Effects of Photographic Effluent on Total Heterotrophic Bacteria and Fungi in Qua Iboe River, Ikwuano LGA, Abia State

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ABSTRACT:
Laboratory scales were set up to study the effects of photographic effluent on heterotrophic microbes (fungi and bacteria) in water. The analyses were based on contemporary scientific principles for microbial, physicochemical and heavy mental analyses. Water samples were designated as groups A, B,C,D E and F which represents the different treatments(TRTo-5) level of photographic effluent addition. Accordingly, the groups were treated with 0, 5, 10, 15, 20, 25mls of the effluent respectively. The result shows that silver (Ag 6.19mg/l), iron(Fe 77.5mg/l), pH (5.6), BOD (391.3mg/l), COD (713mg/l), DO(16.3mg/l), CL (1.31mg/l), TSS (370.1mg/l), TS (4990.7mg/l), contents in photographic effluent were above permissible level and fails to meet the standard for effluent discharge stipulated by Federal Ministry of Environment . All the treatments recorded the same incremental trend in the eight days exposures, for instance Fungal count (cfu/ml) X 10^2 shows as follows**:** **TRT_0**; (Day 0) 5.67, (Day 2) 10.33, (Day 4)13.33, (Day 6)14.67, (Day8)15.33;**TRT_1**;(Day 0) 5.67, (Day 2) 8.67, (Day 4)8.67,(Day 6)10.67, (Day 8)13.00; **$TRT_{2;}$** (Day 0)5.67, (Day 2) 8.00, (Day 4) 8.00, (Day 6) 8.33, (Day 8)11.00; **$TRT_{3;:}$**(Day 0)5.67, (Day 2)7.33, (Day 4)7.67, (Day 6)8.6, (Day 8)10.33; **$TRT_{4\,:}$**(Day 0)5.67, (Day 2)7.33, (Day 4) 7.67, (Day 6)7.67, (Day 8) 9.00; **TRT** (Day 0) 5.67, (Day 2) 7.67, (Day 4) 7.67, (Day 6) 8.67, (Day 8) 10.33. The fungal count shows significant difference in the 6^{th} and 8^{th} days of exposure, while the bacterial counts shows significant difference on the 2^{nd}, 4^{th} and 6^{th} days of exposure. It therefore becomes imperative to pre-treat photographic effluents before discharging them into the environment.

Keywords: Photograph, Heavy metal, Silver, Mutagens, Movie, Treatments

Introduction

Photographic processing is the development or printing of paper prints, slides, negative, enlargements, movie film, and other sensitized materials. This work is performed by establishments providing the following services: portrait photography for the general public; commercial photography; commercial art or graphic design; or photo finishing. The photo processing industry is very diverse. It includes photo finishing laboratories, X-ray processing at medical and dental facilities and industrial sites, professional photographic operations, motion picture laboratories, processing for scientific used such as astronomy and geology, aerial mapmaking and satellite photography, micro film processors, graphic arts operations and others. The major sources of waste water in the photographic processing subcategory are photo processing solution overflows and wash waters. The process wash water discharged by these facilities typically includes:

1. Film and paper wash water
2. Solution make-up water
3. Area and equipment wash water (Thomas, 2006).

According to Saranraj. (2013) photographic processing and its related activities produce waste. The best way to manage this waste is to minimize it where even possible by using the 3Rs-reduse, reuse and recycle. These are the most cost effective and environmentally responsible methods of dealing with waste. Most of the waste photographic processing facility produce is non-hazardous. In addition, their facilities may also generate some waste that is defined by environmental authorities as hazardous, meaning it is capable of affecting human health or the environment if it is not managed properly. Studies have shown that heterotrophic organisms have a feel of these effluents from photographic processing. Within the photographic processing industry, there is a tremendous variation in the size of photographic processors and in the nature of their effluents. The volume of effluents range upwards to over 100,000 gpd (38cum/day) for large photographic processors. Some effluents have 5-day biochemical oxygen demand (BOD) concentrations as high as 3,000mg/l, while others have BOD's typical of domestic waste water. The BOD of most processing effluent is caused by the chemicals. Some of these chemicals include: thiosulfate, acetate, surfeit, benzyl alcohol, formalin, chromium, silver and others. For the past eight years, the east-man Kodak Company has been involved in a program aimed at reducing the pollution from photographic processing laboratories.

