

TOXICITY OF TWO HOUSEHOLD LIQUID SOAPS ON *POECILIA RETICULATA* PETERS, 1859

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ABSTRACT

Lawal, M. O.; Samuel, O. B.; Mogeckwu, T. O. & Bolaji, D. A. (2013) Toxicity of Two Household Liquid Soaps on *Poecilia reticulata* Peters, 1859. Braz. J. Aquat. Sci. Technol. 17(1):35-41. eISSN 1983-9057. DOI:10.14210/bjast.v17.n1.p35-41. The relative acute toxicity and sub-lethal effects of two surfactants; Faab liquid soap (FLS) and Morning Fresh liquid soap (MFLS) were evaluated for the *Poecilia reticulata* in laboratory bioassays. The acute toxicity was evaluated for 96 h while the sub-lethal effects of the two surfactants on the biochemical parameters of *P. reticulata* were investigated for a 6 – day exposure period. The derived toxicity indices showed that the FLS (96hLC₅₀ = 0.062ml/L) was 1.37 times more toxic than the MFLS (96hLC₅₀ = 0.085ml/L) against *P. reticulata*. Analysis of variance (ANOVA) showed significant difference ($p < 0.05$) in the quantal response of *P. reticulata* to different concentrations of FLS and MFLS at 24, 48, 72 and 96 h of exposure. The mean tissue protein, triglyceride, glucose and cholesterol ranged from (21.04 - 48.54 and 18.06 - 58.54mg/dl), (87.43 - 154.95 and 85.63 - 144.28mg/dl), (33.95 - 55.03 and 32.76 - 53.15mg/dl) and (37.30 - 65.38 and 37.12 - 58.11mg/dl) for FLS and MFLS respectively. ANOVA showed significant difference ($p < 0.05$) in the biochemical response of *P. reticulata* to FLS and MFLS. The implications of these findings are highlighted.

Keywords: Toxicity, biochemical, surfactants, fish.

INTRODUCTION

The ever increasing need to keep house-hold and environment clean in order to prevent outbreak of diseases and allergies has led to regular and increased use of domestic liquid soaps (surfactants) which are based on surface active chemical agents. These substances, when dissolved in water, produce a solution that has the ability to remove dirt from surfaces such as textiles and dishes, acting as well as oil dispersant (Liwarska-Bizukojc et al., 2005). Surfactants are not only used as detergents, they have been successfully employed to enhance the efficacy of the active ingredient in pharmaceutical and agriculture formulations, in cosmetics and other industrial processes (Cserháti et al., 2002). However, the indiscriminate discharge of surfactants and their components into the aquatic and terrestrial environments, primarily as a result of their commercial and household use has resulted in pollution of water bodies (Beey, 2001).

According to Madsen et al. (2001) dish washer detergents are capable of destroying the external mucus layers that protect the fish from bacteria and parasite infection. In addition, exposure to low-levels of some surfactants can cause disruption of endocrine functions in fish, such as reproduction (Barber et al., 2007). Sub-lethal concentrations of an anionic detergent were reported to have damage the catfish barbell taste buds (Zeni & Caligiuri, 1992; Zeni et al., 1995). Also the anionic surfactants that belong to alkyl

sulphates (AS), linear alkylbenzene sulphonates (LAS) and alkylpolyoxyethylene sulphates (AES) were harmful to aquatic organisms (*Physa acuta*, *Artemia salina* and *Raphidocelis subcapitata*) at concentration range of 10 and 100mg/L (Liwarska-Bizukojc et al., 2005). Furthermore, documented studies on biochemical changes in fish exposed to toxicants include; blood protein (Omoniyi et al., 2002; Martinez et al., 2004), triglyceride and cholesterol (Abalaka et al., 2011; Maruf Iftekhhar, et al., 2006; Omitoyin, 2007) and tissue glucose (Ajani et al., 2007).

Fish have often been considered as the sentinel organism for health of aquatic environment and respond to chemicals in a manner similar to that of higher vertebrates (Beey, 2001; Barbieri, 2007). Guppy, *Poecilia reticulata* Peters, 1859, occupies a wide range of aquatic habitats, such as ponds, weedy ditches, canals and tolerates a wide range of environmental conditions. They are very sensitive, easy to maintain in the laboratory and very prolific (Lawal, 2010). Earlier similar studies on *P. reticulata* include its use as a test species for a wide spectrum organophosphorus insecticide (Mahmut et al., 2005), spent lubrication oil and laundry detergent (Otitolaju, 2006) and pirimiphos-methyl (Lawal & Samuel, 2010).

