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Hazard Analysis of Poultry Dressing Unit Effluent

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ABSTRACT

The present study was planned with the objectives to study physical and chemical characters, microbial analysis poultry dressing unit effluent. A total of six (6) poultry dressing units were selected from Parbhani city for sample collection on weekly basis for a period of eight (8) weeks. Physical characters studied were colour, odour, total solids (TS), turbidity and hardness, pH, BOD and COD as chemical characters of effluent water. Microbial analysis was done in relation to MPN for coliform, Staphylococcus sp. and Clostridium sp. screening of the samples. It was observed that 50.00% of effluent water showed red colour and 93.75% samples were positive for offensive odour. A significant (P< 0.05) difference in total solids (TS), turbidity, hardness, pH, BOD and COD were observed among poultry dressing. The mean total solids (TS) of effluent water observed was 3241.67 ± 18.00 mg/L and mean turbidity value was 159.42 ± 0.68 NTU. The hardness and pH values of effluent differs significantly (P< 0.05) amongst poultry dressing units with 533.85 ± 4.50 mg/L of hardness and pH of 7.08 ± 0.04 was observed. The mean BOD and COD values were 152.53 ± 0.46 mg/L and 251.25 ± 2.35 mg/L respectively. The MPN for coliform observed before alum treatment were ranged from 1100 to >2400 MPN per 100 ml and all 48 samples (100.00%) screened resulted into showing presence of Staphylococcus and Clostridium sp. colonies. Evaluation of poultry dressing unit effluent water as compared to IFC standards in relation to pH, BOD, COD and total coliform bacteria revealed that the effluent showed values of some parameters within limits of guideline values except BOD, COD and total coliform bacterial count. The results concluded that the physical and chemical characters of poultry dressing unit effluent differ significantly (P< 0.05) amongst poultry dressing units.

Key words: *effluent, colour, odour, total tolids, turbidity, hardness, pH, BOD, COD, MPN, Staphylococcus, Clostridium.*

INTRODUCTION

A slaughter house is a facility, where animals are butchered / killed for consumption as food products. In India there are approximately 3600 legal (authorized) and over 32,000 illegal (unauthorized) slaughterhouses located both inside and in the city outskirts. Most of them are creating enormous hygienic and environmental problems because they are without adequate basic facilities like water supply, proper flooring, ventilation, transport, etc.

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In addition to these, slaughterhouses also suffer from very low hygienic standards posing major public health and environmental hazards due to discrete disposal of waste and highly polluted effluent discharge. Unauthorized and illicit slaughtering has also increased manifolds and thus, the related problems, like disposal of waste in hazardous manner, pollution of land, air and water, horrible smell/stench etc., make lives of those living in immediate vicinity and also those living farther away, miserable. Efforts to close the illegal open slaughter houses have, so far, been largely unsuccessful[23].

Wastes from the slaughterhouse typically contain fat, grease, hairs, feathers, flesh, manure, grit and undigested feed, blood, bones and process water which is typically characterized with high organic level. The animal blood is released untreated into the flowing stream while the consumable parts of the slaughtered animals are washed directly into the flowing water. The total amount of waste produced per animal slaughtered is approximately 35% of its weight. Improper disposal systems of wastes from slaughter houses could lead to transmission of pathogens to humans and cause zoonotic diseases such as *Colibacillosis, Salmonellosis*. Bacteria from abattoir waste discharged into water bodies can subsequently be absorbed to sediments and when the bottom stream is disturbed, the sediments releases the bacteria back into the water columns presenting long term health hazards[22]. Untreated slaughterhouses waste entering into a municipal sewage purification system may create severe problems, due to the very high biological oxygen demand (BOD) and chemical oxygen demand (COD)[4].

Indian Poultry industry is one of the fastest growing segments of the agricultural sector today in India. As the production of agricultural crops has been rising at a rate of 1.5 to 2 percent per annum while the production of eggs and broilers has been rising at a rate of 8 to 10 percent per annum. Today India is World's fifth largest egg producer and the eighteenth largest producer of broilers. The main contributing factors behind these are - growth in per capita income, a growing urban population and falling of poultry prices. The organized sector of Indian Poultry Industry is contributing nearly 70 percent of the total output and the rest 30 percent in the unorganized sector. Broiler industry is well dominated by the southern states in our country with nearly 60 to 70 percent from these states. The layer industry once again is represented more in southern states especially, Andhra Pradesh, Tamil Nadu and Maharashtra producing nearly 70 percent of the country's egg production. Presently, about 800 hatcheries are operating in India today (www.indianmirror.com)[25].

A significant feature of India's poultry industry has been its transformation from a mere backyard activity into a major commercial activity in aspects of production which ultimately leads to the issues relating to environmental pollution in terms of high biological oxygen demand (BOD) and chemical oxygen demand (COD), large amount of total suspended solid (TSS), and various other pollutants[13]. One of the most important analytical characteristics of poultry processing wastewater is total solids (TS), which is composed of floating, settle able, and colloidal matter. TS are defined as the residual material remaining in a vessel after evaporating a sample and then drying it at a specific temperature[2]. Environmental problems have increased in geometric proportion over the last three decades with improper management practices being largely responsible for the gross pollution of the aquatic environment with concomitant increase in water borne diseases especially typhoid, diarrhoea and dysentery. Abattoirs are generally known all over the world to pollute the environment either directly or indirectly from their various processes[1].

