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Life Sustainability of Grass Carp (*Ctenopharyngodon idella*) Fishes on Implication of Distillery Spentwash

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Abstract

Management and conservation of grass-carp fishes was made with different concentration of primary treated spentwash (PTSW) (0.1% to 1.2%) in water. Spentwash was analyzed for its physico-chemical parameters. Fingerlings fishes (obtained from V.C. Farm, Mandya, Karnataka), were divided into 13 groups (G1 to G13) of 10 each and keeping G1 as 'control unit', G2 to G13 were exposed to different concentrations of primary treated spentwash for a period of 6 days in different aquariums of 36" x 15" x 18" size. It was found that all fishes behaved normally up to 1.1% spentwash, thereafter, they behaved abnormally and could not sustain for longer time and eventually died. This is due to high BOD and COD, ammonical nitrogen and also due to the insufficient dissolved oxygen (DO) for natural respiration at higher concentration of spentwash. The 'mortality rate' (MR) was 100% in G13 (1.2% spentwash) and 25.5% in G12 (1.1% spentwash) after 12 hr exposure, and in G2 to G11 MR was 0% even after exposure of 6 days. Implication of distillery spentwash into water bodies at higher concentration results deleterious effect on the life of Grass Carp (*Ctenopharyngodon idella*) fishes.

Key Words: Grass carp Fishes, Sustainability, Distillery Spentwash, Aquarium, Mortality Rate.

Introduction

The grass carp (Fig. 1) is one of the largest members of the family Cyprinidae, and is the only member of the genus *Ctenopharyngodon* (Shireman and Smith, 1983; Chilton and Muoneke, 1992). No subspecies are known (Shireman and Smith, 1983; N. Bogutskaya, Zoological Institute, Russian Academy of Sciences, St. Petersburg, pers. comm.). Grass carp is a sub-tropical to temperate species, native to large rivers and lakes in eastern Asia. In large rivers, like the Amur (border of China and Russia), Yang Tze (northern China), Yellow River (central China) and the Min River (crosses the border from Vietnam into China), the grass carp is found only in the lower and middle reaches of the river. This species is characterized by: a wide, scaleless head; subterminal or terminal mouth with simple lips; no barbels; slightly protracted upper jaw and, very short snout, its length is less than, or equal to, its eye diameter and its postorbital length is more than half its head length (Page and Burr, 1991; Eccles, 1992; Opuszynski and Shireman, 1995). The body is slender and fairly compressed with a rounded belly and a complete, slightly decurved lateral line, extending along the middle of the depth of the tail (Shireman and Smith, 1983; Page and Burr, 1991; Opuszynski and Shireman, 1995). Dorsal fin origin is above, or just in front of, the pelvic fin origin and the number of fin rays for the dorsal, anal and caudal fins are 7, 8 and 18, respectively (Page and Burr, 1991; Keith and Allardi, 2001). The dorsal and anal fins do not have spines (Shireman and Smith, 1983). The moderate to large cycloid scales (35-45 lateral count) are dark-edged with a black spot at the base (Shireman and Smith, 1983, Page and Burr, 1991; Opuszynski and Shireman, 1995). Gill rakers (about 12) are unfused, short, lanceolate and widely set (Shireman and Smith 1983; Opuszynski and Shireman, 1995). The colour of adult grass carp is dark gray on the dorsal surface with lighter sides (white to yellow) that have a slightly golden shine. Fins are clear to gray-brown (Page and Burr, 1991; Opuszynski and Shireman, 1995). This species generally attain weights of 30-50 kg (Chilton and Muoneke, 1992) and can reach lengths greater than 1m (Forester, 1978; Pauley, 1978; Page and Burr, 1991; Nico and Fuller, 2001).

A detailed review of larval morphology has been reported earlier (Shireman and Smith, 1983). Wild grass carp from the Amur basin usually live from 5 to 11 years, although based on scale samples, some individuals can reach up to 15 years of age and one specimen from North Dakota was found to be greater than 33 years old (Shireman and Smith, 1983; W. Courtenay, USGS, pers. comm). Cultured grass carp may reach up to 1 kg in the first year and grow approximately 2-3 kg/yr in temperate areas and 4.5 kg/yr in tropical areas (Shireman and Smith, 1983). A study of grass carp growth at different stocking densities (Shelton *et al.,* 1981) indicates that the growth of age 0 fishes was strongly affected by density. After one year, average size decreased with increasing density, with maximum weights attained in ponds with the lowest density (Shelton *et al.* 1981). Grass carp require cellulose and protein in their diet, with protein being especially important for optimal growth in young fishes (40-120g) (Chilton and Muoneke, 1992).