In spite of the fact that many toxicity data for surfactants have been provided so far, the research of their toxicity is still regarded as relatively limited (Liwarska-Bizukojc et al., 2005) due to their extensive use in an emerging economy such as Nigeria.

The present study evaluated the acute toxicity and biochemical responses of *P. reticulata* to 'Faab' and 'Morning fresh' liquid soaps.

MATERIALS AND METHODS

Test Animal and Acclimatization

Guppy of size range 2.50 to 3.40cm used for this study were obtained from a drainage canal at the entrance of the University of Lagos, Akoka, Lagos, Nigeria. They were caught with a scoop net of mesh size 2.0mm and carried to the laboratory in a plastic bucket half filled with water from source. The collection was made in the morning and evening to reduce stress on the organism. They were kept in holding tanks (80 x 45 x 30cm³) one quarter filled with dechlorinated tap water and allowed to acclimatize to laboratory conditions (27.0 ± 0.6 °C, pH = 7.0) for two weeks before using them in bioassays. Fish were fed with floating pellets at 10% of their body weight. Unconsumed feed and faeces were removed and water replenished twice a week to prevent accumulation of toxic waste metabolites.

Test Chemicals

'Faab' liquid soap is a stain remover and used frequently in the kitchen. This product was manufactured by Washing Up Nigeria Limited. Ingredients that were used in its production are anionic surfactants, perfume, preservative and stabilizer. Similarly, 'Morning fresh' liquid soap removes grease and stains and used more frequently in the kitchen. It was manufactured by PZ Industries Nigeria PLC. Ingredients used in its manufacture are anionic surfactants, hydro-tropes, salts, perfume, and preservatives.

Physico-chemical Parameters of the Test Media

Physico-chemical parameters such as dissolved oxygen (DO), pH, and temperature of the test media were measured before and during the experimental period. The pH and temperature was measured using Hanna instrument (Model H1991301). The dissolved oxygen was determined using a Jenway DO meter (Model 9071).

Acute Toxicity Test

A static bioassay technique (static renewal) was adopted for all the toxicity tests (FAO, 1987). Depending on the test concentrations, a given volume of water from the test organism environment was measured into bioassay glass tank (45 x 30 x 30cm³) and a predetermined volume of Faab liquid soap or Morning fresh liquid soap was added to the water to make up to 1000ml, to achieve the desired concentration.

Ten (10) active fish were introduced into the test medium containing either Faab or Morning fresh liquid soap. Fish used for the test were not fed a day preceding the test and throughout the duration of the test. Each treatment was replicated thrice, given a total of 30 guppies per treatment, including untreated media (control). The concentrations of test chemicals were as follow:

- Faab: 0.05, 0.06, 0.07, 0.08, 0.09ml/L and control
- Morning fresh: 0.082, 0.084, 0.086, 0.088, 0.090ml/L and control

Mortality assessment was carried out every 24 hours over a 96-hour experimental period. Fish were assumed dead when there was no body or operculum movement, even when probed with a glass rod. Dead animals were removed and recorded.

Biochemical Assay Techniques

Exposure of fish to sub-lethal concentrations of 1/10th, 1/50th and 1/100th of 96hrLC₅₀ values of the test compounds for a duration of 6 days were determined as follow:

- Faab: 15.5, 31.0, and 155.0ml/L and control
- Morning fresh: 21.25, 42.50, and 212.50ml/L and control

At day 2, 4 and 6, six live *P. reticulata* were randomly selected per treatment including the control for the Faab and Morning Fresh liquid soaps. The test organisms were weighed to determine their individual weight. Animals were anaesthetized with MS-222 (Methane sulfonate) at 140mg/L for decreased respiration and complete loss of responsiveness (Ross and Ross, 2008) before their whole tissue (flesh) was used. The samples from test animals were homogenized in phosphate buffer (50mM, pH 7.0). The tissue homogenate were analyzed with Human® kits for triglyceride, cholesterol, glucose and protein using GPO-PAP, CHOD-PAP, GOD-PAP and Biuret methods respectively (Josephson & Gyllensward, 1957; Teuscher & Richterich, 1971; Schettler & Nussel, 1975).

