Resilience of a tropical of earthworm *Octochaetona surensis* (Michaelsen) to paper mill effluent

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Abstract **:** Industrial practices are accountable for the discharge of inadequately processed wastewater to the terrestrial environment during its flow to the aquatic destination that threatens all types of terrestrial lives of which earthworm is an important member. Earthworms are considered as ecosystem engineers and contribute to soil fertility, development, and maintenance of soil Physico-chemical properties. In this study, earthworms were exposed to soils with different concentrations (0,25, 50, 100) in % of papermill effluent for 30 days to investigate the response of earthworms to it. It was observed that the body weight was significantly retarded whereas the rate of respiration, ammonia excretion significantly increased with an increase in the concentration of effluent in soil indicating higher metabolic maintenance in the prevailing stress conditions.

Keywords: Paper Mill Effluent, Growth, Respiration, Excretion, ANOVA

I. INTRODUCTION

Increase in population density and industrialisation has exerted tremendous pressure on the environment. Generation of huge amount of waste materials is a burden for the present day society which threatens not only the survival of the human being but also other organisms. Waste management has become a challenge throughout the globe. Many of the industries discharge huge amount liquid waste every hour during their operation and discharge them either directly to the environment or treat the waste and then discharge to different water bodies. Large volume of wastewater constitutes one of the major sources of aquatic pollution. Due to anthropogenic activities, the pollutants from the hydrosphere can spread to the pedosphere there by kills the soil macro as well as micro fauna. As a result of which there is loss of biodiversity. During the loss many beneficial soil organisms are vanished in the particular area causing a great loss to the ecosystem. Various works have been carried out for assessment of the degree of effect of chemicals present in wastewater on soil organisms. Study on the effect of paper mill effluent particularly from a waste paper recycling paper mill on soil organisms is scanty. During paper making by this type of industry the process of deinking is followed where many types of chemicals are used, which have the chance to appear in the waste water. The waste water pollute both water and soil. Soil contains myriads of organisms among which earthworms constitute the major fauna. It is a beneficial soil organism that plays key role in soil fertility by the process of organic matter decomposition in the soil ecosystem. Oligochaetes are one of the most prime groups in terms of changes in soil structure and highly sensitive to the input of harmful compounds. Their activities lead to the creation of biogenic structures like galleries and coprolites, which modify the physical properties of the soil where they live and the availability of resources for other organisms. Earthworms are the important soil macro-organisms called the "Living Treasure of Earth". Waste management has become a challenge for human society. In the waste degradation and management process earthworms have a historical role as they survived even after the vanishment of dinosaurs from the earth **(Darwin 1881)**. Earthworms are versatile waste eaters and decomposers who accumulate pollutants from the waste, in their bodies and act as a bio-reactor to eliminate the waste. Physical processes like aeration, grinding, crushing, chemo-degradation, elimination through coelomic fluids as well as gut are important to note. Soil ingestin and egestion activities and biodegradation processes by microbes present in the gut make the earthworm's whole body to behave as a bio-filter that adsorbs pollutants from the wastewater and promotes the growth of 'beneficial decomposer bacteria' in wastewater reducing BOD, COD,TDS, TSS, and turbidity (**Sinha et al, 2012**).Paper mill industries generate huge volumes of wastewater which not only pollute the soil and water at the outskirt of the industrial premises but also creates a filthy environment. Earthworms degrade the pollutants present in the wastewater and alter the physico-chemical characteristics, nutrient content and composition of the soil used as bedding material during vermifiltration process (**Pradhan et al,, 2021**). But the high intensity of wastewater is also harmful for them. Based on these facts the present study was done to investigate the growth, respiration, excretion, of earthworm *Octochaetona surensis* in laboratory conditions with respect to Emami paper mill wastewater.

II. MATERIALS AND METHODS

The paper mill effluent was collected from an outside discharge point of Emami Paper Mills located at Balgopalpur, Balasore, Odisha, India. It is a waste paper recycling mill using the waste papers collected from different states and nations. The earthworm species *Octocheatona surensis* (Maechelsen, 1910) was collected from uncultivated fields and acclimatized to laboratory conditions for 7 days. They are used in the vermifiltration pracess, after which, taken out to separate experimental pots

to a study the impact of paper mill effluent on them. Four sets of the plastic pots of 600ml capacity were taken with 5 replicates each. The soil used for the experiment was collected from a barren land near the university campus which was made into powder form and was filled in each pot. Each pot's moisture content and temperature were maintained at 60±5g% and 30±5°C respectively. Seven numbers of earthworms from vermifiltration beds were taken out and released into each pot. The first set was taken as control i.e., without any effluent. The second set was taken with 25% paper mill wastewater. The 3rd set was taken with 50% paper mill wastewater. The 4th set was taken with 100% wastewater.