MATERIAL AND METHODS

Collection of samples: A total of six poultry dressing units were randomly selected and given codes *viz.* A, B, C, D, E and F. A total quantity of 500ml poultry dressing unit effluent water was collected in a sterile bottle

on ice and brought to laboratory. A total of 48 samples comprising of six samples per week for eight weeks at the interval of one week were collected.

Physico-chemical parameters: The physical characteristics of colour and odour were assessed qualitatively as per earlier work carried out by Saritha and Ambica[21]. Total solids (TS), turbidity, hardness, pH before and after alum treatment were determined as per the methods given in BIS[5]. Biological oxygen demand (BOD) and Chemical oxygen demand (COD) were determined as per standard method described by Rand *et al*[19].

Most Probable Number (MPN) for coliform: Standard Most Probable Number (MPN) technique was used as described in APHA[2], using Mac Conkey broth (Hi-Media Laboratories, Mumbai) as a cultivating medium, and incubated at 35°C for 24 hours. Results were expressed as MPN per 100 ml samples by using Mc Crady's Probability Table.

Isolation of Organisms: Isolation of *Staphylococci* spp. and *Clostridium* spp. was done as per the method described in BAM[3] and the results were calculated in percentage.

RESULTS AND DISCUSION

A total of six poultry dressing units were randomly selected and given codes *viz.* A, B, C, D, E and F. A total quantity of 500ml poultry dressing unit effluent water was collected in a sterile bottle on ice and brought to laboratory. A total of 48 samples comprising of six samples per week for eight weeks at the interval of one week were collected.

Physical characters: The physical characters of effluent water were studied in relation to colour, odour, total solids (TS) and turbidity. The colour analysis was done visually by classifying colour into various types as blackish, red, pale red. All 48 samples were analysed for colour analysis. The samples showed various colours as blackish (27.08%), red (50.00%) and pale red (22.92%). The colour of effluent water of poultry dressing unit is dependant upon contamination of water with slaughter waste such as blood, tissue, intestinal content, etc. The odour of effluent water was classified into Offensive, Unpleasant and Not Unpleasant. The samples showed odours as Offensive (93.75%), Unpleasant (6.25%) and Not Unpleasant (0.00%).

Total solids estimation of effluent water was done in all the samples. The mean of poultry dressing units A (3140.81 $\pm$ 31.17 mg/L), B (3300.00 $\pm$ 31.17 mg/L), C (3187.50 $\pm$ 31.17 mg/L), D (2100.00 $\pm$ 31.17 mg/L), E (3312.50 $\pm$ 31.17 mg/L) and F (3325.00 $\pm$ 31.17 mg/L) differs significantly ($P< 0.05$) whereas those of poultry dressing unit A and C did not differ significantly. Also the pooled means of poultry dressing unit B, D, E and F did not differ significantly. The differences in mean TS values amongst different poultry dressing units may be due to variations in management of poultry slaughter procedures. The mean value is shown in Table 1.

The turbidity values were compared amongst poultry dressing units. The mean turbidity counts recorded were A (109.75 $\pm$ 1.17 NTU), B (124.25 $\pm$ 1.17 NTU), C (130.81 $\pm$ 1.17 NTU), D (135.25 $\pm$ 1.17 NTU), E (144.31 $\pm$ 1.17 NTU) and F (148.06 $\pm$ 1.17 NTU). The mean turbidity values of poultry dressing units A, B, C, D, E and F differs significantly ($P< 0.05$). The pooled mean turbidity values of A, D and E did not differ. Hanafy and Elbary[9], studied and recorded 152 NTU in wastewater effluent.

Chemical characters: The chemical analysis of effluent was done by estimating hardness, pH, biological oxygen demand (BOD) and chemical oxygen demand (COD). Hardness of all effluent samples was estimated and the mean value is shown in Table 1. The mean hardness of effluent from different poultry dressing units observed were A (607.50 $\pm$ 7.79 mg/L), B (566.87 $\pm$ 7.79 mg/L), C (462.50 $\pm$ 7.79 mg/L), D (462.81 $\pm$ 7.79 mg/L), E (485.31 $\pm$ 7.79 mg/L) and F (493.44 $\pm$ 7.79 mg/L). The means were compared to determine significance of differences of means. The pooled mean hardness of poultry dressing unit A differs significantly ($P< 0.05$)

from B, C and E. However, means of A did not differ with D and B did not differ with F[4,10,17]. The mean pH values observed amongst poultry dressing units were A (6.64 ± 0.07), B (6.05 ± 0.07), C (5.84 ± 0.07), D (6.00 ± 0.07), E (6.26 ± 0.07) and F (6.21 ± 0.07). The mean of poultry dressing unit A, B, C and E differs significantly (P< 0.05), the means of A, D and F did not differ significantly. Also the means of B and E did not differ significantly. Earlier, Osibanjo and Adie[16] reported pH of 6.92 to 8.18 in abattoir effluent. Abattoir effluent pH of 5.75 was also reported by Magaji and Chup[11]. The results are on the lines of earlier work.

