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THE EFFECT OF ABATTOIR EFFLUENT WASTE WATER ON SOILS OF GANDU AREA OF SOKOTO, SOKOTO STATE, NIGERIA

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ABSTRACT: *The study was conducted to investigate the effects of abattoir wastewater on the microbiological and physicochemical properties of soils and neighboring residential wells in Gandu area of Sokoto State. The study was conducted during rainy and the dry season months. The mean count of bacteria in the abattoir waste water was $4.74x10^6$ cfu/ml, while that of the soil was $3.3x10^6$ cfu/g and the well water $2.95x10^5$ cfu/ml. The mean fungal yield was $1.60x10^5$ cfu/ml for the abattoir waste water, $1.5x10^5$ cfu/g for the soil, and $1.0x10^5$ cfu/ml for the well water. A total of 267 different microorganisms belonging to sixteen different genera of public health importance were isolated from the samples. The most frequently isolated microorganisms from abattoir waste water, well water and soil were Bacillus subtilis, Pseudomonas aeruginosa, Escherichia coli, Staphylococcus aureus Aspergillus niger, A. flavus and A. terreus. The physicochemical parameters examined were pH, electrical conductivity, nitrate, phosphate, magnesium, calcium, dissolved oxygen (DO), biological oxygen demand (BOD) and chemical oxygen demand (COD). The result of this study showed that the microbiological and some of the physicochemical properties of the abattoir wastewater, abattoir well water and soil were not within the limits specified by of FEPA and WHO and thus pose threat to the health of the Gandu community.*

Keywords: *Abattoir, wastewater, bacteria, fungus, soil, wells*

INTRODUCTION

Abattoirs, also known as slaughter houses are places where animals are butchered for food. The Abattoir Act (1998) defined abattoir as any premise used for or in connection with the slaughter of animal whose meat is intended for human consumption and include a slaughter house, but does not include a place situated on a farm (Bridges *et al.*, 2000). Abattoir operations, which include slaughtering, boning, and processing of meat products produce wastewater highly charged in soluble and insoluble inorganic matter. This equates to high loading in biological oxygen demand (BOD) due to blood content and high loadings of total suspended solids (TSS) arising from particulates accumulated from the slaughter process.

The whole blood is a rich protein medium for bacterial growth; it is expected that intestinal bacterial flora of slaughtered animals and other pathological lesions on slaughtered animal tissues would suspend in the wastewater and possibly multiply in the stream environment (Coulibaly *et al.*, 2003). Abattoir wastewater is characterized by the presence of high concentration of whole blood of the slaughtered animals and suspended particles of semi-digested and undigested feeds within the stomach and intestine of slaughtered animals (Adeyemo *et al.*, 2002).

The continuous drive to increase meat production for the protein needs of the very increasing world population has some problems attached. In many countries, pollution arises from activities in meat production as a result of failure in adhering to good manufacturing practices (GMP) and Good Hygiene Practices (GHP). Consideration is hardly given to safety practices during animal transport to the abattoir, during slaughter and during dressing. For example, during dressing the esophagus of cattle and sheep are sealed to prevent leakage of animal contents. These ineptitudes often lead to contamination from hide, hooves and content of alimentary tract during evisceration and negatively impact on the environment, including microbes in the soil and surface and ground water (Hinton *et al.*, 2000).

Studies have shown that zoonotic diseases are rampant in over 80% of public abattoir in Nigeria. Some of these infectious diseases include tuberculosis, colibacillosis, salmonellosis, brucellosis, streptococcal infections, staphylococcal infections, helminlthosis pneumonia, diarrhoea, typhoid fever, asthma, wool sorter disease, respiratory and chest diseases (Cadmus *et al.*, 1999).

The aim of this research was to isolate and characterize bacteria in wastewater from the Sokoto State abattoir, investigate the impact of wastewater (effluent) on bacterial population of the soil receiving the effluent and to assess the impact of the abattoir wastewater on the quality of well water, in neighboring residential areas of the abattoir.

MATERIALS AND METHODS

Sampling site: The sampling site was the abattoir located in Gandu Area, off Garba Muhammad Road, Sokoto, Nigeria. Sokoto is located to the extreme Northwestern part of Nigeria between longitudes $4^{O}8'$ and $6^{O}54'E$ and latitudes 12^{O} and $13^{O}58'N$. The total population of Sokoto State is 3, 987, 431 according to the 2006 National Population census. The abattoir is owned by the Sokoto North Local Government Council, the Local Government councils employs and remunerates the menial workers, while the Sokoto State government employs the veterinarians and health personnel for the supervision and monitoring of meat and general abattoir operations. The abattoir is made up of two large slaughter halls: one for the camels and cattle and the other for sheep and goats. However, the abattoir has no chilling rooms and on-rail dressing room. The animals are dressed on bare floor.

