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Management of Effluent from Unorganized Poultry Dressing Units in Parbhani City, Maharashtra

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ABSTRACT

The present study was planned with the objectives to study physico-chemical characters, microbial analysis and effect of alum treatment on effluent water of unorganized poultry dressing units. 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. Physico-chemical characters colour, odour, total solids (TS), turbidity,hardness, pH, BOD and COD of effluent water were studied Micr.obial analysis was done in relation to MPN for coliform, Staphylococcus sp. and Clostridium sp. screening of the samples. It was observed that 83.33% of effluent water before alum treatment showed red colour and 90.12% of effluent water after treatment showed brown colour. A total of 93.75% samples were positive for offensive odour before treatment and 79.17% of the samples after treatment were unpleasant. 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 before alum treatment which reduced to 2873.60 ± 18.00 mg/L after alum treatment. The mean turbidity value was 159.42 ± 0.68 NTU before alum treatment and 104.73 ± 0.68 NTU after alum treatment. 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 before alum treatment and 492.29 ± 4.50 mg/L after treatment, pH of 7.08 ± 0.04 before alum treatment and 5.25 ± 0.04 after alum treatment. The mean BOD and COD values were 152.53 ± 0.46 mg/L before alum treatment and 95.93 ± 0.46 mg/L after alum treatment and 251.25 ± 2.35 mg/L before and 150.96 ± 2.35 mg/L after alum treatment respectively. The MPN for coliform observed before alum treatment were ranged from 1100 to >2400 MPN per 100 ml before alum treatment which reduced to 29 to 240 MPN per 100 ml after alum treatment. All 48 samples (100.00%) screened resulted into showing presence of Staphylococcus and Clostridium sp. colonies before alum treatment. The percentage of Staphylococcus colonies after alum treatment found was 93.75%. and Clostridium sp. after treatment was 95.83% respectively. 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 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 and the alum treatment given was effective in removing physical and chemical impurities except BOD, but not effective on microbial parameters.

Key words: *Effluent, BOD, Hardness, Turbidity, Poultry dressing units, MPN.*

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INTRODUCTION

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).

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[17]. 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].

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 Coli, Bacillosis, 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[27]. 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)[5]. Therefore treating of slaughterhouse wastewater is very important for prevention of high organic loading to municipal wastewater treatment plants.

Aluminium salts are the most widely used coagulants in water and wastewater treatment all over the world. However, the studies by several workers have raised doubts about introducing aluminium into environment. Though, some studies have reported that aluminium that remains in the water after coagulation may induce Alzheimer's disease[14]. Despite its drawback, aluminium is still commonly used as the flocculant to coagulate small particles into larger flocs that can be efficiently removed in the subsequent separation process of sedimentation and/or filtration. It is also used because of its higher efficiency and relatively low costs compared with the traditional flocculants. Alum has been one of the most effective coagulant agents in water and wastewater treatment facilities with various applications, including removal of colloids and suspended particles, organic matter, metal ions, phosphates, toxic metals and colour[29,30].

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.

Alum treatment: Alum treatment of the effluent water samples were given according to the procedure described by Saritha and Ambica[26]. A quantity of 15 gram alum was dissolved in 1 liter of distilled water. After rigorous mixing, a quantity of 100 ml of the alum solution per 1 liter of effluent water was used in the present study.

Poultry dressing unit effluent water with coagulant alum are agitated in a flocculator at 100 rpm for 1 minute and then 30 rpm was quickly established for 10 minutes. The samples were removed carefully from the flocculator and allowed to settle for 60 minutes. The clear effluent from few mm below level of water was taken out for analysis.

Physico-chemical parameters: The physical characteristics of colour and odour were assessed qualitatively as per earlier work carried out by Saritha and Ambica[26]. Total solids (TS), turbidity, hardness, pH before and after alum treatment were determined as per the methods given in BIS[6]. Biological oxygen demand (BOD) and Chemical oxygen demand (COD) were determined as per standard method described by Rand *et al*[24].

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 DISCUSSION

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. Alum is being used for settling down of suspended impurities by coagulation[10]. The results of the present study clearly indicated that colour changes after alum treatment may be due to coagulation. The samples before alum treatment showed odours as offensive which after alum treatment is reduced to unpleasant odour. It is evident from odour analysis that Offensive odour was reduced with alum treatment thereby indicating effect of alum coagulation on odour. Earlier, many workers successfully used alum treatment of effluents in Offensive and Unpleasant odour removal[10,11,26,5,4]. The results of the present study are on similar lines.