The photographic waste water processing system consists of three elements: a film processor, a wash water recycle system and a fixer recycle and silver recovery subsystem. The film processor effluents include: the developer and fixer solutions and the thiosulfate wash water stream. After the film is fixed, it goes through the wash water recycle system, where it is immersed in thiosulfate wash water and sprayed with fresh water (rinse water). This work was therefore designed to investigate the effect of photographic effluent on heterotrophic microbes: fungi and bacteria.

Materials and Methods Study Area

The research work was conducted in Umudike, Ikwuano L.G.A, Abia State., The sampled river was Qua Iboe river coursing through National Root Crops Research Institute, Umudike. The photographic effluent was collected from Photo Fast Laboratory located in Umuahia Abia State

Sampling and Sample Preparation

Sterile bottles were used in the sampling and aseptic conditions were strictly observed during sampling. Samples were collected against the water current. Ten litters of the water was collected from the river, the water samples were taken to the laboratory (CESLAB Global Research Laboratory Unit) without delay (not beyond six hours) while test and analyses started immediately on arrival at the laboratory. The water sample was first analyzed prior to treatment with photo effluent. Similarly, the photo effluent was also analyzed to establish its composition prior to introduction into the water. Treatments were analysed at specific intervals to establish variation in microbial count..

Microbial Analyses Serial Dilution

The water samples were separately diluted serially as shown in the sketch below:

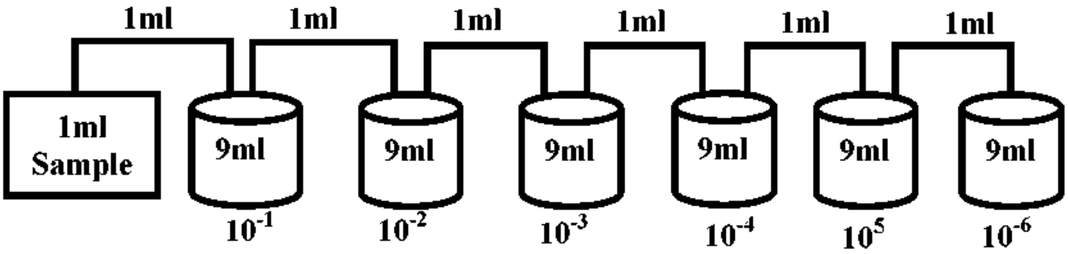


Fig 1. Serial dilution.

1ml of the sample (well mixed by measure) was dilute in 10 folds as shown above and inoculum was collected from the 3rd (10^{-3}) for fungi culture and the sixth (10^{-6}) for bacteria culture as described by Chesbrough, (2005).

Preparation of Media

Two different media were prepared for fungi and bacteria.

a. Preparation of nutrient agar (for bacterial) 2.89 was dissolved in 100ml of distilled water and sterilized by autoclaving at 121^0C for 15 minutes.

b. Preparation of SDA (Sabourad Dextrose Agar) 6.5g was dissolved in 100ml of distilled water and sterilized by autoclaving.

The formula below was used to calculate the heterotropic load as total viable aerobic count:

TVC $_{cfcA}$nl1 x N x D

V

V = Volume of inoculums cultured N

= Number of counted colonies

D=Dilution factor

Inoculation for Culture

Pour plate technique was used after allowing the sterilized media to cool to about 35-40^0C.

Exactly 1ml of inoculum was collected from the 3rd dilute (10^{-3}) of each sample and dispersed into a labeled petri dish and about 15ml of the prepared sterilized SDA was poured into the dish. It was swirled to mix and then allowed to cool to room temperature and solidity.

NOTE: One separated sterile calibrated syringe was used for measuring the inocular for each sample. Inoculation for bacteria was done the same way as listed above but nutrient agar (N.A) was used.