Collection and processing of abattoir wastewater: Wastewater was collection from Sokoto abattoir into sterile 20 ml capacity bottles and transported in an ice box to the laboratory. The wastewater was collected from ten points in the abattoir, 3 samples from each point, at the point of slaughter (point 1), midway through the drainage channel (point 2) and the point where the waste water drained to the surrounding soil (point 3). Samples were collected from 7 other points which were 50 meters apart. A total of 30 samples in the rainy season and 30 samples in the dry season were collected.

Soil samples: Soil samples were collected from the abattoir effluent contaminated area and the neighborhood (without wastewater contamination) to serve as control. These soil samples were collected from 10 points at 50 meters interval. Three samples were collected from each of the points making a total of 60 samples, 30 for each of the rainy and dry seasons.

Water samples: Water samples from three reservoirs in the abattoir and two residential wells close to the abattoir were collected in 20 mls sterile bottles. Three samples each were collected from the reservoirs and the wells. A total of 15 samples were collected for each of the 2 seasons, giving a total of 30 samples in all.

Isolation of the microorganisms: One (1g) gram of soil and 1.0 ml of well water and abattoir waste water were each diluted in 9 ml of sterile distilled water to 10^{-3}, 10^{-4} and 10^{-5} dilution factor. An aliquot of 0.4 milliliter from each test tube was transferred using sterile pipette onto sterile molten nutrient agar plate, then spread using a sterile bent glass rod and incubated at $37^{0}C$ for 24 hours for bacterial growth and streaked on Sabouraud dextrose agar (SDA) plates and incubated at 25ºC for 3-5days for fungal growth. Individual colonies observed were sub-cultured on Nutrient agar and Sabouraud dextrose agar plates for another 18-24 hours and 3-5 days respectively and finally grown on agar slants to preserve the pure cultures.

Identification of microorganisms: The bacterial isolates were characterized based on colonial morphology, cultural characteristics and biochemical tests as described by Cheesbrough (2003). The isolates were identified by comparing their characteristics with those of known taxa using the Bergey's manual of determinative bacteriology (Holts *et al.,* 1994).

To identify the fungi, a small portion of the mycelia growth was carefully picked with the aid of a pair of sterile inoculating needles and placed in a drop of lactophenol cotton blue on a microscope slide and covered with a cover slip. The slide was examined under the microscope, first with (x10) and then with (x40) objective lens for morphological examination as described by Cheesbrough (2003). The isolates were identified by comparing their characteristics with those of known taxa using the schemes of Domsch and Gams (1970).

Determination of physicochemical qualities: The physicochemical qualities of the abattoir wastewater, well water and soil samples were determined as follows: pH was determined as described by Udo and Ogunwale (1986) and Ezeronyo and Okerentugba (1999), dissolved oxygen (DO), Ademoroti (1996), biochemical oxygen demand after five days (BOD_5) (APHA, 1981; Ademoroti, 1996), total nitrate using Micro-Kjeldahl methods, electrical conductivity, calcium, (Black *et al.,* 1965); Black *et al.* (1965), phosphorus, calcium and magnesium by EDTA titration method (Walinga *et al.,* 1989).

Data analyses: Data generated from the study were analyzed using descriptive statistics which include as means, frequencies and percentages

RESULTS

Microbial counts: The mean count of bacteria for the waste water was 4.74×10^6 cfu/ml, soil was 3.3×10^6 cfu/g and the well water 2.95×10^5 cfu/ml, while the mean fungal yield was 1.60×10^5 cfu/ml for the waste water and 1.5×10^5 cfu/g for the soil and 1.0×10^5 cfu/ml for the well water.

Frequency of bacterial isolation from abattoir waste water: Table 1 showed the frequency of bacterial isolation from abattoir waste water. The percentage occurrence of these organisms ranged from not detected (ND) to 60%. *Bacillus subtilis* recorded highest occurrence for both the dry and rainy seasons.

Frequency of bacterial isolation from abattoir soil: Table 2 showed the frequency of bacterial isolation from abattoir well water. *Bacillus subtilis* had a percentage occurrence of 53.3 and 23.33 in the rainy season and dry season respectively followed by *Pseudomonas aeruginosa* with occurrence of 26.66 and 26.66% in the rainy season and dry season respectively.

