Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 7, Issue, 10, pp.21573-21577, October, 2015

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

RESEARCH IN DIFFERENT SUBSTRATES FOR PERIPHYTON BASED CULTURE OF SNOW TROUT IN RACEWAYS

[1]*Shyam S. Kunjwal and [2]Anju Thapliyal

[1]Department of Zoology, Uttarakhand Open University, Haldwani, Uttarakhand 263139 (India)
[2]Department of Zoology, Pauri Campus HNB Garhwal University, Uttarakhand-240061

ARTICLE INFO

Article History:
Received 27th July, 2015
Received in revised form
22nd August, 2015
Accepted 07th September, 2015
Published online 31st October, 2015

Key Words

Periphyton,
Schizothorax richardsonii,
Artificial substrates,
Water quality.

ABSTRACT

The present study was carried out to evaluate the growth of snow trout with periphyton based diet in captive condition in three raceways of running water system with a view to find out the suitable artificial substrate for periphyton based culture of *Schizothorax richardsonii* (Gray). Different artificial substrates; Tree branches, Sugarcane bagasse, Paddy straw, Bamboo poles (Dead organic materials) Plastic sheet, Plastic pipes (non bio degradable) and other material like stones and pebbles were used for the production of periphyton community. Bamboo poles and other non- biodegradable substrates were found suitable substrates having without any adverse effect on the water quality of the pond. Growth, survival and production performance of snow trout was evaluated in the 12 months field experiment using Bamboo poles and Plastic sheet. Periphyton based culture of snow trout is profitable eco-friendly in aquaculture practice for hills.

Citation: Shyam S. Kunjwal and Anju Thapliyal, 2015. "Research in different substrates for periphyton based culture of *Snow trout* in raceways", *International Journal of Current Research*, 7, (10), 21573-21577.

INTRODUCTION

In addition to natural food organism, artificial feed must also be used to meet the demands of various species of fish. Aquaculture is not always a truly sustainable practice, so far the supply of external feeds, chemicals and energy inputs are concerned. Therefore, the trophic status of Zoo and Phyto-periphytonled researchers to realize it as a future potential of sustainable system hiding under the water. Horn (1989) reported that the herbivorous fish in nature feeds largely on benthic, epilithic or epiphytic algae rather than on phytoplankton (Dempster*et al.,* 1993*)* also obtained same result when experimented on *Oreochromisniloticus*in a glass fibre tank. The possibility of consuming periphyton by fish is more due to several reasons. Wetzel (1964) reported that the production of periphytic algae per unit water surface area is higher than phytoplankton. Westlake *et al. (*1980) explained that the periphytic algae are generally more stable than phytoplankton and the risk of collapse is much lower. Horne and Golderman (1994) stated that it is mechanically more efficient to scrap or graze a two dimensional layer of periphyton than a filter algae from three dimensional planktonic environment. In recent years, extensive researches are going on the traditional periphyton based aquaculture practices as fisheries enhancement technique throughout the world.

Corresponding author: Shyam S. Kunjwal
Department of Zoology, Uttarakhand Open University, Haldwani, Uttarakhand (India)

The periphyton community is an important component of aquatic eco-system (Wetzel, 1983). In natural communities, periphyton contributes significantly to primary production (Minshall, 1978; Cattaneo and Kalff, 1980) and represents readily available food for many vertebrates (Lamberti and Moore, 1984), including fish (Power *et al*., 1985). The pioneering work in the Indian sub-continent on substrate based aquaculture was carried out at the North-west Fisheries Extension Project (NFEP), Parbatipur aquaculture complex in Bangladesh. Enhancement of fish pond through provision of substrate for periphyton growth has been demonstrated for carp species (Shanker *et al*., 1998; Ramesh *et al*., 1999; Wahab *et al*., 1999 and Keshavanath *et al*., 2001).

