Effect of Yucca Schidigera on water quality of Nile Tilapia fingerlings

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Abstract: The effect of supplementation of *Yucca Schidigers* in feed and water of Nile tilapia. Sixty fish were stocked in four glass aquaria (15 fish per aquarium). Diets were fed to fish at rate of 3% of body weight as fed control diet in first group, add *Y. Schidigera* (1 g\kg) in second group, add *Y. Schidigera* in water of third and fourth group (0.25,0.5 gm\L) for 6 weeks. The result revealed that Yucca cause significant (p<0.05) lower levels of ammonia and nitrite in the aquaria water especially in groups (4,5) and increase in nitrate in water.

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1. Introduction

The intensive rearing of fish species in aquaculture generates a potentially stressful environment to the fish, with the possible suppression of the immune system, rendering the fish more susceptible to different diseases **(Austin and Austin, 1999).** The routine use of antibiotics during fish culture to minimize the risk of disease is not advisable since it may adversely affect the indigenous microflora of juveniles or adult fish and may increase the risk of promoting antibiotic- resistant microorganisms **(Alderman and Hastings, 1998)**.

Thus, the use of probiotics, in the culture of aquatic organisms, is increasing with the demand for more environment-friendly aquaculture practices **(Gatesoupe, 1999).**

*Yucca schidigera*extract (YE) contains two active ingredients: the sterodialsaponin fraction, which has surface active properties, and the glyco-component fraction, which binds to ammonia. Saponins also improve animal immunity and performance (***Cheeke, 2000; Ayasan et al., 2005***).

YEO and KIM, 1997 noted that the ammonia may be used for microbial protein synthesis or may enter the blood stream. The effects of yucca extract may be associated with the glyco-components which bind ammonia and decreasing emissions from the manure pit.

Jacques and Bastien (1989) and ***Headon and Dawson, 1990*** reported that, ammonia average in manure of a bird not fed *Y. schidigera* extract was 29 ml/L and 2 ml/L from bird receiving extract. Suggested modes of action include urease inhibition, increased bacterial use of ammonia and direct binding of ammonia. They concluded that an extract of the *Yucca shadier* plant has shown to be promising in controlling ammonia accumulation.

AMBER et al. (2004) study the effect of feeding diets containing yucca extract or probiotic on growth performance, nitrogen utilization, digestibility, blood parameters, ceacal microbial activity and relative revenue. The results showed that the yucca extract reduced blood and caecal urea and ammonia concentrations by using these additives. The effects of yucca extract addition in the reducing urea and ammonia levels seems to be more effective than effect of probiotic. It could be concluded that the dietary yucca extract or probiotic decrease urea and ammonia levels in the blood and caecal and thus may be beneficial for improving the health, by reducing ammonia emission.

In this experment we will measure water quality parameters (dissolved oxygen (DO), water pH, Temperatures, Total ammonia mg. /L., non-ionized form of ammonia (N-NH3); ammonium ion, the ionized form (N-NH4 +), ammoniacal nitrogen (ammoniacal-N) refers to both nitrite (N-NO2-) and nitrate (N-NO3-), Alkalinity, Hardness (as CaCO3) and Hydrogen sulphide (H2S).

2. Material and Method

1- Fish:

A total of 60 apparently healthy ***Oreochromisniloticus***, (100 ± 5g / fish) were placed in four aquaria (15 in each aquarium) and temperature (26°C) controlled water, supplied with chlorine free tap water according to ***(Innes, 1966)***. The continuous aeration was maintained in each aquarium.The experimental period lasted 42 days.

All fish were placed in aquaria and acclimatized for 2 weeks prior to the experiments.

The fish feed was prepared from local company (Hendrix) and daily provided at a fixed feeding ratio of 3% of body weight of fish as described by ***Eurell et***

al. (1978) *Yucca schidegra* add in feed and water of the experimental fish). First group did not receive any extract with diet and feed on basal diets (G1 control). Second group (G2) received *Yucca schidigera* extract in feed (1 gm/kg), and the last two groups of fishes (G3,4) received the *Yucca schidigera* extract in water with ratios of 0.25 gm. / liter and 0.5 gm. / liter, and the fishes were hand-fed once a day with diet medicated with extracts at a rate of 2% body weight at 9:00 a.m. for 6 weeks and three times with normal diet. The samples of both water and fish were taken every two weeks to determine the different water quality.