Statistical Analysis

The quantal response (mortality) data were analyzed by probit analysis after Finney (1971). The indices of toxicity measurement derived from the analysis were;

- LC₅₀ = the concentration that kills 50% of the population.
- TF (Toxicity factor) for relative potency measurements.

One-way analysis of variance (ANOVA) and Student Newman-Keul's, (SNK) tests were used to test for significant difference (5% level) in the mean mortality response of *P. reticulata* to different concentrations of Faab and Morning fresh liquid soaps at 24, 48, 72

and 96 hours of exposure. The significant differences in biochemical assay data were analysed using ANOVA and Duncan multiple range test (DMRT) at $P = 0.05$. Analysis was performed using SPSS 10.0 for Windows.

RESULTS

Physico-chemical conditions of the test media during the experimental period were fairly constant. The temperature ranged between 25.0 and 27.0°C, pH ranged between 7.0 and 7.8 while dissolved oxygen ranged from 5.0 to 6.8mg/L over the 96h acute toxicity and sub-lethal evaluations.

Relative Toxicity of Faab and Morning Fresh Liquid Soaps on *P. reticulata*

The results of the acute toxicity of Faab and Morning fresh liquid soaps on *P. reticulata* at 24, 48, 72 and 96h of exposure are shown in Table 1. The analysis of concentration-mortality data of Faab liquid soap (FLS) when tested against *P. reticulata* revealed that the derived toxicity indices (LC_{50}) ranged from 0.062 (96h LC_{50}) to 0.079ml/L (24h LC_{50}), while for Morning fresh liquid soap (MFLS), the LC_{50} ranged from 0.085 (96h LC_{50}) to 0.089 ml/L (24h LC_{50}). On the basis of computed toxicity factor (TF) using 96h LC_{50} , the FLS was found to be 1.37 times more toxic on *P. reticulata* than the MFLS (Table 1).

An analysis of variance (ANOVA) showed that there was significant difference ($p < 0.05$) in the quantal response (mortality) of *P. reticulata* to different treatments (concentrations) of Faab and Morning fresh liquid soaps at 24, 48, 72 and 96h of exposure. Further analysis using Student Newman Keul's (SNK) test ($p = 0.05$) revealed that the percentage mortality response of *P. reticulata* to 0.09ml/L of FLS at 24, 48, 72 and 96h of exposure was significantly different ($p < 0.05$) from its response to all other concentrations (Table 2). However, at 72h of exposure no significant difference ($p > 0.05$) was observed in the quantal response of *P.*

reticulata exposed to 0.0 (control) and 0.05ml/L of FLS, while at 96h of exposure no significant difference ($p > 0.05$) was observed in the quantal response of *P. reticulata* exposed to 0.07 and 0.08ml/L of FLS (Table 2). Similarly, SNK showed that the percentage mortality response of guppies to 0.090ml/L of MFLS at 24, 48, 72 and 96h of exposure was significantly different ($p < 0.05$) from its response to all other concentrations (Table 3). However, at 24h of exposure no significant difference ($p > 0.05$) was observed in the quantal response of guppies exposed to 0.0 and 0.082ml/L of MFLS while at 72h of exposure no significant difference ($p > 0.05$) was observed in the quantal response of guppies exposed to 0.082 and 0.084ml/L of MFLS (Table 3).

No adverse behavioral changes or mortality was observed in the control fish throughout the experimental period. However, erratic swimming, restlessness and impaired balance were observed in test animals exposed to surfactants before their eventual death.

Sub-lethal effects of Faab and Morning Fresh Liquid Soaps on Tissue Chemistry of *P. reticulata*

The results of the biochemical changes in tissue protein, triglyceride, glucose and cholesterol observed in *P. reticulata* exposed to different sub-lethal concentrations of Faab and Morning fresh liquid soaps are shown in Tables 4 and 5 respectively.

The lowest value (21.04±0.71mg/dl) of mean tissue protein was recorded in organism exposed to 31.0ml/L on day 6 while the highest value (39.29±2.85mg/dl) was recorded in organism exposed to 15.5ml/L on day 2. The values of mean tissue protein in the guppy decreased with increased days across treatments with FLS (Table 4). There was significant difference ($p < 0.05$) in the mean tissue protein of test organisms exposed to different concentrations of FLS (Table 4). Duncan Multiple Range Test (DMRT) showed significant difference ($p < 0.05$) in the mean tissue protein of *P. reticulata* across treatments and days. However, there was no significant difference ($p > 0.05$) in the mean tissue protein values of treatments

Table 1 - Relative Toxicity of Faab and Morning Fresh liquid soaps on *P. reticulata*.