Table 1: Frequency of bacterial isolation from abattoir waste water

Bacteria	Frequency		Percentage %	
	Rainy	Dry	Rainy	Dry
Bacillus subtilis	18	13	60	43.33
Pseudomonas aeruginosa	7	1	23.34	3.33
Escherichia coli	3	5	10	16.67
Salmonella typhi	1	ND	3.33	ND
Yersinia ruckert	1	1	3.33	3.33
Staphylococcus aureus	ND	7	ND	23.33
Neisseria lactamica	ND	1	ND	3.33
Klebsiella pneumonia	ND	2	ND	6.67

Key: ND- Not detected

Table 2: Frequency of bacteria isolated from abattoir soil

Bacteria	Frequency		Percentage %	
	Rainy	Dry	Rainy	Dry
Bacillus subtilis	16	7	53.3	23.33
Staphylococcus aureus	3	3	10	10
Pseudomonas aeruginosa	8	8	26.66	26.66
Klebsiella pneumonia	3	ND	10	ND
Escherichia coli	ND	8	ND	26.66
Vibrio cholera	ND	1	ND	3.33
Salmonella typhi	ND	3	ND	10

Key: ND- Not detected

Frequency of bacterial isolation from abattoir well: Table 3 showed the frequency of bacterial isolation from abattoir well water. *Bacillus subtilis* again had percentage occurrence of 40 and 53.33 in the rainy season and dry season respectively followed by *Staphylococcus aureus* with percentage occurrence of 26.66 and 20.00 in the rainy season and dry season respectively.

Table 3: Frequency of bacterial isolation from abattoir well water

Bacteria	Frequency		Percentage %	
	Rainy	Dry	Rainy	Dry
Pseudomonas aeruginosa	3	3	20	20
Staphylococcus aureus	4	3	26.66	20
Bacillus subtilis	6	8	40	53.33
Escherichia coli	2	1	13.33	16.66

Frequency of fungal isolation from abattoir waste water: Table 4 showed the frequency of fungal isolation from abattoir waste water. *Aspergillus terreus* had the highest percentage occurrence of 26.66 and 30 in the rainy season and dry season respectively followed by *A. niger* with occurrence of 26.66 and 16.66% in the rainy season and dry season respectively. The fungi having the least occurrence were *A. fumigatus* and *Curvularia* sp. (3.33% and ND) in the rainy season and dry season respectively.

Table 4: Frequency of fungal isolation from abattoir waste water

Fungi	Frequency		Percentage %	
	Rainy	Dry	Rainy	Dry
Aspergillus terreus	8	9	26.66	30
Aspergillus flavus	5	2	16.66	6.66
Aspergillus niger	8	5	26.66	16.66
Aspergillus fumigatus	1	ND	3.33	ND
Curvularia sp.	1	ND	3.33	ND

Key: ND- Not detected

Frequency of fungal isolation from abattoir well water: Table 5 showed the frequency of fungal isolation from abattoir well water. *Penicillium echinulatum* had a percentage occurrence of 40 in the rainy season; while *A. flavus* recorded 26.66 and 20% and *A. niger* had 16.66 and 36.66% in the rainy season and dry season respectively.

Table 5: Frequency of fungal isolation from abattoir well water

Fungi	Frequency		Percentage %	
	Rainy	Dry	Rainy	Dry
Aspergillus niger	3	3	20	20
Aspergillus flavus	4	ND	26.66	20
Penicillium echinulatum	6	3	40	ND

Key: ND- Not detected

Frequency of fungal isolation from abattoir soils: Table 6 showed the frequency of fungal isolation from abattoir soils. *A. flavus* had a percentage occurrence of 40 and 16.66 in the rainy season and dry season respectively followed by *A. niger*, which had a percentage occurrence of 16.66 and 36.66 in the rainy season and dry season respectively.

Table 6: Frequency of fungal isolation from abattoir soil

Fungi	Frequency		Percentage %	
	Rainy	Dry	Rainy	Dry
Aspergillus terreus	9	4	10	13.33
Aspergillus flavus	12	5	40	16.66
Aspergillus niger	5	11	16.66	36.66
Aspergillus fumigatus	1	NA	3.33	NA
Curvularia sp.	3	NA	10	NA
Penicillium notatum	NA	8	NA	26.66
Mucor sp	NA	1	NA	3.33

Physicochemical qualities of abattoir waste: Table 7 showed the mean physicochemical parameters of abattoir waste water during the rainy and dry seasons. For the rainy season and dry season respectively, the physicochemical values ranged as follows; pH 5.15 and 6.15, E.C (µs/cm) -1 and -1, nitrate 10.764 and 9.001 mg/l, phosphorus 0.143 and 0.111 mg/kg, potassium 3.88 and 39.86 mg/kg, sodium 22.62 and 7.5 mg/kg, % calcium 0.29 and 0.56, among others.

