EFFECT OF SALON EFFLUENT ON *Oreochromis niloticus* FINGERLINGS.

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ABSTRACT: A total of 180 *Oreochromis niloticus* fingerlings with mean weight of 3.8g ± 0.13g S.E. and length range of 4-6cm caught from the canal in the National Root Crops Research Institute's reservoir, Umudike were used to determine the toxicity of hair dressing salon effluent while monitoring some physico-chemical parameters. Values of pH and temperature showed fair stability ($p > 0.05$) with all toxicant concentrations. Total alkalinity and dissolved oxygen showed corresponding decrease as toxicant concentrations increased while the levels of free carbon dioxide increased. Thus, relative to alkalinity and dissolved oxygen this showed direct relationship, free carbon dioxide exhibited inverse relationship. The salon effluent was found to be toxic to *Oreochromis niloticus* fingerlings. Effect was monitored through change in activity rate of both opercular plate and pectoral fin beat. Both body parts showed immediate increase in frequency (hyperactivity) followed by a decrease which tended towards zero or termination of the test fish. Death outcome occurred on a daily basis from day 2 with low toxicant concentrations of 20ppm and 40ppm but from day 1 with high toxicant concentrations of 60ppm to 100ppm. All but the lowest toxicant concentration of 20ppm killed off 50% of test fish population within 60 hours. The 96hrLC_{50}, threshold (safe level), lower and upper limit values were determined to be 18.62ppm,14.13ppm,15.26ppm and 22.72ppm respectively. This waste water should be treated before it gets to the aquatic ecosystems to avoid mortality of aquatic biota and man who is at the end of the foodchain and water quality alternation.

INTRODUCTION

Man in his continual attempt to achieve absolute comfort and conveniences invent and manufacture various products only to simultaneously discard some other products which he considers non-useful. Most of these waste products (usually agricultural and urban pollutants) are dumped directly into the aquatic environment. Chude (2008) reported that these agricultural and urban pollutants find their way into aquatic ecosystems by four main pathways - direct human voluntary introductions, direct human involuntary introductions, direct natural introductions and indirect human introductions. Such introductions from external sources into the aquatic ecosystem are referred to as allochthonous inputs and broadly fall into six main groups namely - petroleum based products, pesticides/chemicals, detergents/ surfactants, natural contaminants/pollutants, fertilizers and body care products. Body care products used by beauty salon outfits and which are ultimately disposed of into drains and gutters as effluents include- hair conditioners, hair relaxers, hair shampoos, hair dyes and skin care products. Most of the ingredients from which these products are manufactured are surfactants. Examples of these ingredients are isopropyl alcohol, propylene glycol, poly ethylene glycol, sodium lauryl sulphate, sodium laureth sulphate, cocamide DEA or MEA, colour pigments, formaldehyde donors, ammonia, peroxide etc.

When the word "fragrance" is listed on a label, it usually means a synthetic fragrance made from any of over 200 synthetic chemicals. Surfactants are surface-active agents capable of acting on either oil or water. Surfactants and detergents are common household and industrial products whose role as polluting agents of natural water systems has been highlighted (LeClerc and DerLaminck1952; Foster *et al*., 1966; Cairns and Lloos 1967; Goldacre 1968). Toxic property of any pollutant must surely come into play once safe limits are exceeded irrespective of intention, source or mode of the pollutant's entry into the water medium.

Much work has been done on the toxicity of these allochthonous inputs in water (Konar *et al.*, 1990; Ufodike and Omoregie 1991; Faleye and Olaniran 1995; Okpokwasili and Odokuma 1996a and b; Annune and Ajike 1999; Boudreau *et al*., 2003). There is no information on studies relating to the effect of hair dressing salon effluents. Thus, this research therefore aims at investigating the effect of hair dressing salon effluent on the fingerlings of *Oreochromis niloticus* and water quality since it is frequently channeled into natural aquatic ecosystems, thus, providing a baseline data which could be used as a reference point for further studies.