Exposure Time (h)	LC_{50} (95% CL) (ml/L)	Slope ± SE	Probit line equation	TF
Faab				
24	0.079 (0.075 - 0.084)	10.53 ± 1.70	16.62 + 10.53x	
48	0.074 (0.070 - 0.080)	8.48 ± 1.40	14.59 + 8.48x	
72	0.066 (0.062 - 0.070)	10.14 ± 1.46	16.96 + 10.14x	
96	0.062 (0.058 - 0.066)	9.90 ± 1.50	16.93 + 9.89x	1.3
Morning Fresh				
24	0.089 (0.088 - 0.902)	58.37 ± 10.24	66.37 + 58.37x	
48	0.088 (0.087 - 0.090)	46.92 ± 8.56	54.56 + 46.92x	
72	0.087 (0.086 - 0.088)	54.49 ± 8.66	62.90 + 54.49x	
96	0.085 (0.084 - 0.086)	64.13 ± 9.44	73.66 + 64.13x	1.03

CL = Confidence limit, SE = Standard error, TF = Toxicity factor = 96h LC_{50} value of Faab and Morning Fresh /96h LC_{50} .

Table 2 - Percentage (%) mortality of *P. reticulata* exposed to different concentrations of Faab liquid soap for 96 hours.

Concentration (mL/L)	No. of tested organisms	Percentage Mortality/Time			
		24h	48h	72h	96h
Control (0)	30	0.00 ^a	0.00 ^a	0.00 ^a	0.00 ^a
0.05	30	33.3 ^{ab}	10.0 ^b	10.0 ^a	16.3 ^b
0.06	30	10.0 ^b	20.0 ^c	26.7 ^b	40.0 ^c
0.07	30	26.7 ^c	40.0 ^d	73.3 ^c	76.6 ^d
0.08	30	50.0 ^d	60.0 ^e	80.0 ^{cd}	83.3 ^d
0.09	30	76.7 ^e	80.0 ^f	86.7 ^d	93.3 ^e

Means with the same superscript letter(s) in a column are not significantly different in the SNK test at P = 0.05

0.0 (control) and 155.0ml/L on day 2. Similarly, there was no significant difference ($p > 0.05$) in the mean tissue protein values of treatments 0.0 (control) and 15.5ml/L on day 4 and also between treatments 15.5 and 155.0ml/L on day 6 (Table 4).

Also, the lowest value (87.43 ± 5.23 mg/dl) of the mean tissue triglyceride was recorded in organism exposed to 0.0ml/L (control) on day 6 while the highest value (154.95 ± 3.96 mg/dl) was recorded in organism exposed to 31.0ml/L on day 2. The values of mean tissue triglyceride in guppy decreased with increased days across treatments with FLS. Significant difference ($p < 0.05$) was recorded in the mean tissue triglyceride of test organisms exposed to different concentrations of FLS. DMRT showed significant differences ($p < 0.05$) in the mean tissue triglyceride of *P. reticulata* across treatments and days. However, there was no significant difference ($p > 0.05$) in the mean tissue triglyceride values of treatments 0.0 (control) and 15.5ml/L on days 2, 4 and 6. Similarly, no significant difference ($p > 0.05$) was observed in the mean tissue triglyceride values of treatments 31.0 and 155.0ml/L on days 2 and 4 (Table 4).

Furthermore, the lowest value (33.95 ± 0.98 mg/dl) of the mean tissue glucose was recorded in organisms exposed to 31.0ml/L on day 6 while the highest value (55.03 ± 2.18 mg/dl) was recorded in organisms exposed to 15.5ml/L on day 2. The values of mean tissue glucose in guppy decreased with increased days across treatments with FLS. Significant difference ($p < 0.05$) was recorded in the mean tissue glucose of test organisms exposed to different concentrations of FLS (Table 4). DMRT showed significant difference ($p < 0.05$) in the mean tissue glucose of *P. reticulata* across treatments and days. However, on day 2, no significant difference ($p > 0.05$) was recorded in the mean tissue glucose values between treatments 0.0 (control) and 15.5ml/L and treatments 31.0 and 155.0ml/L. Similarly, on day 6 no significant difference ($p > 0.05$) was recorded in the mean tissue glucose values between treatments 0.0 (control) and 155.0ml/L and treatments 15.5 and 31.0ml/L (Table 4).