The major fishery in the uplands mainly consists of very popular Snow trout (*Schizothorax richardsonii*) and Mahseer. Snow trout is endemic to the Himalayas and, true to its name, it is found in streams and lakes which receive snow melt water from the hills. Most of the snow trout species are of Central Asian origin. Nine principal species belonging to two genera *viz.* Schizothoraichthys and Schizothorax, inhabit the Himalayan region. From the foregoing account, it will be apparent that there is not much information available on the fishery position of snow-trout. The growth of this fish is not very encouraging, so that its culture in captivity has not attracted the attention of the aquaculturists. As this is an important fish for hill biodiversity and is a preferable fish of the people, it is desirable to develop a culture technique of this fish. Attempt has been made by DCFR (erstwhile NRCCWF), Bhimtal to evaluate the growth of this fish in pond condition. Asela is a phytophagous fish and has a special mouth adapted to scraping attached algae from the surfaces of stones. It feeds on attached algae including *Spirogyra, Ulothrix, Oedogonium,* as well as on the benthic insect larvae. Fry feed on larvae of chironomids and caddis flies, but also on microscopic algae. In present study, different types of substrates were used to evaluate the performance of each substrate for the production of an important coldwater indigenous food fish, *Schizothoraxrichardsonii* in pond condition and its impact on the water quality of the pond.

MATERIALS AND METHODS

Experiment was carried out in the raceways (Size-8.73m x 1.63m x 0.84m) at Department of Zoology, D.S.B Campus, Kumaun University, Nainital (1938 msl, Long. 29 ^{0} 23 ʹN, lat. 79 ^{0} 30 ʹE) and at experimental field Centre, DCFR, Champawat (1670 msl, Long. 80^0 07 ʹN, lat. 29^0 30 ʹE)during the period April 2008 to Aug.2009 (5 months for periphyton production and 12 months for fish rearing). Raceways were cleaned and filled with tube well water. The flow rate of water was maintained 5 liter/minute in all the raceways. In the first phase of experiment, for substrates study, Sugarcane bagasse, Paddy straw, Tree branches, Bamboo poles (Dead organic materials) Plastic sheet, Plastic pipes (non- bio degradable) and other material like stones and pebbles were used. Sugarcane bagasse, procured locally was sun dried and added at the rate of 10 kg in first raceway (R1). The dried Sugarcane bagasse was spread uniformly in the bottom of the pond with approximately 3 m^2 surface area. In the second raceway (R2), paddy straw, tree branches, and bamboo poles were inoculated at the same rate in the pond water. All non-degradable organic material and solid material i.e plastic sheet, plastic pipes and stones and pebbles were inoculated in the water of the third raceway (R3). Sampling was done from the all treated raceways for the qualitative and quantitative study of the periphyton. Performance of the tested substrates was evaluated on the basis of quality and quantity of grown periphyton and their impact on pond water quality. The similar experiment was repeated at field centre, DCFR Champawat during the period Sept. 2009-Dec. 2009.

In second phase of the experiment, selected substrates, bamboo splits (Dead organic materials) and Plastic sheet (non - degradable organic material) were inoculated in the water of raceway prior to one month of stocking having total surface area of 3m^2 in the raceways (R2). The raceway (R1) was without the substrate as control having exclusively artificial feeding. Healthy fry of *Schizothorax richardsonii* (Stocking density 8-10 fish/m^2) of average weight 1.11±0.04 to 1.85±0.07g were stocked in each raceway. The pelleted artificial feed (25% crude protein) was prepared by using mixture of rice bran (40%), mustard oil cake 25%, soyabean oil cake 25% and fish meal 10% and provided @3% of the total fish biomass to the control group. Fortnightly analysis of water samples was carried out following the standard methods of APHA (1985).Artificial diet and periphyton diet were analysed for proximate composition (crude protein, crude fat, moisture and ash content) by the AOAC method (1995).

For the numerical estimation of periphyton, sample from 1cm^2 area was used. Depending on the density of organisms the scraping was dispersed in 10 to 100ml water in a beaker. One ml of the dispersed material was placed in the sedgewick rafter counting cell and the counting was done. The counts were expressed as cells or filaments per square centimeter of substrate area.