MATERIALS AND METHOD

A total of 180 *Oreochromis niloticus* fingerlings with mean weight of 3.8g ± 0.13g S.E. and length range of 4-6cm used in this experiment were caught from the canal linking the National Root Crops Research Institute's reservoir to the fish farm of Michael Okpara University of Agriculture, Umudike, Abia State. The fish were retained in holding tanks for two weeks acclimation during which period they were fed twice daily (morning and evening) at 4% body weight with "BIOFOOD"– a commercially marketed pellet diet containing approximately 52% protein. The holding tanks had net covers and were aerated using a super 555 Oxyguard aquarium air pump. Water in these holding tanks was changed every morning (at feeding time) throughout the period of acclimation to remove uneaten food and faecal droppings. Feeding was discontinued 24hours before commencement of the actual experiment. The flow-through system (Chude 2008) was modified after Gharton (1980) to suit prevailing laboratory condition. This consist of a tub-stand with provision to hold six tubs, each tub appropriately fitted with a net covered lid. This set up was repeated in triplicate; into each of the six tubs of a tub-stand was randomly introduced ten fish. Water was kept up at the 20-litre level by the aid of an outlet regulator at the center of each tub. This regulator was simply a tube with net covered mouth and whose height was at the 20-litre mark. It therefore let out water continuously but not fish thereby keeping the tub water volume constantly at the required 20-litre mark. The experiment was a continuous flow-through bioassay with toxicant auto-delivery system rigged on a wooden T-shaped cross.

The fish were not fed during the period of the experiment and the tubs too were not artificially aerated as doing so would have encouraged degradation of the pollutant. After the initial exploratory tests, stock solution was prepared (1000mg or ml per litre) as pollutant-water-dispersion modified from the method described by Keke (1986) which itself was a modification of Anderson *et al.,* (1974). Thereafter the experimental solutions (hair dressing salon effluent) used or test media were obtained by sequential serial dilution. Thus, the salon effluent concentrations used were 20ppm, 40ppm, 60ppm, 80ppm and 100ppm. The sixth tub was devoid of toxicant and served as control. Effect of salon effluent on both test fish species was monitored through frequency or beat rate of both opercular plate and pectoral fin. Fish mortality was recorded for 24hours, 48hours, 72hours and 96hours. Observations for loss of equilibrium, vigorous movement of gulping of air and other behavioural indices, death inclusive, were noted for fish in each tub. Death was ascertained when fish did not react to gentle prodding with a glass rod. Time of death of fish was recorded, dead fish removed and its weight and length measurements taken. Mortality record for each test tub was painstakingly kept. During the experiment there were no mortalities in the control tubs. Also the test fish were not fed because remnants of uneaten food would have contaminated the water thereby increasing mortality rates. The experiment lasted for four days (96 hrs).

The physico-chemical properties of the experimental water: pH, temperature, dissolved oxygen, total alkalinity and free carbon dioxide were monitored using the standard methods described by AOAC (1980) and APHA (1989). The experiment was designed as a split plot experiment in a randomized complete block design in three replicates. All data collected were statistically analyzed using Statistical Analytical Systems of 2004 series and Fisher's Least Significant Difference was used to separate differences between treatment "means" at $p < 0.05$.

RESULTS

Hair dressing salon effluent affected both the water quality and the fish species. While pH showed slight increase in acidity with increase in toxicant concentration, values for temperature showed some form of stability ($p>0.05$) with all toxicant concentrations but values for total alkalinity decreased while free carbon dioxide values showed increase as corresponding values for dissolved oxygen decreased with increase in toxicant concentrations (Table 1).

Table 1: Water quality parameters during exposure of *Oreochromis niloticus* fingerlings to different concentrations of hair dressing salon effluent.