Tools for determination of Physico-chemical properties of water quality:-

1. Dissolved Oxygen meter for measuring the level of dissolved oxygen in the water.
2. Salinometer for measuring of % of water salinity.
3. pH meter for measuring the pH values**. (A.P.H.A., 1998)**
4. Kits for measuring the levels of unionized ammonia (NH 3), Nitrate (No_2) and Sulphate in the water. (USA, Virginia Company, lot. No.201134)

3. Result

Result of Physiochemical Parameter of Water Quality

Tables (2, 3 and 4) and Figures (2-4) shows significant differences ($p \leq 0.05$) between the groups during different periods, for the physical and chemical parameters evaluated, with the exception of pH and Temperatures.

Water temperature was fixed all over the experimental periods (6th weeks) 27.0°C.

DO levels The highest DO concentration ($p \leq 0.05$) was observed in the (G 3,4) treated with *Yucca schidigera* in water in both doses (0.25 and 0.5 gm. /L.).

Water pH remained between 7.23;7.27;7.52 and 7.66 within the range established for freshwater bodies' aquaculture.

Alkalinity was significantly higher ($p \leq 0.05$) in the (G 1, 2) than (G 3,4).

In this study, Total ammonia mg. /L., non-ionized form of ammonia (N-NH3); ammonium ion, the ionized form (N-NH4 +), ammoniacal nitrogen (ammoniacal-N) refers to nitrite (N-NO2-) was significantly lower ($p \leq 0.05$) in the (G 3) and (G 4) **and nitrate (N-NO3-)** was higher in groups (3,4) than other groups.

However, the concentrations Hardness (as $CaCO_3$) (mg/l) were within the range considered of good buffering capacity between 20 to 300 mg L-1 CaCO3. Furthermore, reported that higher levels of ions carbonate and bicarbonate in the water increase the alkalinity, making more difficult to change the water pH.

Hydrogen sulphide (H2S) The lower values were reported in the (G 3) and (G 4) than (G 1) and (G 2).

Table (2): Water quality in different experimental groups of *Oreochromisniloticus*after 6th weeks (Mean ± SE, = 3).

Groups	Periods(week)	Dissolved O2 (mg/l)	PH	Temperatures °C
G 1	Zero day	5.31± 0.31 ^{c}	7.26 ± 0.11 ^{a}	27.0± 1.0
	2nd week	5.56 ± 0.27 ^{ab}	7.12 ± 0.12 ^{ab}	27.0± 1.0
	4th week	5.75 ± 0.28 ^{a}	7.12 ± 0.13 ^{b}	27.0± 1.0
	6th week	5.42 ± 0.25 ^{b}	7.08 ± 0.16 ^{c}	27.0± 1.0
G 2	Zero day	5.31± 0.31 ^{c}	7.24 ± 0.14 b	27.0± 1.0
	2nd week	5.56 ± 0.32 b	7.12 ± 0.12 bc	27.0± 1.0
	4th week	5.74 ± 0.31 ab	7.36 ± 0.14 ab	27.0± 1.0
	6th week	5.89 ± 0.32 a	7.45 ± 0.16 a	27.0± 1.0
G 3	Zero day	5.31± 0.31 c	7.47 ± 0.14 bc	27.0± 1.0
	2nd week	5.54 ± 0.27 b	7.52 ± 0.14 b	27.0± 1.0
	4th week	5.88 ± 0.26 ab	7.84 ± 0.14 a	27.0± 1.0
	6th week	6.29 ± 0.27 a	7.75 ± 0.17 ab	27.0± 1.0
G 4	Zero day	5.31± 0.31 c	7.23 ± 0.11 bc	27.0± 1.0
	2nd week	6.22± 0.24 ab	7.27 ± 0.10 b	27.0± 1.0
	4th week	6.67 ± 0.23 b	7.52 ± 0.13 ab	27.0± 1.0
	6th week	6.82 ± 0.20 a	7.66 ± 0.14 a	27.0± 1.0

Means with different superscripts in the same column are significantly different at *P* <0.05.