Cells/cm^2 area = cells/ml suspended scrapings

For wet biomass analysis, 1cm^2 of scraping was taken from natural substrate and then by using pre-weighted filter paper, extra moisture was removed by putting scrapping material on this filter paper and there after weight of filter paper with periphyton sample was taken using Digital balance and obtained biomass was expressed in mg/cm^2. Randomly 10 fishes from each raceway were selected for taking length weight data for computing C.F and S.G.R. Each harvested fish was measured and weighed to quantify the production. Weight gain, condition factor (CF), specific growth rate (SGR), feed conversion ratio (FCR), survival and yield were calculated according to Castell and Tiews (1980) and Devendra (1989). The mean values were compared and data were analysed using analysis of variance.

RESULTS AND DISCUSSION

Production of periphyton biomass

Observed data on seasonal variation in periphyton population (No./cm^2) at Nainital on different substrates (Fig-1) reveal that highest population was produced with bamboo poles (1608 nos./cm^2) followed by sugarcane bagasse (1508 nos./cm^2) and plastic sheet (1433 nos./cm^2). The average of the periphyton population on all tested substrate was 1291 nos./cm^2 on all substrates. Population on the bamboo pole was 24.6% higher, on sugarcane bagasse 16.8% higher and on the plastic sheet 11% higher than the average. Minimum population was recorded with stones/pebbles (943nos./cm^2), which is 27% less than the overall average. Seasonally, population on all substrates was higher in the month of May followed by April and June. Almost similar pattern of seasonal variation in periphyton population at Champawat was observed on different substrates (Fig.1). Seasonally, population on all substrates was higher in the month of Oct. followed by Sept. and Nov. These results in pond condition regarding the periphyton population are in higher side than the previous reports for natural water bodies. Sukumaran *et al.* (1996) found 14-66 nos. /cm^{2}periphyton population in Lalbagh tank of Karnataka and Philipose *et al.* (1976) also observed 18-127 nos. /cm^{2}periphyton population in a pond at Cuttak (Orisa).

Themaximum periphyton biomass at Nainital was observed in bamboo poles (6.01 mg/cm^2) followed by sugarcane bagasse (5.8 mg/cm^2) and plastic sheet (5.45 mg/cm^2) on dry matter base. The similar pattern was observed at Champawat with maximum biomass as (5.3 mg/cm^2) on bamboo poles (Table 1&2). In general, periphyton population and biomass was comparatively higher on biodegradable substrates than the non-biodegradable substrates. About 26 phytoplankton and 20 species of zooplankton were recorded from the collected biomass of the periphyton on all substrates.

Table 1. Seasonal variation in periphyton biomass on dry matter base (mg/cm^2) with different substrates at Nainital

Month	Sugar cane bagasse	Plastic sheet	Bamboo poles	Paddy straw	Plastic pipe	Tree branches	Stones/ pebbles
Apr	1.42	1.40	1.42	1.22	0.98	1.24	1.20
May	1.28	1.28	1.64	1.24	1.26	0.86	0.84
Jun	0.98	0.87	0.93	0.86	0.64	0.78	0.64
Jul	1.26	0.96	0.88	0.65	0.64	0.58	0.56
Aug	0.86	0.94	1.14	1.04	0.68	0.42	0.86

Table 2. Seasonal variation in periphyton biomass on dry matter base (mg/cm^2) with different substrates

Month	Sugar cane bagasse	Plastic sheet	Bamboo poles	Paddy straw	Plastic pipe	Tree branches	Stones/ pebbles
Sept	1.45	1.52	1.56	1.24	1.28	1.40	0.98
Oct	1.42	1.28	1.64	1.46	1.45	1.34	1.20
Nov	1.20	1.46	1.24	1.20	1.12	0.46	0.48
Dec	0.64	0.88	0.86	0.82	0.40	0.44	0.26

Table 3. Mean values (± SD) of physico-chemical characteristics of water having different substrates (R1, R2, R3)

Parameters	Raceways		
	R1	R2	R3
Water temperature (°C)	15.98 ±2.709	15.96±2.667	15.8±2.670
pH	7.28±0.370	7.49±0.407	7.44±0.434
Dissolved oxygen (mg/l)	6.70±0.581	6.68±0.530	6.40±0.466
Free carbon dioxide (mg/l)	2.22±0.147	2.36±0.209	2.2±0.135
Total alkalinity (mg/l)	168.6±0.013	168.41±1.176	168.3±1.468
Ammonia-nitrogen (mg/l)	0.11±0.066	0.11±0.067	0.102±0.060
Nitrite-nitrogen (mg/l)	0.011±0.002	0.11±0.001	0.11±0.001
Nitrate-nitrogen (mg/l)	0.129±0.025	0.12±0.022	0.114±0.019
Phosphate-phosphorus (mg/l)	0.223±0.065	0.24±0.069	0.19±0.055