	Hair dressing salon effluent concentrations (ppm)					
Parameters	0	20	40	60	80	100
pH	6.90 ± 0.1	6.90 ± 0.1	6.85 ± 0.1	6.85 ± 0.1	6.80 ± 0.1	6.80 ± 0.1
Temp(^{o}C)	25.2 ± 0.2	25.2 ± 0.2	25.2 ± 0.2	25.2 ± 0.2	25.2 ± 0.2	25.2 ± 0.2
D.O (mg/l)	6.65 ± 0.2	6.60 ± 0.2	6.40 ± 0.2	6.20 ± 0.2	6.20 ± 0.2	6.00 ± 0.2
Free CO_2(mg/l)	0.80 ± 0.1	1.40 ± 0.1	1.60 ± 0.1	1.60 ± 0.1	1.20 ± 0.1	1.20 ± 0.1
T.A.(mg/l$CaCO_3$	11.00 ± 0.2	11.00 ± 0.2	9.00± 0.2	9.00 ± 0.2	8.00 ± 0.2	8.00 ± 0.2

D.O. = Dissolved Oxygen; T.A. = Total Alkalinity. Values are mean of three determinations.

Effect of hair dressing salon effluent on *O. niloticus* fingerlings was monitored through change in activity rate of both opercular plate and pectoral fin. The beat rate of both plate and fin showed heightened activity phase or hyperactivity followed by decrease in frequency (Tables 2 and 3).

Table 2: Opercular ventilation rates and pectoral fin beat frequencies of *Oreochromis niloticus* fingerlings when exposed to hair dressing salon effluent.

	0hrs		24hrs		48hrs		72hrs		96hrs	
	Ovr	pfb	ovr	pfb	ovr	Pfb	ovr	Pfb	ovr	Pfb
0	94	96	92	98	92	100	92	96	88	90
20	98	126	96	130	94	132	96	126	92	118
40	110	130	118	134	115	136	116	128	114	122
60	116	136	124	138	120	136	118	134	116	128
80	130	144	128	146	126	148	124	134	118	130
100	138	148	136	150	130	152	128	140	120	136

C(ppm) = Concentration (ppm); ovr = operculum ventilation rate; pfb= pectoral fin beat. Values are mean of three determinations.

Death was evident on a daily basis from day 2 with low toxicant concentrations of 20ppm and 40ppm but from day 1 with high toxicant concentrations of 60ppm to 100ppm (Table 3). Furthermore, except for the lowest toxicant concentration of 20ppm, all other toxicant concentrations killed off 50% of test fish population within 60 hours.

Table 3: Comprehensive mean mortality records for different concentrations of hair dressing salon effluent on *Oreochromis niloticus* fingerlings.

T.no	F/tub	C(ppm)	Log.c	Mortalities				C.m.	Surv.	C%m	P.k	T
				Day 1	Day 2	Day 3	Day 4					
1	10	0	0	0	0	0	0	0	10	0	0	0
2	10	20	1.30	0	2	1	3	6	4	60	5.25	73
3	10	40	1.60	0	2	3	2	7	3	70	5.53	54
4	10	60	1.78	2	2	3	1	8	2	80	5.84	48
5	10	80	1.90	3	2	2	1	8	2	80	5.84	45
6	10	100	2.00	2	4	2	1	9	1	90	6.39	44

T.no = Tub number; F/tub = Fish per tub; C(ppm) = Concentration (ppm); Log.c = Log concentration; C.m = cumulative mortality; surv. = survival; C%m = cumulative % mortality; P.k = Probit % kill; T = Time (hours) for 50% mortality; Day 1= 0-24hrs; Day 2= 24-48hrs; Day 3= 48-72hrs; Day 4= 72-96hrs

The 96hrLC$_{50}$, threshold (safe level), lower and upper limit toxic values (Table 4) were determined to be 18.62ppm, 14.13ppm, 15.26ppm and 22.72ppm respectively. Death was evident on a daily basis from day 2 with low toxicant concentrations of 20ppm and 40ppm but from day 1 with high toxicant concentrations of 60ppm to 100ppm.

Table 4: 96hrLC$_{50}$, Threshold (safe level) and Lower/Upper limit toxic values of hair dressing salon effluent on *Oreochromis niloticus* fingerlings.