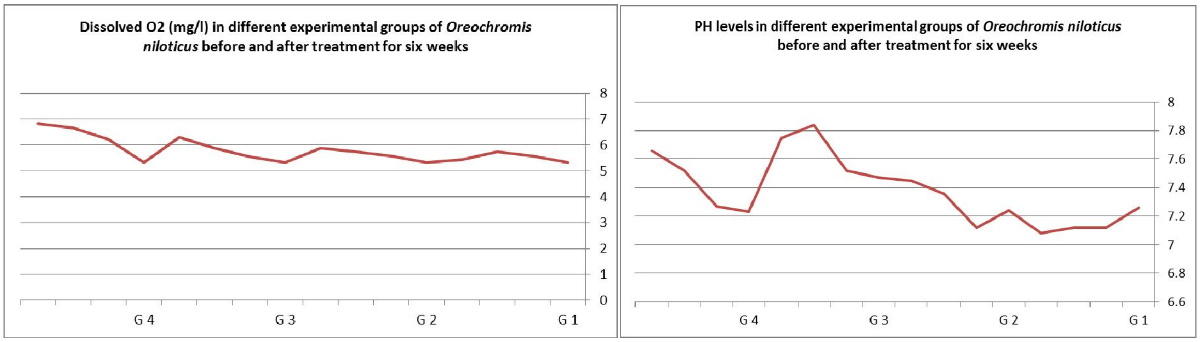


Figure (2 A & B): Water quality (Dissolved oxygen and pH levels) in different experimental *Oreochromisniloticus* after 6th weeks.

Table (3): Water quality in different experimental groups of *Oreochromisniloticus*after 6th weeks (Mean ± SE, = 3).

Groups	Periods (week)	Total ammonia mg./L.	Unionized ammonia (NH_3) mg./L.	Nitrite (No2-N) mg./L.	Nitrate (No3-N) mg./L.
G 1	Zero day	0.243 ± 0.02 ^{c}	0.01 ± 0.001 ^{c}	0. 21 ± 0.035^{bc}	2.15 ± 0.42^{c}
	2nd week	0.251 ± 0.02 ^{b}	0.06 ± 0.001 b	0. 23 ± 0.035^{ab}	1.22 ± 0.43^{bc}
	4th week	0.257 ± 0.02 ab	0.08 ± 0.001 a	0. 22 ± 0.035 b	0.95 ± 0.44ab
	6th week	0.260 ± 0.02 a	0.07 ± 0.001 ab	0. 25 ± 0.035 a	0.73 ± 0.45 a
G 2	Zero day	0.243 ± 0.02 a	0.01 ± 0.001 c	0. 21 ± 0.035 a	2.15 ± 0.42 a
	2nd week	0.225 ± 0.02 b	0.04 ± 0.001 b	0. 20 ± 0.035ab	1.47 ± 0.38 b
	4th week	0.194 ± 0.01 c	0.05 ± 0.001 ab	0. 19 ± 0.033 b	1.22 ± 0.38bc
	6th week	0.218 ± 0.01 bc	0.06 ± 0.001 a	0. 17 ± 0.031 c	0.85 ± 0.37 c
G 3	Zero day	0.243 ± 0.02 a	0.01 ± 0.001 b	0. 21 ± 0.035 a	2.15 ± 0.42 a
	2nd week	0.147 ± 0.01 c	0.02 ± 0.001 a	0. 20 ± 0.035ab	1.98 ± 0.31 b
	4th week	0.154 ± 0.01 bc	0.02 ± 0.001 a	0. 14 ± 0.029 b	1.89 ± 0.27 c
	6th week	0.165 ± 0.01 b	0.01 ± 0.001 b	0. 08 ± 0.019 c	1.68 ± 0.19 d
G 4	Zero day	0.243 ± 0.02 a	0.01 ± 0.001 a	0. 21 ± 0.035 a	2.15 ± 0.42 a
	2nd week	0.199 ± 0.01 c	0.00 ± 0.000 b	0. 17 ± 0.027 b	2.22 ± 0.27 b
	4th week	0.133 ± 0.01 b	0.00 ± 0.000 b	0. 11 ± 0.021 c	2.27 ± 0.23 c
	6th week	0.122 ± 0.01 bc	0.00 ± 0.000 b	0. 04 ± 0.014 d	2.35 ± 0.14 d