Nowadays, water pollution has become a more serious problem in the world due to increasing population (Benefield *et al.,* 1982; Chu, 2001). The main pollutants or impurities in the wastewater come from human activities such as cooking and washing, industry, agriculture and transportation (Metcalf and Eddy Inc., 2004). Development of industries with rapid pace during the recent times has taken its toll by causing environmental pollution of air, water and soil. The contamination of inland & surface waters and land/soil, due to the release of variety of chemicals may prove toxic to all classes of living organisms.

Molasses (one of the important by- products of sugar industry) is the chief source for production of ethanol by fermentation method. In the year 1999, there were 285 distilleries in India producing 2.7 x 10^9 l of alcohol and generating 4 x 10^{10} l of wastewater each year (Joshi et al., 1999). This number has gone up to 319, producing 3.25 x 10^9 l of alcohol and generating 40.4 x 10^{10} l of wastewater annually (Uppal *et al.,* 2004). In this chemical process, with every liter of ethanol production emerges out 8 liters of waste water called as 'raw spentwash' (RSW). This RSW is known for high BOD (5000-8000mg\L) and COD (25000-30000mg\L) (Joshi *et al.,* 1994), undesirable color due to the presence of water soluble recalcitrant colouring compound called melanoidin (Evershed *et al.,* 1997) and foul odor (Sirianuntapiboon *et al.,* 2004; Chandra and Pandey, 2001; Cerniglia, 1992; Urso and Gengazian, 1982), besides a number of pathological pollutants. The chief among the notable pollutants, is melanoidin pigment which is brown in color that stains the superficial water sheet and in turn cuts off the light rays and dulls photosynthesis when RSW is let into water bodies (tanks, lakes, channels, Ponds, etc). The brown ting of melanoidin pigment is the outcome of 'mailard reaction' between sugar and amino compounds (Martins and Vanbackel, 2004). The raw spentwash contains pyrogenic compound like polycyclic aromatic hydrocarbons (PAHS) and benzo (a) pyrene, a known environmental carcinogen (Stein *et al.,* 1990; Agarwal and Pandey, 1994; Vethaak and Wester., 1996; Holladay *et al.,* 1998; Shailaja and Siliva, 2003; Raghu kumar *et al.,* 2004; Patil *et al.,* 1987). RSW is highly acidic and contains an easily oxidisable organic matter with very high BOD and COD, this untreated RSW is let into water courses could definitely cause a great strain on aquatic life. But by installing biomethonation plant in distilleries would positively reduces oxygen demand of RSW. Thus, the resulting spentwash is known as primary treated spentwash (PTSW). Though, PTSW has adverse effect on the aquatic life.

As a part of our ongoing studies of implication of distillery spent wash on the aquatic life (Chandraju *et al.,* 2010), the present work is focused on the study of life sustainability of grass carp *(Ctenopharyngodon Idella)* fishes exposed to different concentrations of PTSW.

Materials and Methods

Physico chemical parameters of PTSW (100%, 0.1%, 0.2%, 0.3%, 0.4%, 0.5%, 0.6%, 0.7%, 0.8%, 0.9%, 1.0%, 1.1%, and 1.2%) were analyzed by standard methods (Table-1). One hundred and fifty six grass carp finger ling fishes *(Ctenopharyngodon idella)* obtained from V. C. Farm, Mandya, Karnataka and divided into 13 groups, G1 to G13 and were set in aquarium of 36" x 15" x 18" size. These were exposed to different concentration of PTSW (0.1% to 1.2%) with normal feeding. G1 was kept as control unit. The MR was noted in each case up to 6 days of exposure and recorded (Table-2).

Table. 1 - Physico-chemical parameters of different dilutions of spentwash

Sl.No.	Parameters	100% PTSW	0.1% PTSW	0.2% PTSW	0.3% PTSW	0.4% PTSW	0.5% PTSW	0.6% PTSW	0.7% PTSW	0.8% PTSW	0.9% PTSW	1.0% PTSW	1.1% PTSW	1.2% PTSW
1	pH	7.57	7.62	7.60	7.56	7.49	7.86	7.94	7.96	7.98	7.80	7.98	7.80	`7.96
2	EC	40264	500	570	575	586	598	670	690	726	815	886	905	925
3	TS	49116	220	250	285	292	320	390	435	534	624	688	710	724
4	TDS	471323	290	320	360	364	400	480	530	608	640	696	720	780
5	TSS	1984	6	7	7.5	8	9	1.0	11	12	13	14	15	16
6	Setteleable Solids	-	-	-	-	-	-	-	-	-	-	-	-	-
7	COD	38692	120	140	160	189	200	230	260	300	350	400	450	500
8	BOD	28476	100	110	120	130	140	150	160	170	180	190	200	240
9	Carbonates	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
10	Bi-Carbonates	14126	192	192	192	193	194	194	195	196	196	196	196	196
11	Total P	24.28	16.2	17.2	18.0	18.5	19.0	19.2	19.6	20.2	21.1	22.2	28.2	32.4