Incubation

SDA plate for fungi where incubated at room temperature for 2-5 days The average room temperature was between 32^0C maximum thermometer.

N.A plates for bacteria were incubated at 37^0C for 2448 hours.

Determination of Physico-chemical and Biological Parameters of Qua-Iboe river.

Determination of pH

This was done by direct reading using colonial electrode pH meter (Model H 70300m).The instrument was calibrated with buffered solution of pH 4.0 and 7.0 separately. To read the pH of water sample, the electrode of the instrument was inserted inside a small portion of the sample (20ml) in a glass beaker and its pH was read from the screen when the figures became steady. The electrode was rinsed in distilled water after the reading.

Determination of temperature: The temperature of the water samples were determined by the use of the conventional mercury in bulb thermometer and expressed in degree Celsius.

Determination of Hardness
Hardness was determined using the EDTA criterion metric titrimetric described by Okeke and Adina (2013) based on APHA (1995).Total hardness was calculated as the sum of calcium and magnesium hardness.

Determination of BOD
This was determined using the oxygen balance difference titrimetric method (APHA 2005). the dissolved oxygen (DO) was determined at two different levels: Day zero(0) & Day five(5) and the difference between the value at the zero day and after 5 days of incubation gave the Biological Oxygen Demand (BOD).

Determination of Turbidity
Turbidity was determined by direct measurement using a ranch laboratory turbidometer.

Determination of Electrical Conductivity
Was done using Hannah Multimeter instrument H19298

Determination of Chemical Oxygen Demand
COD was determined using D1-chromate oxidized ferric sulphate titrimetry (APHA 2000)

Photographic Effluent Analysis
Determination of Heavy Metals in the Photographic Effluent (Particularly Silver and Iron)
The effluent sample was digested and the extract obtained for Atomic Absorption spectrophotometry (AAS) determination of metals. Dry ash acid extraction method was used and the instrument, Cecil Atomic Absorption Spectrophotometer AAS was set up according to the manufacturers directives.

Determination of Silver and Iron (Ag &Fe)
Silver determination was done by the ion replacement gravimetric method (Kodak).

Statistical Analysis
The data collected from this study was subjected to Analysis of Variance (ANOVA) using statistical package for Social Sciences (SPSS) to determine the variation of means of the result from various sections of sample collection. Results of the water quality parameter and photographic effluent obtained were compared with values recommended as international minimum standards by FMEnv (2001) and WHO (1984

Results
Table 1: Result of Photographic Effluent Analysis

Parameters	Value
pH	5.6 ± 0.00
BOD mg/1	391.3 ± 20.18
COD mg/1	713 ± 25.71
DO mg/1	16.3 ± 12.21
CL mg/1	1.31 ± 0.041
TSS mg/1	370.1 ± 57.0
TS mg/1	4990.7 ± 110.5
Ag mg/1	6.19 ± 5.08
Fe mg/1	77.5 ± 63.2

Value show means of triplicate analysis ± standard deviation

Table 2. Physico Chemical and Biological Parameters of Qua Iboe River Water

Parameters	Value
pH	6.067 ± 1.44
Temp	30 ± 0.00
Turbidity	8.966 ± 0.116
Ts mg/l	326.66 ± 15.28
EC ps/ cm	178.33 ± 1.801
TDS mg/1	183.33 ± 15.28
TSS mg/1	143.33 ± 5.774

Hardness mg/1	29.23 ±1.793
Acidity mg/1	6.83 ± 0.299
DO mg/1	9.13 ± 0.306
BODmg/1	7.13 ± 0.306
Ag mg/1	
CL mg/1	21.56 ± 0.207
TVC (cfu/ml):	
Bacterial	142.33 ± 4.042
Fungi	6.33 ± 1.155