Figures having same superscript in each row are significantly different ($P < 0.05$)

Table 4. Growth performance of fish in control/ experimental raceways (R1, R2)

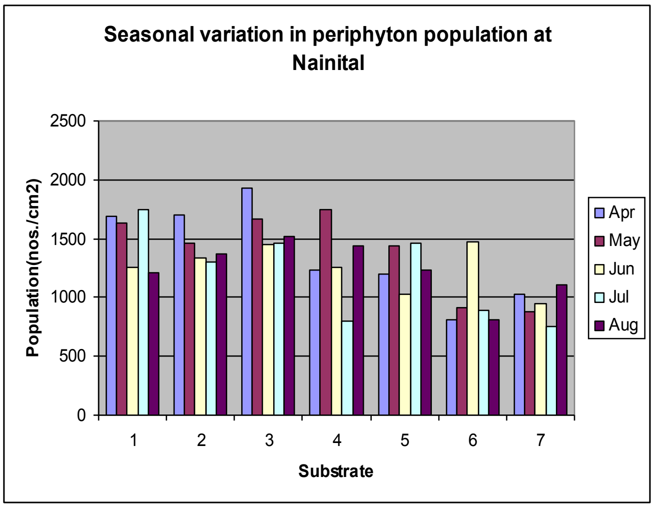
Parameter/ Raceway	R_1 (Artificial, control)	R_2 Natural	Difference from control
Pond size (m^2)	14.42	14.42	-
Stocking no.	120	120	-
Initial Av. Weight (gm.)	1.1	1.1	-
Final Av. Weight (gm.)	14.9	18.8	+3.9 (26.2%)
Net gain in Av. Weight (gm.)	13.8	17.7	-
Initial Av. Length (mm.)	18	19	-
Final Av. Length (mm.)	132	142	-
Net gain in Av. Length (mm.)	114	123	-
Total production (Kg.)	1.609	2.143	+0.534 (33.2%)
Survival (%)	90	95	
SGR	2.67	2.90	+0.23 (8.6%)
Condition factor(k)	0.931	0.951	
Protein content (%)	17.76	17.98	

Out of 26 species, 11 species belonging to Chlorophyceae, 10 species belonging to Bacillariophyceae and 5 species belonging to Cynophyceae were observed. Zooplankton species were recorded as 7 species of minor phyla Rotifera, 6 species of Cladocera, 4 species of Diptera, 3 species of Copepoda and 1 species of Oligochaeta. In species composition, maximum percentage was contributed by Chlorophyceae followed by Bacillariophyceae, Cladoceran and Dipteran (Fig. 2). Azim *et al.* (2004) also reported rich periphyton biomass with 32 genera of algae and 10 genera of plankton by placing bamboo poles in carp rearing ponds.

On analysis of proximate composition, the natural food, Periphyton contains the crude protein as 61.2%, while it was 25.55 in the artificial feed. The fat content was lower in natural diet i.e. 4.8%, while it was 6.2 % in the case of artificial diet.

Impact of different substrates on water quality of the pond

Water qualities must be within the tolerant limit for fish throughout the rearing period. Temperature was in lower side during the months of April and June (15-19.2) in all raceways. Little difference was observed in water temperature in the pond having biodegradable substrates and non-biodegradable substrates.