At the interval of 5 days, the earthworms from each pot were collected by hand sorting and were subjected to study their body weight, rate of respiration and excretion. The experiment was continued for 30 days. For growth experiment they were cleaned properly without gut cleaning and were soaked with blotting paper; their live weights in groups were measured by gravimetric method. The rate of respiration was determined by Winkler's method as described by **Welch (1948)**. The rate of excretion was estimated by following the Indophenol blue method **(Kaplan et al,, 1965)**. All the results obtained were subjected to two-way ANOVA to find out the significant difference between treatments as well as between days of incubation.

III. RESULTS AND DISCUSSION

In the present study, the body weight increased with respect to incubation periods both in control and concentrated media. In 0th day the weight of earthworm in control, 25%, 50%, 100%was 0.60gm/individual(ind), 0.59gm/ind, 0.61gm/ind, 0.58gm/ind respectively which in each gradually increased with increase in time period and at 30th day the weight of earthworms was 1.24gm/ind, 0.99gm/ind, 0.89gm/ind, 0.85gm/ind respectively. But the body weight was significantly low ($p \leq 0.01$) in effluent treated soil as compared to control throughout the incubation period **(Fig.1)**. The growth on 30th day over 0th day was high in control and gradually decreased with an increase in concentrations of effluent.

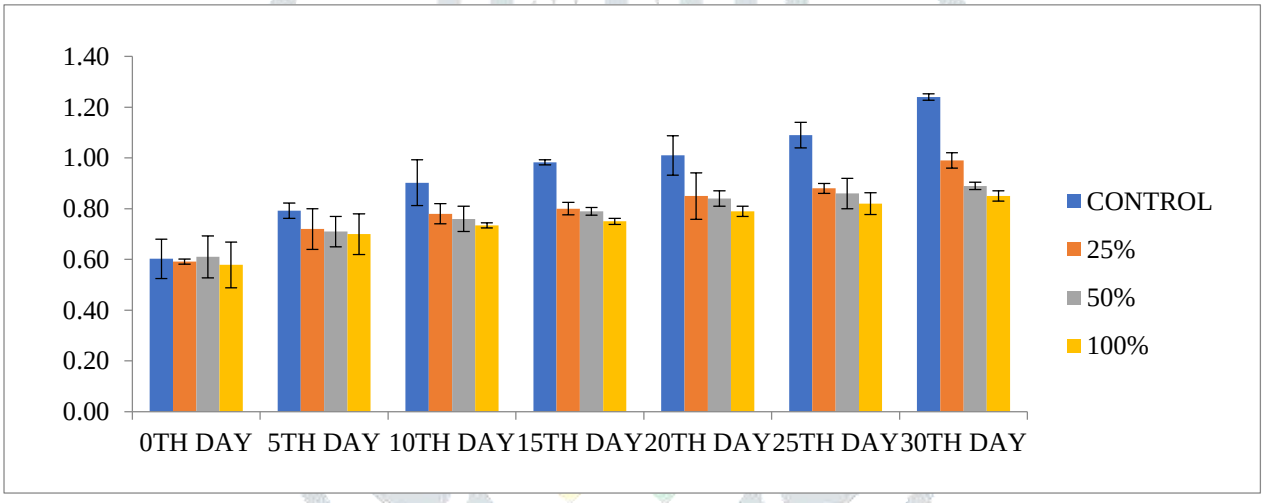

Figure 1: Change in the body weight of earthworm exposed to different concentrations of paper mill effluent

An decrease in body weight in all concentrations over their respective controls might be due to interference of the pollutants in tissue growth during the experiment. In concentrated media growth was low because in the adverse environmental condition, change in individual energy budget occurs due to its energy expenditure to resist the contaminants by avoidance and exclusion as pointed out by **Donker et al, 1993; Sibly and Calow, 1989**. This additional energy requirement perhaps decreased the "scope for growth" of the exposed earthworm species (**Maltby et al, 1990; Widdows and Donkin, 1991**). **Xing et al,** in 2010 studied that the body weight of earthworms increased in vermifiltration unit but when the hydraulic loading rate increased body weight gradually was slow which indicates that pollutant has an adverse effect on the growth process. **Pattanayak** in **2013** found the rate of growth of *Octochaetona surensis* significantly declined with an increase in concentrations of heavy metals(Cr and Ni). Similar observation was found in the body weight of juvenile earthworms of *O. surensis* and *D. calebi* in fly ash amended soil (**Mahakur et al, 2004**).