Estimation of BOD values of all the collected samples (48) from all six poultry dressing units was done. The BOD determination is a chemical procedure for determining the amount of dissolved oxygen (DO) needed by aerobic organisms in a water body to break the organic materials present in the given water sample at certain temperature for a specific period of time. BOD of polluted water is the amount of oxygen required for the biological decomposition of dissolved organic matter under standard conditions. The values observed were A (120.62 ± 0.79 mg/L), B (124.78 ± 0.79 mg/L), C (123.60 ± 0.79 mg/L), D (122.18 ± 0.79 mg/L), E (124.80 ± 0.79 mg/L) and F (129.40 ± 0.79 mg/L). The mean BOD value observed was 152.53 ± 0.46 mg/L as shown in Table 1.

All the 48 samples of effluent were analysed for estimation of COD. The mean COD values observed were A (207.25 ± 4.07 mg/L), B (208.63 ± 4.07 mg/L), C B (200.38 ± 4.07 mg/L), D (198.38 ± 4.07 mg/L), E (187.63 ± 4.07 mg/L) and F (204.37 ± 4.07 mg/L). It is evident that mean COD value of effluents of poultry dressing unit A, B, C, E and F differs significantly (P< 0.05). The mean COD values of effluent of poultry dressing unit A and B, B and E, C and F did not differ. The mean COD of effluent water was 251.25 ± 2.35 mg/L as shown in Table 1.

Table 1: Means of physical and chemical characters of poultry dressing unit effluent

Sr. No	Total No. of Samples	Parameter	Results
1.	48	Colour	Red
2.	48	Odour	Offensive
3.	48	Total solids (mg/L)	3241.67 ± 18.00
4.	48	Turbidity (NTU)	159.42 ± 0.68
5.	48	Hardness (mg/L)	533.85 ± 4.50
6.	48	pH	7.08 ± 0.04
7.	48	BOD (mg/L)	152.53 ± 0.46
8.	48	COD (mg/L)	251.25 ± 2.35

Microbial analysis: All the effluent samples collected from different poultry dressing unit (N = 6) were pooled together and estimation of MPN for coliform was done. The effluents contain high MPN for coliform ranging from 1100 to >2400 per 100 ml. The coliform count between 3 to 1100 MPN per 100 ml was reported from Dal lake water contamination[20]. High MPN values of coliform in slaughterhouse effluent water were reported by Olayinka *et al*[14]. The results of the present study are in agreement with earlier works.

Staphylococcus species was found in abundance in slaughter effluent water[18,15,12,8,24]. In the present study also, all the effluent samples (N = 48) showed presence of *Staphylococcus* sp. (100.00%) as given in Table 2. The result is in agreement with earlier work. The screening of all effluent samples (N = 48) on selective medium Sodium Polymixin Sulpha-diazine (SPS) agar is done for *Clostridium* sp. It is quite evident that all the effluent samples (100.00%) were positive for *Clostridium* sp. presence. Earlier, Fransen *et al.*[7] reported presence of *Clostridium* sp. in slaughter effluent at the level of 3.1 to 5.8 N/gram. Ezeronye and Ubalua[6] reported presence of *Clostridium* sp. in abattoir effluent. In the present study also, *Clostridium* sp. were observed on similar lines.

Table 2: Details of microbial analysis of poultry dressing unit effluent

Sr. No	Total No. of samples	Parameter	Results
1.	48	Most Probable Number (MPN/100ml)	1100 - >2400
2.	48	*Staphylococcus* spp. (% of positive)	100
3.	48	*Clostridium* spp.(% of positive)	100

CONCLUSION

pH, BOD, COD and total coliform bacterial counts are being used as Environmental, Health and Safety guidelines by IFC for poultry processing. pH of 6 to 9 is standard pH as per the IFC guidelines. In the present study, the effluent pH of 7.08 ± 0.04 was obtained. The values obtained in the present study are within prescribed limit.

The BOD values of 152.53 ± 0.46 mg/L in effluent was higher than the prescribed limit of 50 mg/L in IFC standards. Higher levels of BOD in poultry dressing unit effluent indicate availability of lower level of biological oxygen for aerobes. This indicate the pollution level of poultry dressing unit water.

The permissible limits of COD are 250 mg/L as per IFC guidelines. In the present study, the COD values observed was 251.25 ± 2.35 mg/L in effluent. The result showed that the COD value was higher than the permissible limits of IFC standard.

In the present study, the minimum coliform count of 1100 MPN per 100 ml was seen in the effluent and the maximum was >2400 MPN per 100 ml. As per the guideline of IFC, the standard guideline value is of 400 MPN per 100 ml in poultry dressing unit .The results of the present study clearly indicated that the coliform counts of effluents were higher than prescribed limits.

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