Value show means of triplicate analysis ± standard deviation

Effect of photographic effluent on Fungi load

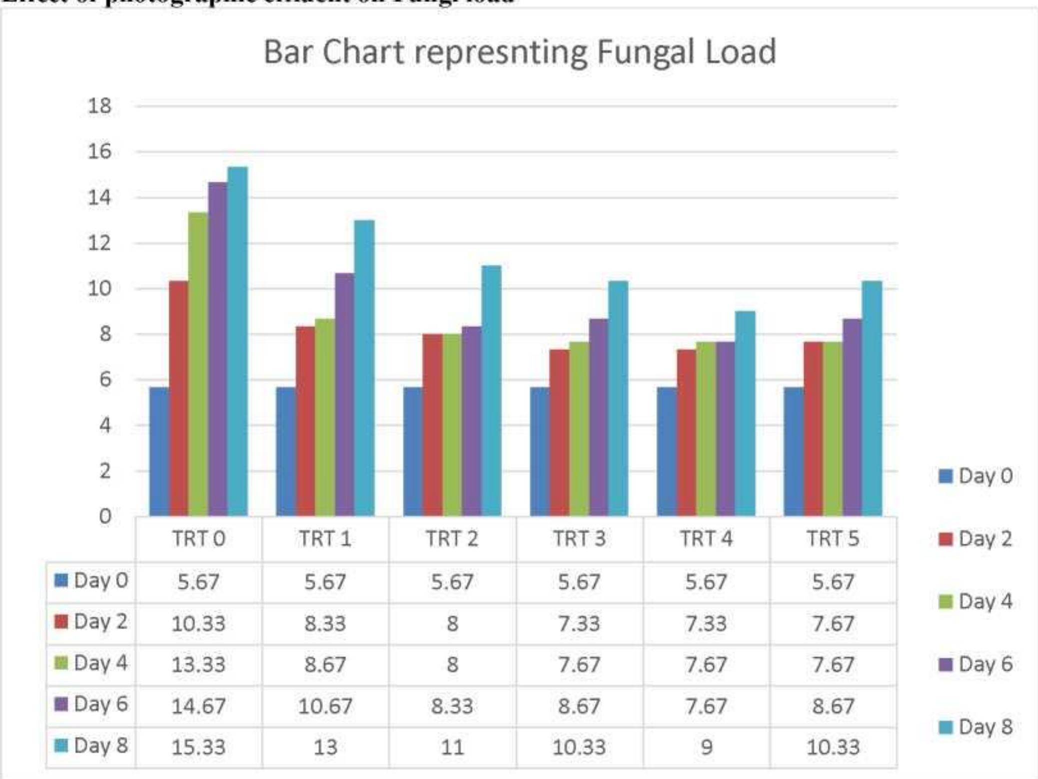


Fig.2. Bar chart showing fungal count

The Bar chart representing fungal load shows that on Day Zero treatment Zero which is the control increases from 5.67 to 15.33 based on their days of storage.

Treatment one that undergoes 5% concentration of photographic effluent which increase from day zero 5.67 to 13.00 of day eight.