The lowest value (37.30 ± 0.30 mg/dl) and the highest value (65.38 ± 4.60 mg/dl) of the mean tissue

Table 3 - Percentage (%) mortality of *P. reticulata* exposed to different concentrations of Morning Fresh liquid soap for 96 hours.

Concentration (mL/L)	No. of tested organisms	Percentage Mortality/Time			
		24h	48h	72h	96h
Control (0)	30	0.00 ^a	0.00 ^a	0.00 ^a	0.00 ^a
0.082	30	3.3 ^a	10.0 ^{ab}	13.0 ^b	20.0 ^b
0.084	30	10.0 ^{ab}	20.0 ^{bc}	20.0 ^b	30.0 ^c
0.086	30	16.7 ^b	26.6 ^c	40.0 ^c	66.7 ^d
0.088	30	33.3 ^c	50.0 ^d	66.7 ^d	80.0 ^e
0.090	30	70.0 ^d	73.3 ^e	83.3 ^e	96.7 ^f

Means with the same superscript letter(s) in a column are not significantly different in the SNK test at P = 0.05

cholesterol were recorded in organisms exposed to 31.0ml/L on days 6 and 4 respectively. In addition, significant difference ($p < 0.05$) was observed between the control group and other treatments in the mean tissue cholesterol of test organisms exposed to FLS on days 2, 4 and 6. DMRT showed no significant difference ($p < 0.05$) in the mean tissue cholesterol of *P. reticulata* amongst treatments 15.5, 31.0 and 155.0ml/L (Table 4).

The lowest (18.06 ± 0.55 mg/dl) and highest (58.54 ± 4.04 mg/dl) values of the mean tissue protein of *P. reticulata* were recorded in organisms exposed to 21.25ml/L on days 6 and 2 respectively. The values of mean tissue protein in guppy decreased with increased days across treatments with MFLS (Table 5). However, no significant difference ($p > 0.05$) in the mean tissue protein of test organisms exposed to different concentrations of MFLS on day 4. On day 2, DMRT showed significant difference ($p < 0.05$) in the mean tissue protein of *P. reticulata* exposed to 21.25ml/L and other treatments. Similarly, on day 6, DMRT showed significant difference ($p < 0.05$) in the mean tissue protein of *P. reticulata* exposed to 212.5ml/L and other treatments (Table 5).

The lowest value (85.63 ± 7.85 mg/dl) of the mean tissue triglyceride was recorded in organism exposed to 21.25ml/L on day 6 while the highest value (144.28 ± 6.33 mg/dl) was recorded in organism exposed to 212.50ml/L on day 2. The values of mean tissue triglyceride in guppy decreased with increased days across treatments with MFLS. There was significant difference ($p < 0.05$) in the mean tissue triglyceride of test organisms exposed to different concentrations of MFLS. DMRT showed significant differences ($p < 0.05$) in the mean tissue triglyceride of *P. reticulata* across treatments and days. However, there was no significant difference ($p > 0.05$) in the mean tissue triglyceride values of treatments 0.0 (control) and 21.25ml/L on days 2, 4 and 6. Similarly, no significant difference ($p > 0.05$) was observed in the mean tissue triglyceride values of treatments 42.50 and 212.50ml/L on days 2 and 4 (Table 5).

The lowest value (32.76 ± 1.29 mg/dl) and the highest value (53.15 ± 1.67 mg/dl) of mean tissue glucose were recorded in organisms exposed to 21.25ml/L

Table 4 - Mean protein, triglyceride, glucose and cholesterol contents in the tissue of *P. reticulata* exposed to sublethal concentrations of Faab liquid soap.