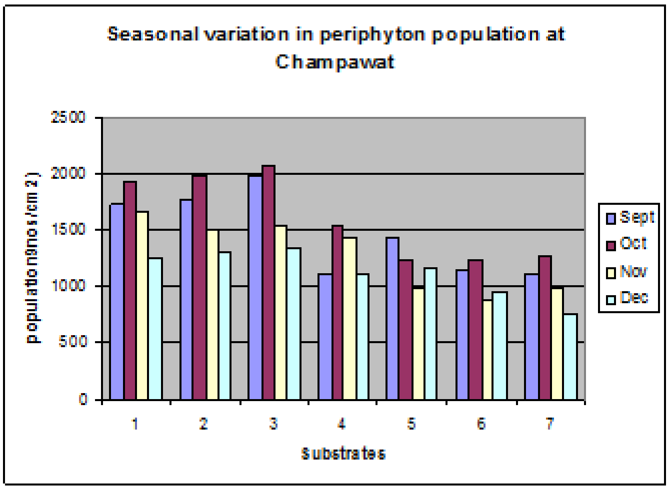


Fig. 1. Seasonal variation in periphyton population with different substrates

But, significant differences were observed in dissolved oxygen content.In the case of sugar cane bagasse the dissolved oxygen content was in decreasing trends after one months of the substrate placing and continued up to next two month, similar trends of the dissolved oxygen contents was also observed in raceway R_2, it might be due to the presence of paddy straw, got rotten after 15 days. In case of sugar cane bagasse and paddy straw the dissolved oxygen concentration went to down up to critical level (4.7 ppm.). Favorable dissolved oxygen range (6-6.5 ppm) was observed in the pond water having non-biodegradable substrates. Water pH and free carbon dioxide was more stable in the pond having non- biodegradable substrates. Similar trend of the alkalinity was observed in all raceways having lower concentration in June.

Concentration of free Ammonia fluctuated between 1-1.7 and did not show clear trends in time. It showed downfall towards the end of experiment. Pond of non- biodegradable substrates contains comparatively low concentration on ammonia. The concentration of Ammonical nitrogen (NH_4-N) and NO_3-N fluctuated around 0.20 and 0.05 ppm, respectively. NH_4-N was comparatively low in the pond having bamboo poles and plastic sheets. Concentration of NO_2-N was observed in the range of 0.01-.015 ppm with higher concentration in the pond having sugarcane bagasse. NO_3-N was in lower concentration in the pond of non- biodegradable substrates. Mean PO_4-P concentration decreased from 0.28-0.04 ppm during the experiment with a peak during June, then showed continuos downfall towards the end of the experiment (Table 3). The results of the present study were in the conformity of Azim (2001). Keshavanath (2001) also resulted that bamboo poles and sugar cane bagasse yields greater periphyton production but sugar cane bagasse created serious water quality problems in terms of low dissolved oxygen concentration. The present results reflected that bamboo poles and other non-biodegradable substrates are suitable for aquaculture points of view having without any adverse effect on the water quality of the pond.

Fish growth and production

In periphyton fed fish, the average final weight was found as 18.8 gm. with 2.143 kg. (15.31 kg/100m2/yr) fish production. It was 26.2% higher in average growth and 33.2% higher in total production over the control. 7 % increase was due to the better survival (95%) of this group. In the control, raceway (R1), the average weight gain was 14.9g with total production of 1.609Kg. (11.50 kg/100m^2/yr) and survival of 90%. SGR in R2 was 2.90, which was 8.6 % more than the control. Condition factor was also better for periphyton fed group (Table 4). The results of weight gain in the present study are superior to the previous reports. Joshi et al. (2005) reported that fish merely attained an average length of 8.4 cm, 12.1 cm, 15.6 cm, 18.2 cm, 20.4 cm, with corresponding weight of 5.2 g, 10.6 g, 25.8 g, 44.6 g and 72.0 g. during 1st to 5th year life span, respectively.

Azim *et al.* (2001) studied growth and production of Indian major carps, rohu (*Labeorohita* H. and *Labeogonius* L.) using bamboo substrate in ponds and recorded a 77% higher production of rohu with bamboo substrates than the ponds without substrates. It was concluded that the growth, survival, production and nutritive value is better in natural periphyton fed snow trout. Net yield of snow trout may be increased by providing bamboo poles and other non- biodegradable substrates like plastic sheet for periphyton production despite the fact that there was positive impact on growth and production without deteriorating water quality.