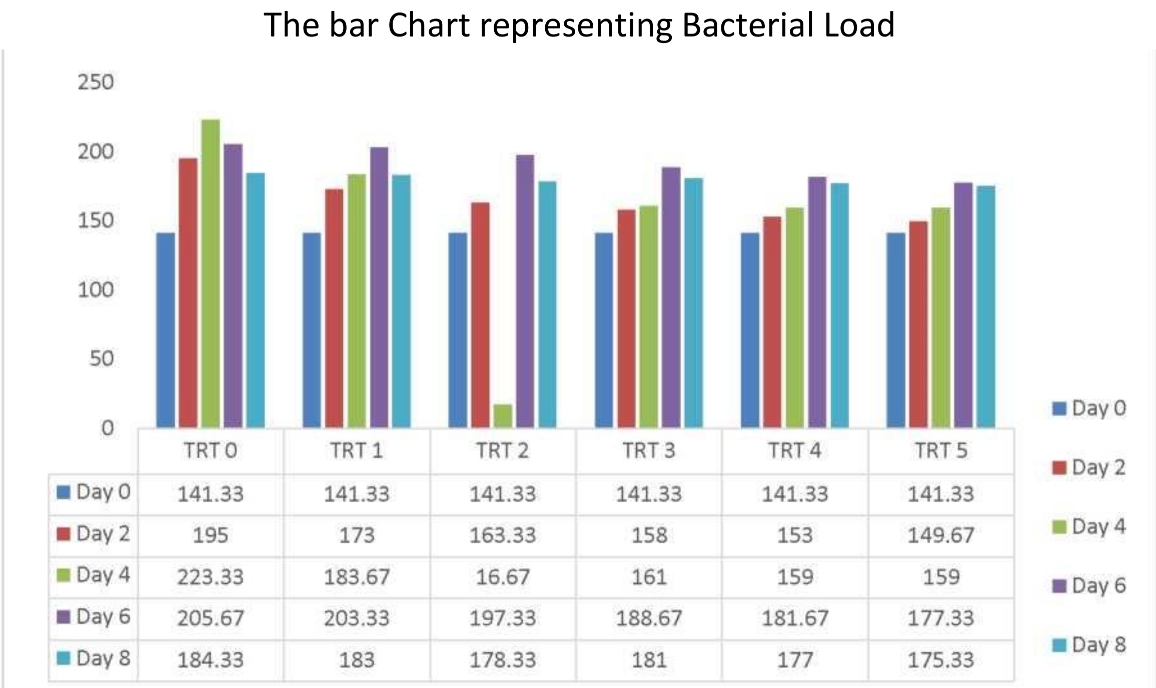
Treatment two that undergoes 10% concentration of photographic effluent which increase from day zero 5.67 to 11.0 of day eight.

Treatment Three that undergoes 15% concentration of photographic effluent which increase from day zero 5.67 to 10.33 of day eight.

Treatment Four that undergoes 20% concentration of photographic effluent which increase from day zero 5.67 to 9.0 of day eight.

Treatment Five that undergoes 25% concentration of photographic effluent which increase from day zero 5.67 to 10.33 of day eight.

Effect of photographic effluent on bacterial load



	TRT 0	TRT 1	TRT 2	TRT 3	TRT 4	TRT 5
Day 0	141.33	141.33	141.33	141.33	141.33	141.33
Day 2	195	173	163.33	158	153	149.67
Day 4	223.33	183.67	16.67	161	159	159
Day 6	205.67	203.33	197.33	188.67	181.67	177.33
Day 8	184.33	183	178.33	181	177	175.33

Fig 3. Bar chart representing bacterial load

The Bar chart representing bacterial load shows that on Day Zero treatment Zero which is the control increases from 141.33 to 184.33 based on their days of storage.

Treatment One that undergoes 5% concentration of photographic effluent which increase from day zero 141.33 to 183.0 of day eight.

Treatment Two that undergoes 10% concentration of photographic effluent which increase from day zero 141.33 to 178.33 of day eight.

Treatment Three that undergoes 15% concentration of photographic effluent which increase from day zero 141.33 to 181.0 of day eight.

Treatment Four that undergoes 20% concentration of photographic effluent which increase from day zero 141.33to 177.0 of day eight.

Treatment Five that undergoes 25% concentration of photographic effluent which increase from day zero 141.33 to 175.33 of day eight.

Discussion

The result shows that there were significant differences in the fungal count between the control and the contaminated water on one hand and between the same sample at different days of storage. In the control, the fungi load increased from 5.67 x 10^2 cfu/ml to 15.33 x 10^2 cfu/ml after eight days of storage. The increase in the fungi load of the contaminated water varied with the concentration of the pollutant in which the increase were 5.67 x 10^6 cfu/ml to 13.00 x 10^2 cfu/ml at pollutant concentration of 5% but dropped to a lower increase from 5.67 x 10^2 cfu/ml to 9.00 x 10^2 cfu/ml at a higher concentration of 25% of the pollutant as is shown in Fig.3, the higher the level of pollution, the lower the population of the fungi in the water (Gucker,2006). Also the variation in the daily fungi load of the water at different level of pollution was significantly different ($P<0.05$).

From the result shown earlier in the work, the photo effluent contained high level of organics as well as high concentration of silver and iron. These chemicals and organics perhaps affected the constituent of the test water thereby inhibiting normal fungi reproduction (multiplication) activity hence the reaction in the load with increasing contamination level (Canada 2010).