Means with different superscripts in the same column are significantly different at *P* <0.05.

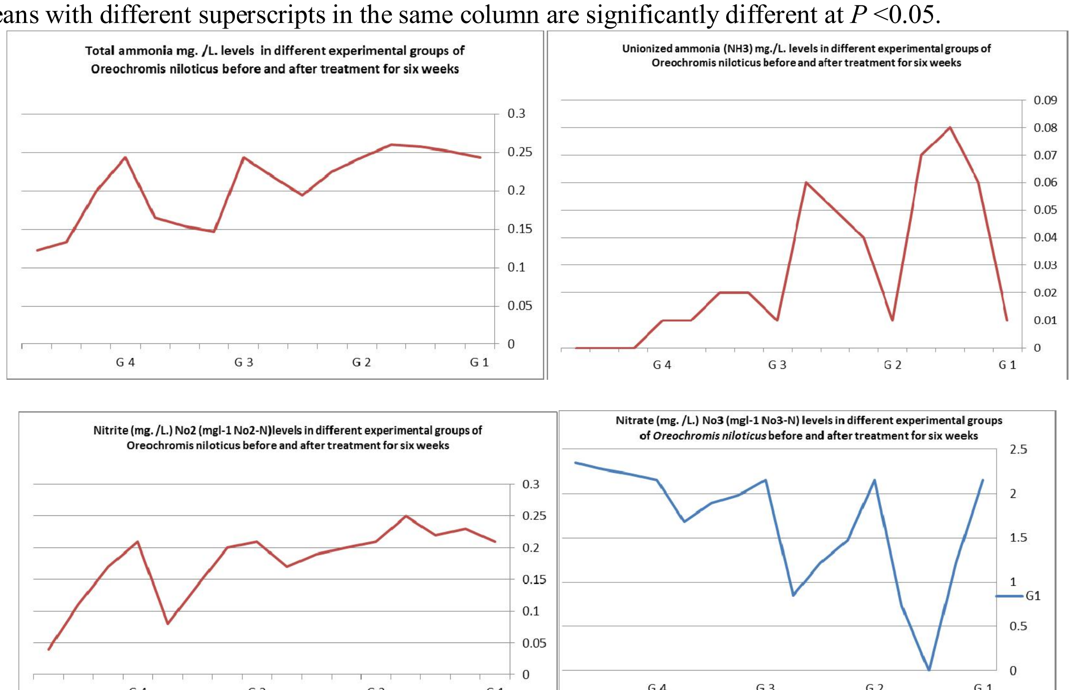


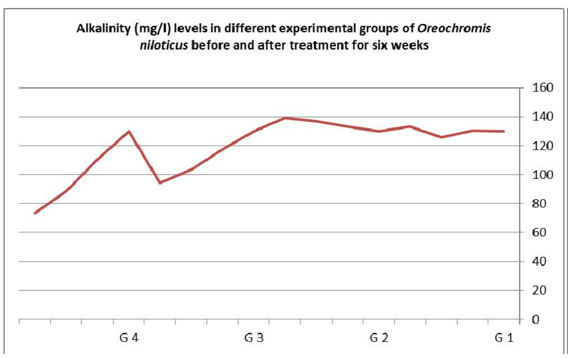
Figure (3 A, B, C and D): Water quality (Total ammonia mg./L. Unionized ammonia (NH3) mg./L. Nitrite (mg. /L.) No2 (mgl-1 No2-N)

