhood Participation for Sustainable Management. *The International Journal of Interdisciplinary Social Sciences* 6(8): 11-24.

Hammed T.B., Sridhar M.K.C., Wahab B. (2016). Enhancing solid waste collection and transportation for sustainable development in the Ibadan metropolis, Nigeria. *European Journal of Research in Social Sciences* 4 (7): 23-32.

Huang G. F., Wong J.W.C., We Q.T., Nagar B.B. (2004). Effect of C/N on composting of pig manure with saw dust. *Waste manage.* 24: 805-813.

Ibrahim, U.I., Mbaya, A.W., Geidam Y.A., Geidam A.M. (2006). Endoparasites and associated worm burden of captive and free-living ostriches (*Struthiocamelus*) in the semi-arid region of Northeastern Nigeria. *International Journal of Poultry Science* 12: 1128-1132.

Khan, M.A., Khan, M.S., Shafee, M. and Khan, J.A. (2010). Prevalence and chemotherapy of helminthiasis in parrots at Lahore Zoo, Pakistan. *Journal of Animal and Plant Sciences* 3: 189-192.

Kumar, M.O., Yan, L. and Lin, J. G. (2010). Co-composting of green waste and food waste at low C/N ratio. *Waste management* 30: 602-609.

Mbaya, A.W., Nwosu, C.O., Aliyu, M.M., Ahmed, T.A. (2006). A comparative study of gastrointestinal parasites of captive and free-living wild animals in the semi-arid zone of Northeastern Nigeria. *Nigerian Journal of Pure and Applied biology* 7: 185 – 193.

Metcalf and Eddy Inc. (2003). Wastewater Engineering: Treatment and Reuse. New York, USA: McGraw-Hill. 4th edition. 1546 – 1554.

Motsara, M.R. and Roy, R.N. (2008). Guide to laboratory establishment for plant nutrient analysis. FAO Fertilizer and Plant Nutrition Bulletin (ISSN 0259-2495): 103-103.

Olayide, J. Adeniji and Adekunle, B. Ayomide (2008). Preliminary Investigation of Zooanthroponosis in a Nigerian Zoological Garden. Veterinary Research 2 (3-4): 38-41.

Otegbade, A.C., Morenikeji, O.A. (2014). Gastrointestinal parasites of birds in zoological gardens in south-west Nigeria. *Tropical Biomedicine* 31(1): 54–62.

Papini, R., Girivetto, M., Marangi, M., Francesca Mancianti M., Giangaspero A. (2012). Endoparasite infections in pet and zoo birds in Italy. *The Scientific World Journal.* 12: 1-9.

Parvaresh, A., Shahmansouri, M.R., Alidadi, H. (2004). Determination C/N ratio and heavy metals in bulking agents used for sewage composting. *Iranian J. Public Health* 33(2): 20-23.

Sharma, B.M., Sridhar, M.K.C. (1981). The productivity of *Pistastratiotes* in an eutrophic lake. *Environmental pollution*, series A 24: 277-289.

Sridhar, M.K.C., Adeoye, G.O. (2003). Organo-mineral fertilizers from urban Wastes: Developments in Nigeria. *The Nigeria Field* 68: 91-111.

Sridhar, M.K.C., and Hammed, T.B. (2014). Turning Waste to Wealth in Nigeria: An Overview. *Journal of Human Ecology* (JHE) 46(2): 195-203.

Wang, R., Qi, M., Jingjing, Z., Sun, D., Ning, C., Zhao, J., Zhang L., Lihua Xiao L. (2011). Prevalence of *Cryptosporidium baileyi* in ostriches (*Struthiocamelus*) in Zhengzhou, China.

Veterinary Parasitology 1-2: 151-154.

Yabsley, M.J. (2009). Capillarid Nematodes. In: *Parasitic Diseases of Wild Birds*, Atkinson, C.T., Thomas, N.J. & Hunter, D.B. (Editors). Johnwiley& Sons, Oxford, UK: pp. 463-497.

Yager, G.O., Alarape A.A., Gideon P.K. (2015). Assessment of Recreational Potentials of Makurdi Zoological Garden, Benue State, Nigeria. *Nigerian Journal of Agriculture, Food and Environment* 11(3):80-86.

Zhu, N.W., Deng C.Y., Xiong Y.Z., Qian H.Y. (2004). Performance characteristics of three aeration systems in the swine manure composting. *Bioresource Technology* 95: 319–326.

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