For total aerobic bacterial count, the bacteria count of control increased from 141.33 x 10^6 cfu/ml to 184.33 x 10^6 cfu/ml after eight days of storage. However, a peak of 223.33 x10^6 was attained on the fourth day of storage. In the photo-effluent treated waters, the bacteria load on day two, was in the range of 173.0 cfu/ml. to 149.69 cfu/ml as against 159.00 x10^6 similarly on the fourth day the bacteria load was in the range of 183.67 x 10^6 cfu/ml to 159.00 cfu/ml as against 223.33 x 10^6 cfu/ml. The same level of treads was obtained in the sixth and eight day where the bacteria loads were 203.33 x 10^6 cfu/ml to 177.33 x 10^6 cfu/ml and 184.33 to 175.33 cfu/ml respectively as against 205.67 x 10^6 cfu/ml in the control.

The above result shows that the photo effluent retarded the growth and multiplication of the bacteria in the treated water samples. The photo effluent was found to contain high level of biochemical. BOD, DO, COD mg/l and also has silver and iron at levels above permissible levels(LASEPA 2002). Chlorine has strong antimicrobial activity and can affect the activities of the microorganisms in the water samples (Larsdotter, 2006). The lower bacteria load in the photo effluent treated waters in indicative of suppressive activity of the effluent on the bacteria. Also, the levels of changes in the bacteria load was found to be significantly difference (P<0.05).

The result shows a moderated acidic effluent with a pH of 5.6. This level of acidity was outside the acceptable criteria for general effluent to be discharged into the environment which is pH of 6-9 (LASEPA 2002). The Dissolved oxygen was 16.3mg/l which was also outside the set limits. Biological Oxygen Demand (BOD) of 391.3mg/l was recorded for the effluent alongside a Chemical Oxygen Demand (COD) of 713mg/l. this two is above of 200mg/l bench mark set by the World Health Organization. (FMEnv 1992). It was also observed that the total solid of 4990.7mg/l was almost twice the 2030.0mg/l set by regulatory bodies.

Total suspended solid of 370.1mg/l was observed to be above the regulatory standard which is 30mg/l that possess environmental problems and also silver (Ag) content in photo effluent6.19 mg/l and iron (Fe) 77.5 mg/l the both heavy metal content in photo effluent fail the limit standard for discharge into the environment which are toxic to aquatic bodies (Ag 0.1 mg/l, Fe 20mg/l)

(FME_{nv}, 1992) Chlorine is heavily above the threshold 1.31 mg/l and the permissible limit is 1mg/l.

The above findings show that the photo effluent failed to meet the set standard for effluent and as such possess environmental problems when discharged into the environment without further treatment. Obviously, the entrant of this photo effluent into surface water was of toxicity to aquatic lives.

The result of the water quality shows a pH of 6.067, Turbidity of 8.966 NTU and total solid of 326.66mg/l. This result show a slightly acidity water with pH which conform to the acceptable limits of 68.5 (APHA 2000). The turbidity level is above the acceptable limit (5.0 NTU). The total solids were an average of 326.66mg/l which exceeds the 300mg/l regulatory limit of (300mg/l) by Federal Ministry of Environment (1990). The hardness in the river water was an average of 29.23mg/l which was found to be much lower than the set limit of 100mg/l. however the Dissolved Oxygen (DO) and Biological Oxygen Demand (BOD) were found to be slightly higher than the set limits. The metals sought for was silver (Ag) which was not detected in the water sample while the chloride content recorded an average of 21.56mg/l.

Biological indices analysis show a mean value of 142.33×10^6 colony forming units of bacteria per milliliter of the water while the fungi road recorded mean count of 6.33×10^2/ml. in general, the physicochemical properties of the water show that it can support the life of micro and macro aquatic organisms but is not wholesome for drinking without further purification.

Conclusion

Following the above, it is therefore necessary to conclude that the photographic effluent contains high level of pollutants as well as high concentration of silver and iron above permissible level which affects the constituent of the water samples from Qua Iboe River by inhibiting normal fungi and bacteria activities.

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