Mean TS of all the samples from all poultry dressing units were determined before and after alum treatment. The results are shown in Table 01. The pooled TS values differ significantly ($P < 0.05$) when compared before and after alum treatment. The TS value was reduced from 3241.67 $\pm$ 18.00 mg/L to 2873.60 $\pm$ 18.00 mg/L. This may be due to the effect of alum treatment. Earlier Hanafy and Elbary[10], found TS value of 706 mg/L before alum treatment which was reduced to 104mg/L in effluent water. Reduction in TS in industrial wastewater after alum treatment was also reported by Karamany[11]. The results of the present study are in agreement with earlier works. The mean turbidity of effluent before alum treatment was 159.42 $\pm$ 0.68 NTU and after alum treatment reduced to 104.73 $\pm$ 0.68 NTU. The pooled mean turbidity of alum treated effluent was significantly ($P < 0.05$)

reduced. Effect of alum resulted into reduction in turbidity to 152 NTU in wastewater effluent[10]. Significant effect of alum treatment on wastewater was reported by Parmar *et al*[21,26], removed 97% turbidity from tannery effluent by using alum. The results of present study are in agreement with earlier work.

The mean hardness of effluent before alum treatment was 533.85 $\pm$ 4.50 mg/L and after alum treatment was 492.29$\pm$ 4.50 mg/L. The mean hardness of effluent was significantly reduced ($P< 0.05$) after alum treatment. Parmar *et al.*[21] reported significant effect of alum in reduction of hardness of dairy industry wastewater. Bazrafshan *et al.*[5] successfully treated slaughterhouse effluent with alum for removal of hardness. Loloei *et al.*[12] found high efficiency of alum than ferrous sulfate. Qasim and Mane[22] showed better ability of alum in removal of hardness of food industrial effluents. The results of present study are on similar lines. The mean pH of effluent before alum treatment and after alum treatment shown in Table 01. The pH of effluent before alum treatment (7.08 $\pm$ 0.04) was significantly ($P< 0.05$) lowered to 5.25 $\pm$ 0.04. Earlier, Osibanjo and Adie[20] reported pH of 6.92 to 8.18 in abattoir effluent. Abattoir effluent pH of 5.75 was also reported by Magaji and Chup[13]. Lowering of pH of effluent water due to alum treatment on tannery effluent was reported by Banuraman and Meikandaan[4]. In the present study also, alum treatment resulted into reduction in pH of effluent from 7.08 $\pm$ 0.04 to 5.25 $\pm$ 0.04. The results are on the lines of earlier work.

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. In the present study, alum treatment significantly ($P< 0.05$) reduced BOD of poultry dressing unit effluents thereby indicating a positive role of alum in reduction of BOD. The results are on similar lines of earlier work. Qasim and Mane[22] reported reduction in BOD values due to alum treatment of food industrial effluents. Initial BOD value of 3480mg/L of tannery effluent was reduced by 82% with the application of alum. Muralimohan and Palanisamy[15] reported better efficiency of coagulation method in removing BOD of textile mill effluent. The mean COD of effluent before alum treatment was 251.25 $\pm$ 2.35 mg/L and after alum treatment was 150.96 $\pm$ 2.35 mg/L. The results are shown in Table 01. The mean COD of effluent after alum treatment reduced significantly ($P< 0.05$). Significant effect of alum on reducing COD in effluent water was observed by Hanafy and Elbary[10]. Efficiency of alum in treatment of effluent water was also observed by Hassan and Puteh. Many workers used alum for reduction of COD values in effluent water[11,21,26,12,4]. The results of present study are on similar lines.