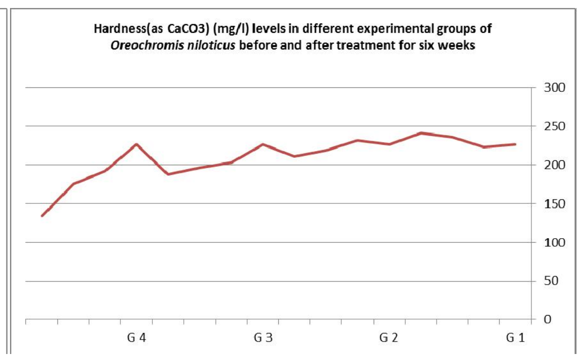
Nitrate (mg. /L.) No3 (mgl-1 No3-N) in different experimental groups of *Oreochromisniloticus*after 6th weeks.

Table (4): Water quality in different experimental groups of *Oreochromisniloticus*after 6th weeks (Mean ± SE, = 3).

Groups	Periods (week)	Alkalinity (mg/l)	Hardness(as CaCO3) (mg/l)	Hydrogen sulphide (H2S) (mg/l)
G 1	Zero day	129.8 ± 6.83 b	226.44 ± 10.35 bc	11.78 ± 1.67 c
	2nd week	130.2 ± 6.92 ab	223.25 ± 10.14 c	27.32 ± 2.15 b
	4th week	125.6 ± 6.59 c	235.88 ± 10.71 ab	27.46 ± 2.60 bc
	6th week	133.2 ± 6.91 a	241.37 ± 10.87 a	34.33 ± 2.77 a
G 2	Zero day	129.8 ± 6.83 c	226.44 ± 10.35 ab	10.59 ± 1.44 d
	2nd week	133.4 ± 6.87 b	231.65 ± 10.42 a	13.19 ± 2.33 c
	4th week	137.1 ± 6.59 ab	219.22 ± 10.13 c	15.51 ± 2.87 b
	6th week	139.4 ± 6.74 a	211.37 ± 10.11 d	16.11 ± 3.14 a
G 3	Zero day	129.8 ± 6.83 a	226.44 ± 10.35 a	9.47 ± 1.41 a
	2nd week	117.3 ± 6.41 b	203.27 ± 10.07 b	5.44 ± 1.62 b
	4th week	103.5 ± 6.23 c	196.11 ± 9.89 c	5.46 ± 2.41 bc
	6th week	94.3 ± 5.79 d	187.65 ± 9.73 d	3.44 ± 2.66 c
G 4	Zero day	129.8 ± 6.83 a	226.44 ± 10.35 a	7.43 ± 0.57 a
	2nd week	110.4 ± 5.19 b	192.25 ± 9.47 b	3.52 ± 0.08 b
	4th week	88.5 ± 5.14 c	175.46 ± 8.95 c	2.66 ± 0.04 c
	6th week	73.4 ± 4.62 d	134.26 ± 8.68 d	1.73 ± 0.02 d

Means with different superscripts in the same column are significantly different at P <0.05.