Toxicant	96hrLC$_{50}$ (ppm)	Threshold (ppm)	Lower limit (ppm)	Upper limit (ppm)
h. d. s. e.	18.62	14.13	15.26	22.72

h. d. s. e. = Hair dressing salon effluent

DISCUSSION

With a slight increase in temperature, the dissolved oxygen of the system reduces; hence the amount of dissolved oxygen available for respiration was increasingly reduced upto mortality. While values for total alkalinity and dissolved oxygen showed corresponding decrease as toxicant concentrations increased, those for free carbon dioxide increased. Thus, relative to alkalinity and dissolved oxygen which showed direct relationship, free carbon dioxide exhibited inverse relationship. This inverse relationship had also been obtained by other workers (Ofojekwu *et al*., 2001; Oti 2003).

Water toxicants are risks and hazards to health, both animate and inanimate things including human health. Toxic property of any pollutant must surely come into play once safe limits are exceeded irrespective of intention, source or mode of the pollutant's entry into the water medium. Recently, toxicological studies have linked detergents and surfactants to endocrine related disorders in humans, fish and wildlife in many parts of the world (USEPA 1997; Environmental Canada 1999).These reports specifically and separately cited natural oestrogens in plants (phytoestrogens), alkylphenolics (a family of surfactants) and alkylphenolics as compounds that alter the properties of a fish's gill and thus, consequently change the fish's normal uptake of ions from the water. Effect of hair dressing salon effluent on *O. niloticus* fingerlings was monitored through change in activity rate of both opercular plate and pectoral fin. The beat rate of both plate and fin showed heightened activity phase or hyperactivity followed by decrease in frequency. Chude (2008) described the three phases as "active", "fatigue" and "collapse" – which were more discernible with higher concentrations of 60ppm, 80ppm and 100ppm. The observed ascending and descending phases of activity seem to indicate the fish's initial attempt to annul the effect of the hair dressing salon effluent by increase in activity which demanded a call-up of energy reserve. Ultimately energy regeneration seemed not to match energy expenditure and hence the decline in activity. Other workers had attributed this latter state of exhaustion to reduction in energy availability through Adenosine Triphosphate (ATP) depletion in the test fish (Omoregie and Ufodike 1991; Wade *et al*., 2002). Death outcome was evident on a daily basis from day 2 with lower toxicant concentrations of 20ppm and 40ppm but from day 1 with higher toxicant concentrations of 60ppm to 100ppm. At high concentrations of detergent/surfactant, the survival rate of fish decreases very significantly (Chattopodhyay and Konar 1985; Awasthi *et al*., 2000).

Furthermore, except for the lowest toxicant concentration of 20ppm, all other toxicant concentrations killed off 50% of test fish population within 60 hours. Alcohol ethoxylate surfactants were also reported toxic at concentrations as low as 0.37mg/l (Maki 1979) while quaternary ammonium compounds were reported toxic to gills and blood chemistry of rainbow trout at concentrations as low as 1.0mg/l and o.5mg/l for *Daphnia puler* (Moore *et al*., 1987; Byrne *et al.*, 1989). Okpokwasili and Odokuma (1997) reported that commercial oil spill dispersants are usually a blend of three chemical classes - surfactants, solvents and stabilizers which cause cell mortality in aquatic organisms. Other investigators had zeroed in on the synergistic properties of surfactants (Ghatak and Konar 1991) as well as on the pathway of bio-degradation of surfactants in liquid detergents and shampoos (Okpokwasili and Olisa 1991).

CONCLUSION

Pesticides and surfactants (pollutants) exert acute and chronic toxic effects on different target and non – target organisms in the ecosystem including humans. This study has revealed that salon effluent is acutely toxic to *O. niloticus* and should not be introduced into the natural aquatic ecosystems without being duly treated. This will help to prevent pollution of aquatic biota, food poisoning by man and alteration of water quality.

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