In this study, the respiration rate (oxygen consumption) of *Octochaetona surensis* decreased with an increase in incubation period both in control and treated beds (fig.2). The initial respiration rate of earthworms in all the pots was 2.93, 2.80, 2.97, and 3.0mg O_2 /g wet tissue/hr; after 30th days the respiration rate decreased to1.53, 1.63, 1.70, 1.93mg O_2 /g wet tissue/hr respectively. This initial high respiration rate might be due to the effect of effluent on vermi bed when earthworms are further introduced into the pot soil their respiration rate gradually decreased in the control pot but, when the concentration of effluent increased in pot soils, the respiration rate was found to increase simultaneously. The rate of respiration was significantly high in all types of treatments than in control ($p \leq 0.01$) throughout the experiment. The higher rate of respiration in effluent treated soil bed when compared to control in the present study indicates higher maintenance metabolism due to prevailing stress conditions. **Yali et al, in 2021** studied the respiration responses of earthworms (*Eisenia fetida*) to soil arsenite pollution which was decreased with an increased in arsenite concentration in soil. **Pradhan and Mishra (1986)** concluded a three-fold increase in the respiration rate in

insecticide-treated soil indicating their higher maintenance metabolism due to insecticide stress. **Pattanayak in 2013** found that the rate of respiration decreased in *Octochaetona surensis* with increase in days of incubation when they are exposed to the heavy metal Cr and Ni. **Caliss et al, (2011)** reported that in stress condition the haemoglobin content of earthworms increase depending on the pollutant types to which they are exposed. Thus, the stress imposed by effluent water in this experiment might be responsible for the increase of haemoglobin which might have caused higher oxygen uptake by *O. surensis* in the treated soil. The decrease in rate of respiration with increasing days of incubation probably due to decrease in percent growth in all types of treatment including control during the study period.

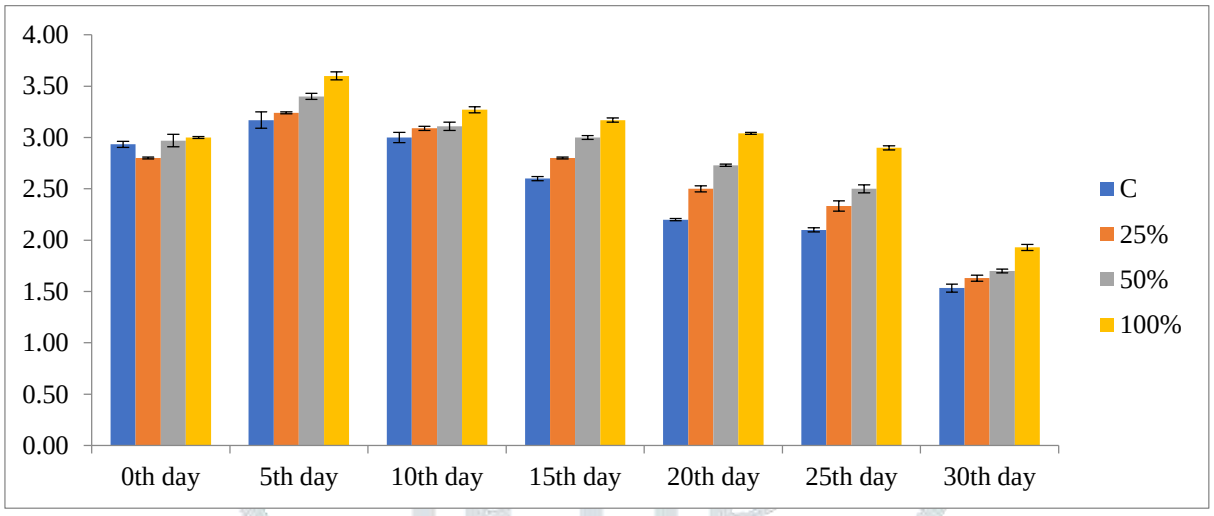

Figure 2: Change in the Respiration Rate of earthworms exposed to different concentrations of paper mill effluent