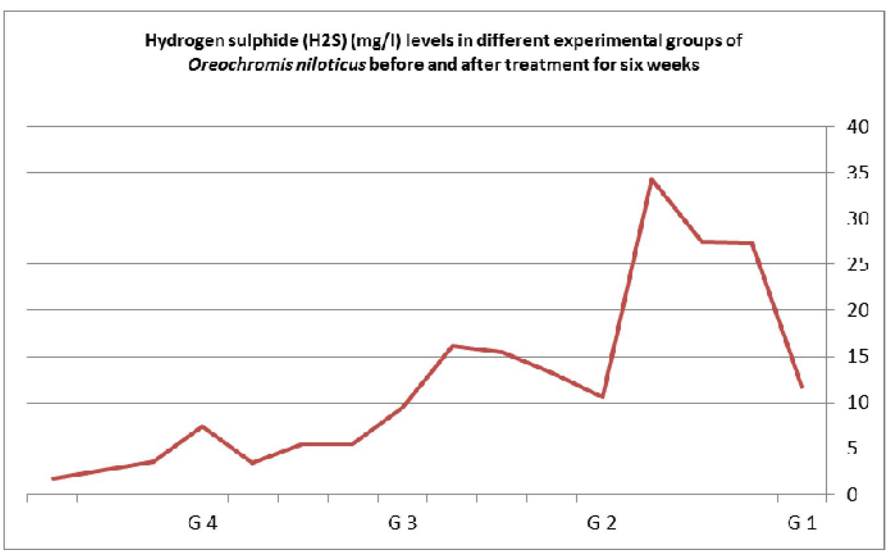


Figure (4A, B and C): Water quality (Alkalinity (mg/l) Hardness (as CaCO3) (mg/l) Hydrogen sulphide (H2S) mg. /l) in different experimental groups of *Oreochromisniloticus* after 6th weeks.

V-Discussion

An extract of *Yucca schidigera*plant has a promising effect in the control of ammonia with various terrestrial livestock animals. It is not known if the reduction is due to urease inhibition, increased use of ammonia ***(Jacques and Bastien, 1989)***, or direct binding of ammonia ***(Headon and Dawson 1990)***. Previous studies ***(Tidwell et al., 1992)*** utilized channel catfish and two different commercial sources of *Y. schidigera* extract. These extracts can contain at least three steroid saponins ***(Kaneda et al., 1987),*** but the exact extraction procedures utilized by different companies conceivably can result in significantly different levels of active compounds in the end products. Specifically, it appears that saponin component of the extract can be removed without eliminating its ammonia reduction capabilities (Headon, university college, Galway, Ireland, personal communication to ***Tidwell et al., 1992).*** Accordingly, the extract used in the Kelly and Kohler study may prove highly useful in reducing N content in tilapia feces. Moreover, the long intestinal tract of Nile tilapia compared to channel catfish may be more conductive for N reduction. In the present study, the addition of *Y. schidigera*in Nile tilapia feed reduced ammonia concentration in the aquaria water. These results agree with those of ***Tidwell et al., (1992),*** who stated that addition of *Y. schidigera*extract to in vitro ammonia solutions reduced ammonia concentrations. Also, ***Headen and Dawson (1990)*** reported that reduction of ammonia could be due to either binding of ammonia with some fraction of *Y. schidigera*or by conversion of ammonia to another compound. In fish groups fed on diets supplemented with Yucca, the water of aquaria showed increase nitrate concentration as ammonia levels declined, subsequently, nitrite concentrations decreased. These indicate the action of either chemical oxidation or nitrifying bacteria. In aquatic systems, bacteria of the genus *Nitrosomonas*oxidize ammonia to nitrite which is oxidized to nitrate by bacteria of the genus *Nitrobacter*. Microbial or chemical nitrification is also supported by concurrent declines in oxygen levels, because these are oxygen-consuming reactions. ***(Tidwell et al., 1992)*** shown that addition of *Y. schidigera*to formulated channel catfish diets reduced ammonia accumulation and decreased fish growth performance**.** In our study on Nile tilapia, a reduction in ammonia production or accumulation was demonstrated when *Y. schidigera*was incorporated into prepared Nile tilapia feeds.

The nitrate, final product of the nitrogen cycle, is considered harmless to fish in lagoons and natural systems. However, in closed systems, with very little water renewal or without it, the accumulation can become harmful if higher than 250 mg L **(Francis-Floyd *et al.,* 2005**). In this study, NNO3 concentration was significantly higher ($p \leq 0.05$) in G1 than other groups

Nitrite is toxic to fish even at levels as low as 0.1 mg L **(Francis-Floyd *et al.,* 2005).** Average concentration of N-NO2 in our study is low in groups with *Y. schidigera*in water.

Abdelaziz and Mamal (2010), studying tilapias, observed that when ammonia water concentration was higher than 2 mg L there was massive mortality, while concentration higher than 1 mg L-1 causes losses, especially juveniles, when there is prolonged exposure (several weeks).In this study there is marked decrease in total ammonia and unionized ammonia in groups with *Y. schidigera*in water.

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