Concentration (ml/L)	Duration of treatment (Days) mg/dl		
	2	4	6
Protein			
Control (0)	30.81±1.00 ^a	24.78±1.10 ^a	25.79±2.20 ^b
15.5	39.29±2.85 ^{ab}	24.69±1.65 ^a	23.32±0.53 ^{ab}
31.0	48.54±5.44 ^b	30.78±0.77 ^b	21.04±0.71 ^a
155.0	34.79±3.37 ^a	27.40±0.87 ^{ab}	24.86±1.34 ^{ab}
Triglyceride			
Control (0)	96.03±5.56 ^a	87.67±4.74 ^a	87.43±5.23 ^a
15.5	115.62±9.08 ^a	101.94±7.92 ^a	99.65±8.72 ^a
31.0	154.95±3.96 ^b	151.56±4.26 ^b	131.46±5.90 ^b
155.0	142.96±9.56 ^b	136.38±9.17 ^b	109.58±8.26 ^a
Glucose			
Control (0)	47.33±0.90 ^a	37.18±0.30 ^a	43.31±1.04 ^b
15.5	55.03±2.18 ^c	40.87±1.92 ^a	34.05±1.29 ^a
31.0	54.34±0.65 ^{bc}	46.25±1.69 ^b	33.95±0.98 ^a
155.0	49.65±2.11 ^{ab}	46.34±0.88 ^b	40.53±1.41 ^b
Cholesterol			
Control (0)	45.07±1.26 ^a	41.82±2.28 ^a	40.91±1.28 ^a
15.5	54.21±1.58 ^b	54.58±4.16 ^b	43.41±1.77 ^b
31.0	55.56±1.06 ^b	65.38±4.60 ^b	37.30±0.30 ^b
155.0	53.26±2.73 ^b	62.93±3.22 ^b	43.18±2.71 ^b

Means with the same superscript letter(s) in a column are not significantly different in the DMRT test at P = 0.05.

on days 6 and 2 respectively. The values of mean tissue glucose in guppy decreased with increased days across treatments with MFLS. There was significant difference ($p < 0.05$) in the mean tissue glucose of test organisms exposed to different concentrations of MFLS. DMRT showed significant difference ($p < 0.05$) in the mean tissue glucose of *P. reticulata* across treatments and days. However, on days 2 and 6, no significant difference ($p > 0.05$) was recorded in the mean tissue glucose values between treatments 0.0 (control) and 212.50ml/L. Similarly, on days 2, 4 and 6 no significant difference ($p > 0.05$) was recorded in the mean tissue glucose values between treatments 21.25 and 42.50ml/L (Table 5).

The lowest (37.12±0.40mg/dl) and highest (54.41±0.77mg/dl) values of the mean tissue cholesterol were recorded in organisms exposed to 42.50ml/L on days 6 and 2 respectively. There was significant difference ($p < 0.05$) in the mean tissue cholesterol of test organisms exposed to different concentrations of MFLS. On day 2, DMRT did not show any significant difference ($p > 0.05$) in the mean tissue cholesterol values between treatments 0.0 (control) and 21.25ml/L and treatments 42.50 and 212.50ml/L. Similarly, on day 6 no significant difference ($p > 0.05$) was recorded in the mean tissue cholesterol values between treatments 21.25 and 212.50ml/L (Table 5).

Table 5 - Mean protein, triglyceride, glucose and cholesterol contents in the tissue of *P. reticulata* exposed to sublethal concentrations of Morning Fresh liquid soap.

Concentration (ml/L)	Duration of treatment (Days) mg/dl		
	2	4	6
Protein			
Control (0)	30.81±1.00 ^a	24.78±1.10 ^a	23.80±2.19 ^a
21.25	58.54±4.04 ^b	26.25±0.84 ^a	18.06±0.55 ^a
42.50	36.34±2.79 ^a	28.17±0.94 ^a	18.94±0.33 ^a
212.50	31.29±1.74 ^a	28.39±1.81 ^a	22.40±1.87 ^{ab}
Triglyceride			
Control (0)	96.03±5.56 ^a	87.66±4.74 ^a	87.43±5.23 ^a
21.25	103.42±4.47 ^a	100.14±6.41 ^a	85.63±7.85 ^a
42.50	139.96±4.51 ^b	137.63±6.05 ^b	116.11±7.42 ^b
212.50	144.28±6.33 ^b	139.78±7.59 ^b	99.86±4.11 ^{ab}
Glucose			
Control (0)	47.33±0.90 ^a	37.18±0.30 ^a	43.31±1.04 ^b
21.25	53.15±1.67 ^b	39.70±1.67 ^{ab}	32.76±1.29 ^a
42.50	52.95±1.43 ^b	40.99±1.32 ^{ab}	34.11±0.92 ^a
212.50	48.04±1.38 ^a	43.53±2.01 ^b	40.80±2.28 ^b
Cholesterol			
Control (0)	45.07±1.26 ^a	41.82±2.28 ^a	40.91±1.28 ^b
21.25	57.33±1.65 ^c	45.55±1.32 ^a	40.21±1.35 ^{ab}
42.50	54.41±0.77 ^{bc}	58.11±3.92 ^b	37.12±0.40 ^a
212.50	51.34±2.41 ^b	55.06±3.62 ^b	40.27±1.18 ^{ab}

Means with the same superscript letter(s) in a column are not significantly different in the DMRT test at P = 0.05.