Table 1: Details of physico-chemical characters of poultry dressing unit effluent water before and after alum treatment

Sr. No	Total No. of Samples	Parameter	Before treatment	Alum treatment
1.	48	Colour	Red	Brown
2.	48	Odour	Offensive	Unpleasant
3.	48	Total solids (mg/L)	3241.67 $\pm$ 18.00	2873.60 $\pm$ 18.00
4.	48	Turbidity (NTU)	159.42 $\pm$ 0.68	104.73 $\pm$ 0.68
5.	48	Hardness (mg/L)	533.85 $\pm$ 4.50	492.29$\pm$ 4.50
6.	48	pH	7.08 $\pm$ 0.04	5.25 $\pm$ 0.04
7.	48	BOD (mg/L)	152.53 $\pm$ 0.46	95.93 $\pm$ 0.46
8.	48	COD (mg/L)	251.25 $\pm$ 2.35	150.96 $\pm$ 2.35

The estimation of MPN for coliform was done before and after alum treatment. The results are shown in Table 02. The effluents contain high MPN for coliform ranging from 1100 to >2400 per 100 ml before alum treatment. The values reduced drastically in all alum treated samples. After alum treatment, the count ranged from between 29 to 490 MPN coliform per 100 ml. Rajanna *et al.*[23] reported MPN of 150 per 100 ml in industrial effluent water. The coliform count between 3 to 1100 MPN per 100 ml was reported from Dal lake water contamination[25]. High MPN values of coliform in slaughterhouse effluent water were reported by Olayinka *et al*[18]. The results of the present study are in agreement with earlier works.

Staphylococcus species was found in abundance in slaughter effluent water. In the present study also, all the effluent samples (N = 48) showed presence of *Staphylococcus* sp. (100.00%) before alum treatment. The percentage of *Staphylococcus* sp. after alum treatment was reduced to 93.75 % only. The results are given in Table 02. The results are in agreement with earlier work. However, alum treatment did not affect much on microbial quality of effluent in relation to *Staphylococcus* sp.

The results of screening of all effluent samples (N = 48) on selective medium Sodium Polymixin Sulpha-diazine (SPS) agar, are shown in Table 02. It is quite evident that all the effluent samples (100.00%) were positive for *Clostridium* sp. presence. The percent positivity of 95.83 % was observed after alum treatment. Earlier, Fransen *et al.*[8] reported presence of *Clostridium* sp. in slaughter effluent at the level of 3.1 to 5.8 N/gram. Ezernye and Ubalua[7] reported presence of *Clostridium* sp. in abattoir effluent. In the present study also, *Clostridium* sp. were observed on similar lines. However, the effect of alum treatment on reduction in *Clostridium* sp. was not observed.

Table 2: Details of microbial analysis of poultry dressing unit effluent water before and after alum treatment

Sr. No	Total No. of samples	Parameter	Before treatment	Alum treatment
1.	48	Most Probable Number (MPN/100ml)	1100 - >2400	29 - 490
2.	48	*Staphylococcus* spp. (% of positive)	100	93.75
3.	48	*Clostridium* spp.(% of positive)	100	95.83

CONCLUSION

The 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 $\pm$ 0.04 before alum treatment was reduced to 5.25 $\pm$ 0.04 after alum treatment (Table 01). The values obtained in the present study are within prescribed limit.

The BOD values of 152.53 $\pm$ 0.46 mg/L in effluent before alum treatment and that of 95.93 $\pm$ 0.46 mg/L after alum treatment were 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. Also, it is noticeable that alum treatment of effluent water could not reduced BOD values to permissible limits.

The permissible limits of COD are 250 mg/L as per IFC guidelines. In the present study, the COD values observed were 251.25 $\pm$ 2.35 mg/L in effluent before alum treatment which was reduced to 150.96 $\pm$ 2.35 mg/L after alum treatment (Table 01). The result showed that the COD values were within 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. The reduction in coliform count was from 29 to 460 MPN per 100 ml (Table 02). As per the guideline of IFC, the standard guideline value is of 400 MPN per 100 ml in poultry dressing unit effluent. The results of the present study clearly indicated that the coliform counts of effluents were higher than prescribed limits. However, the counts were reduced due to alum treatment of effluent thereby indicating its effectiveness.

Therefore, the physico-chemical characters of poultry dressing unit effluent were affected by alum treatment in relation to colour, odour, total solids (TS), turbidity, hardness, pH, BOD and COD. The poultry dressing unit effluent values of pH and COD were found to be within permissible limits of IFC guideline values in samples before and after alum treatment. The Microbial analysis of poultry dressing unit effluent revealed the presence of coliform, *Staphylococcus* sp. and *Clostridium* sp. The alum treatment was found to be effective in removing physical and chemical impurities except BOD, but not effective on microbial parameters.

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