Acknowledgement

The authors express sincere gratitude to Head of the Department, Department of Zoology, D.S.B campus, Kumaon University, Nainital, Uttarakhand Open University and to Director, DCFR, Bhimtal for providing facilities and able guidance to carry out the study.

REFERENCES

APHA. 1985. Standard methods for examination of water and wastewater, 16th ed. *American Public Health Association*, New York.

AOAC. 1980. Official method of analysis of the association of analytical chemist (*Ed. W. Horwitz), 3rd edition, Washington, D.C.*

Azim, M.E., Wahab, M. A., Van Dam, A. A., Beveridge, M. C. M. and M. C. J . 2001. The potential of periphyton based culture of two Indian major carps, rohu *Labeo rohita* (Hamilton) and gonia labeo gonius (Linnaeus). *Aquaculture Research,* 32: 209-216.

Azim, M.E., Wahab, M.A., Biswas, P.K., Asaeda, T., Fujino, T. and Verdegem, M.C.J. 2004. The effect of periphyton substrate density on production in freshwater polyculture ponds. *Aquaculture*. 232(1-4) : 441-453.

Castell, J.D. and Tiews, K.1980. Report of the EIFAC, IUCN and ICES working group on the standardization of methodology in fish nutrition research, March 21-23, 1979. EIFAC Technical Paper 36, Hamburg, Germany.

Cattaneo, A. and Kalff, J. 1980. The relative contribution of aquatic macrophytes and their epiphytes to the production of macrophyte beds. *Limnology Oceanography,* 25 : 280 - 289.

Devendra, C. 1989. Nomenclature, terminology and definition appropriate to animal nutrition, pp1-10. *In S.S. De Silva. (Ed.), Fish Nutrition Research in Asia.* Asian Fisheries Society, Manila.

Horne, A.J. and Golderman. 1994. *Limnology*, 2nd ed. (McGraw-Hill Book Company, USA.

Keshavnath, P., Gangadhar, B., Ramesh, T. J., Vanrooij, J.M., Beveridge, M.C.M., Baird, D.J., Verdegem, M.C.J. and Van dam, A.A. 2001. Use of artificial substrates to enhance production of fresh water herbivourous fish in pond culture. *Aquaculture Research*, 32 :189-197.

Lamberti, G.A. and Moore, J.W. 1984. Aquatic insects as primary consumers, pp 164-195. *In Resh, V.H. and Rosenberg, D.M. (Eds.), The ecology of aquatic insects.* Praegar Scientific, New York.

Minshall, G.W. 1978. Autotrophy in stream ecosystems. *Bioscienc,* 28 : 767-771.

Power, M.E., Matthews, W.J. and Stewart, A.J. 1985. Grazing minnows, piscivorous bass and stream algae :dynamics of strong interaction. *Ecology,* 66 :1448-1456.

Ramesh, M.R., Shankar, K.M., Mohan, C.V. and Varghesh, T.J. 1999. Comparison of three plant substrates for enhancing carp growth through bacterial biofilm. *Aquaculture Engineering*., 19 : 119-131.

Shankar, K. M., Mohan, C. V. and Nandeesha, M. C. 1998. The ICLARM Quarterly NAGA 21, 18 p.

Sukumaran, P.K., Shakuntala, K. and Parmeswaran, S. 1996. Production of periphyton in a lentic habitat in Bangalore (Karnataka). J. *Inland Fish.Soc. India.* 28(1): 28-32.

Wahab, M.A., Mannan, M.A., Huda, M.A., Azim, M.E., Tollervey, A.G. and Beveridge, M.C.M. 1999. Effect of Periphyton growth on bamboo substrates on growth and production of Indian major carp, rohu (*Labeo rohita*, Ham.). *Bangladesh J. Fish. Res*., 3 (1) : 1-10.

Westlake, D.E. 1980. Primary production. *In Le Cren, E.D.; Lowe, M.C. and Connell, R.H. (eds.), The functioning of fresh water ecosystems.* Cambridge Univ. Press, Cambridge.

Wetzel, R.G. 1983. Attached algal-substrata interactions ; fact or myth and when and how? pp 208-215. *In Wetzel, R.G. (Eds.), Periphyton of freshwater ecosystems.* The Hague: Dr. W. Junk Publishers.

****