DISCUSSION

The results obtained indicate that the 96hLC₅₀ value of Faab and Morning fresh liquid soaps were found to be 0.062 and 0.085ml/L respectively when tested on the guppy, *P. reticulata*. Analysis of Variance (ANOVA) showed that the quantal response of *P. reticulata* differs significantly ($p < 0.05$) among different concentrations at 24, 48, 72 and 96h of exposure to both toxicants. The results agreed with those of several authors (Anastácio et al., 2000; Morrall et al., 2003; Nalecz-Jawecki et al., 2003; Liwarska-Bizukojc et al., 2005) who observed that detergent products and their ingredients were relatively toxic to aquatic life. These results were also corroborated by Pettersson et al. (2000) who reported that anionic surfactants give toxic effects to various aquatic organisms at the concentrations from 0.0025 to 300mg/L.

On the basis of relative sensitivity of test species to Faab and Morning fresh liquid soaps, *P. reticulata* was more susceptible to FLS (96hLC₅₀ = 0.062ml/L) than to MFLS (96hLC₅₀ = 0.085ml/L). Based on derived 96hLC₅₀, the computed toxicity factor (TF) revealed that FLS was slightly more toxic to *P. reticulata* than MFLS. The differential toxicity observed between test compounds; FLS and MFLS could be attributed to the difference in physical and chemical compositions of the surfactants. This observation is in consonance with investigations from other authors (Aguigwo, 2002; Otitoloju, 2005; Lawal & Samuel, 2010) who reported that the level of toxicity of any toxicant depends on its

bioaccumulation, the differential physical and chemical compositions of the compound forming the toxicant and the reaction of the exposed organism. The exposure of *P. reticulata* to FLS and MFLS resulted in exhibition of aggressive behavior, increased opercular movement and abnormal swimming movement. Similar behavioral responses were reported in *P. reticulata* exposed to chlorpyrifos-methyl (Mahmut et al., 2005) and pirimiphos-methyl (Lawal & Samuel, 2010).

There was a decrease in the values of biochemical parameters; tissue protein, triglyceride, glucose and cholesterol in *P. reticulata* exposed to sub-lethal concentrations of surfactants with increased experimental days across treatments. This is in agreement with Joshi et al. (2002) that reported decrease in blood parameters of freshwater teleost fish *Clarias batrachus* after its exposure to lindane and malathion.

The progressive decrease in tissue protein observed in test organisms exposed to toxicants could be attributed to the utilization of protein in gluconeogenesis for the generation of glucose to overcome the stress posed by the toxicants (Omoniyi et al., 2002; Martinez et al., 2004). This result is corroborated by Wankede et al. (2000) who observed in the liver of fish, *Channa orientalis* a prominent protein decrease after exposure to lethal and sub-lethal concentrations of endosulfan and concluded that proteins were utilized in the production of energy to eradicate the pesticide stress. Maruthanayagam et al. (2000) also concluded that the decrease in total protein content in the kidney tissues of *Channa punctatus* fingerlings was due to the impact of detergent chemicals.

Triglyceride and cholesterol which are types of lipid found in blood and a source of energy, decreased progressively as the concentration of the toxicants increased. This may be due to the increased cellular activities resulted in metabolism of lipids to meet the increased physiological demand (Maruf Iftexhar et al., 2006; Abalaka et al., 2011) posed by the surfactants. Furthermore, lower level of triglyceride indicated the deficiency of hepatic metabolites compound as well as abnormal physiological function of the metabolism (Omitoyin, 2007). Similarly, progressive reduction observed in the tissue glucose value of *P. reticulata* exposed to sub-lethal concentration of surfactant, could be due to the impairment of the liver cells which consequently hinder gluconeogenesis. This result is in agreement with Ajani et al. (2007) who reported the decrease in plasma glucose concentrations after an initial increase to progressive depletion of energy due to the fact that the initial increased mobilization could not overcome the immediate threat of the toxicity.

The results obtained in this study showed that Faab and Morning Fresh liquid soaps are toxic on *P. reticulata*, therefore their indiscriminate discharge into

drainage canals should be discouraged for healthy aquatic ecosystems particularly in an emerging economy.

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