Figure.3 shows the ammonia excretion rate of *Octochaetona surensis* in effluent treated soil beds of different concentrations. A downwards trend was found in ammonia excretion of *O. surensis* in control soil with increase in days of incubation in paper mill effluent treated soil. Lowest ammonia excretion of 179.30, 187.19, 193.28µg NH_3 /wet wt/h *by O. surensis* were recorded on 30th day in effluent treated soil bed of concentration 25%, 50% and 100% respectively and in control soil ammonia excretion was 118.90 µg NH3 / wet wt/h on 30th day. On 0th day the excretion rate in control bed, 25%, 50% and 100% concentrated bed was 340, 335, 341, 329 µg NH_3 / wet wt/hr respectively. The differences between both control and effluent treated soil in all observations and also between days were found to be significant at ($p \leq 0.01$). Same trend was found by **Pattanayak** in **2013**in which they concluded that under stress condition excretion rate of heavy metal exposed earthworms were increased as compared to control soil earthworms.

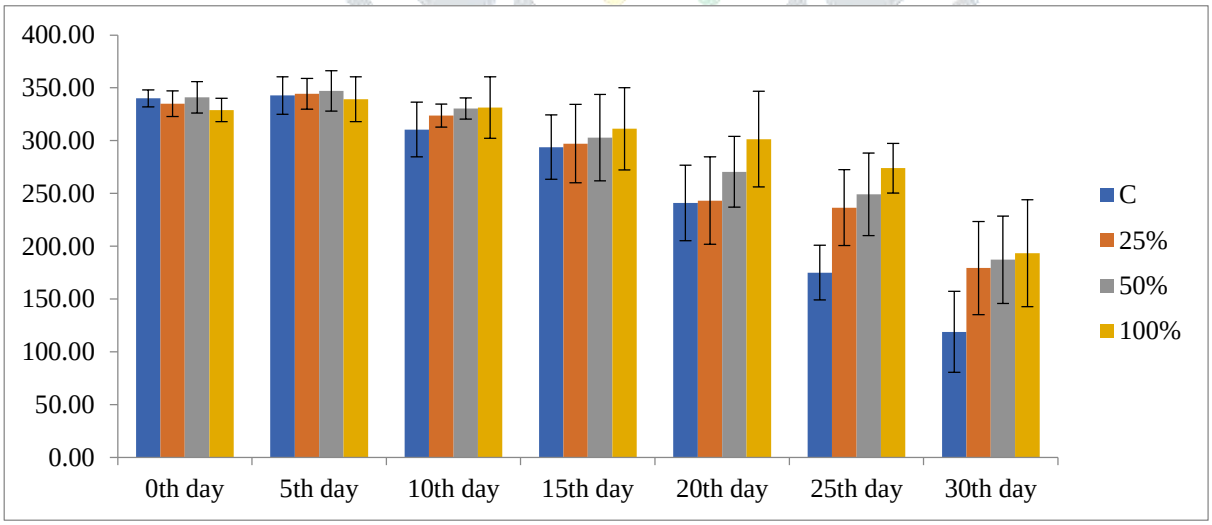

Figure 3: Change in the excretion rate of earthworms exposed to different concentrations of paper mill effluent

According to **Edwards and Lofty, (1977)** nitrogen excretion is an essential contribution of earthworms to soil fertility**. Mahakur et al, in 2004** reported a high excretion rate of earthworm under fly-ash (10%) stress condition. By the exposure to insecticide, earthworms show a high excretion rate concluded by **Pradhan and Mishra** in **1986.** Thus, in the present study, the stress imposed by paper mill effluent is supposed to cause higher ammonia excretion by *O. surensis* in treated soil than the control soil bed, in confirmation with the above findings.

IV. CONCLUSION

The results in this study depicted that, paper mill effluent has a significant effect on earthworm's (*O. surensis)* metabolism. It highlights the effect of effluent on the growth, respiration, and excretion rate of the earthworm. The rate of respiration and excretion gradually increased with increase in concentration. Retardation in the growth of *O. surensis* was observed in effluent-treated soil as the concentration increased. But in this experiment, no mortality has been observed. This proves that the earthworm species *Octochaetona surensis* is highly resilient to the paper mill effluent.

V. ACKNOWLEDGMENT

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