Table 7: Mean physicochemical parameters of abattoir waste water

Parameters	Rainy season	Dry season	FEPA maximum acceptable limits	WHO Maximum acceptable limits
pH	5.15	6.15	6-9	6.5-9
Electric conductivity (µs/cm)	-1	-1	1000	5
Nitrate (Mg/l)	10.764	9.001	20	50
Phosphate (mg/l)	0.143	0.111	-	5
Magnesium (%)	1.30	0.15	200	-
Calcium	0.29	0.56	200	-
Dissolved oxygen (DO)mg/l	13.89	13.32	-	4
Biological Oxygen Demand (BOD) (mg/l)	11.12	8.88	30	28-30
Chemical oxygen demand (COD) (mg/l)	16.68	19.98	80	1000

Physiochemical qualities of abattoir soil and well water during the rainy and dry seasons: Table 8 showed the mean physicochemical parameters of soil samples during rainy and dry season. For the rainy season and dry season respectively, the physicochemical values range as follows; pH 6.49 and 7.63. E.C (µs/cm) 5438.92 and 733.44, % organic carbon 2.193 and 0.096, % nitrogen 0.0384 and 0.061, phosphorus 2.096 and 2.364mg/kg, potassium 78.4 and 9.575mg/kg, sodium 43.8 and 1.203mg/kg, % calcium 0.394 and 0.094, % magnesium 14.08 and 0.121.

Table 8: Mean physicochemical qualities of abattoir soil and well water samples during rainy and dry seasons

Parameters	Soil Rainy season	Dry season	Well Rainy season	Dry season	FEPA maximum acceptable limits	WHO maximum acceptable limits
pH	6.49	7.63	6.06	5.6	6-9	6.5-9
Electric conductivity (µs/cm)	5438.92	733.44	5376.2	1192.6	1000	5
Organic C (%)	2.193	0.896	5.98	1.44	-	-
Nitrate (%)	0.0384	0.061	3.12	0.92	20	50
Phosphate (mg/l)	2.096	2.364	2.32	0.47	-	5
Calcium (mg/l)	0.394	0.094	3.5	4.68	200	-
Magnesium (%)	14.08	0.121			200	-
DO	-	-	3.5	4.68	-	4
BOD	-	-	7.3	0.94	30	28-30
COD	-	-	10.95	1.41	80	1000

DISCUSSION

A total of 267 different organisms belonging to sixteen different genera of public health importance were isolated from the samples. Several authors have isolated some of these microorganisms from different abattoirs in Nigeria (Benka-Coker and Ojior, 2000; Ezeronye and Ubalua, 2005; Adesemoye *et al.*, 2006; Odeyemi *et al.,* 2011). Most of the fungal isolates were soil- inhabiting microorganisms (Atlas and Bartha, 2007) as well as common spoilage organisms associated with beef industry (Alonge, 1991).

The mean total bacteria count and fungi were high for the sample sites in the abattoir. The presence of these organisms is a pointer to possible pollution and may have an effect on the soil ecological balance. Going by standards, any water contaminated to this level is neither good for domestic use nor is it supposed to be discharged directly into the environment without treatment. The presence of these organisms in the stream and wells that serve as a source of domestic water supply to the neighborhood is a significant health risk (Ezeama and Nwankpa, 2002).

The pH of abattoir wastewater in the dry season, magnesium, phosphate, calcium, nitrate, phosphate, BOD, COD were within the FEPA/WHO limits but the dissolved oxygen and pH of the wastewater in the rainy season were not within FEPA limits. However, the electrical conductivity of abattoir soil was not within FEPA/WHO limits. Thus, the result does give concern and it could make the receiving stream unsuitable for domestic use.

CONCLUSION

The abattoir wastewater analyzed had high counts of various species of fungi and bacteria. It also had some physiochemical properties in amounts that indicated that the waste water was highly polluted. This may pose a health risk to Gandua community in Sokoto which rely on the receiving water body primarily as their source of domestic water. There is need for the intervention of appropriate regulatory agencies to ensure production of high quality treated final effluent from Sokoto abattoir.

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