12	Total K	5240	5.2	5.7	6.1	6.8	7.0	7.9	8.1	8.4	9.2	10.8	11.6	12.2
13	Calcium	510	165	170	175	180	185	190	195	200	206	210	216	220
14	Magnesium	1922	19.8	21.0	21.5	22.0	22.5	23.0	23.5	24	25	26	27	28
15	Sulphur	-	-	-	-	-	-	-	-	-	-	-	-	-
16	Sodium	210	19	20	21	21.5	22	24	26	28	30	32	34	36
17	chlorides	6108	91	92	92	93	92	92	92	95	94	93	95	98
18	Iron	19.32	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.55	0.6	0.6	0.6
19	Manganese	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
20	Zinc	0.35	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
21	Copper	-	-	-	-	-	-	-	-	-	-	-	-	-
22	Cadmium	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
23	Lead	0.10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
24	Chromium	0.20	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
25	Nickel	0.10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
26	Ammonical Nitrogen	1458	7.8	8.1	8.5	8.96	10.2	11.8	12.2	12.6	13.0	13.44	13.84	14.28

PTSW – Primary Treated spentwash

Table. 2 - Mortality rate (%) of fish exposed to different dilutions of spentwash

Groups	No. of fish exposed	Concentration of PTSW (%)	No of fish dead	No. of Fish survived	% mortality
G1	12	0.0	0	12	0
G2	12	0.1	0	12	0
G3	12	0.2	0	12	0
G4	12	0.3	0	12	0
G5	12	0.4	0	12	0
G6	12	0.5	0	12	0
G7	12	0.6	0	12	0
G8	12	0.7	0	12	0
G9	12	0.8	0	12	0
G10	12	0.9	0	12	0
G11	12	1.0	0	12	0
G12	12	1.1	03	9	25.5
G13	12	1.2	12	0	100

PTSW – Primary Treated spentwash

Result and Discussion

In G13 (1.2% PTSW) the MR was 100% after 12hr exposure, It was found that MR differs for G13, where as in G2 to G12 the MR was zero even after exposure for 6 days (Fig. 2). The higher MR was noticed in G13 at higher concentration of PTSW with insufficient DO. But in G2 to G12, DO was sufficient for respiration of the fishes as such they behaved normally and in higher concentration of PTSW, fishes get distrubed and were swimming rapidly while in other it shows normal movements. A thick coat of mucus was observed all over the body of the fishes making the fish slimier. Similar results were noticed by Carpenter (1924, 1927). Durve and Jain (1980) observed similar behavior changes in *Rasbora daniconious* when treated with distillery effulent. The fishes were swimming with belly upward and zig-zag motion. There were also eratic and parallel movements observed in fish, indicating the loss of equilibrium. It concludes that, the discharge of distillery spentwash into water bodies at higher concentration leads to deficient of sunlight into water (due to brown color) and further the spentwash promotes mucus formation on the gills of the fishes. Hence, there will be a reduction of oxygen tension in gills of fishes, which makes them behave abnormal due to insufficient dissolved oxygen and finally leads to death.

Fig. 1 - Grass carp (*Ctenopharyngodon idella*)

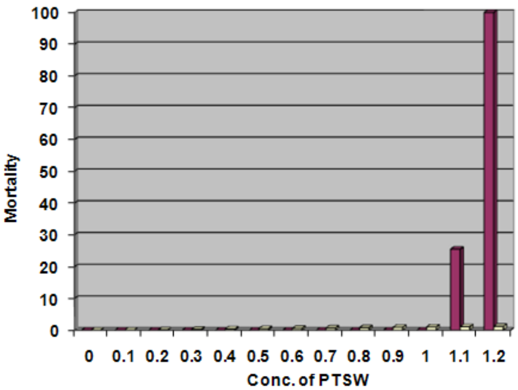

Fig. 2: Rate of mortality

Conclusion

The present work reveals that, the increase in spentwash concentration lead into water bodies will cause deleterious effect on life cycle of grass carp *(Ctenopharyngodon Idella)* fishes. If this continues, a day may come for the complete eradication of fishes causing food scarcity.

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