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Effect of different diets using sewage sludge on the growth performance of the gold fish *Carassius auratus*

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ABSTRACT The gold fish *Carassius auratus* was selected for the present investigation. The growth rate and other parameters of gold fish (18 days old) *Carassius auratus* juveniles were investigated using four different types of diets for 21 days. The diets were prepared using the sewage sludge after they were treated in two methods namely antibiotic treatment and acid treatment. This was compared with diets prepared from untreated (raw) sewage sludge and conventional feed (without sewage sludge). The juveniles fed with acid treated sewage sludge showed the best growth rate of 0.194 g, and specific growth rate of 0.685%/ day and FCR (%) of 0.027, while other diets of untreated sludge, conventional feed, and antibiotic treated sludge showed minimum growth rates of 0.069 g, 0.067 g, and 0.129g respectively. Acid-treated sludge feed showed the best gross growth efficiency, net growth efficiency, relative growth efficiency and FCR (%) of 4.232, 4.455, 0.040 and 0.027, respectively. Antibiotic treated sludge feed showed the best assimilation efficiency of 95.8%. Untreated sludge feed showed the assimilation, metabolism and contractory consumption (C) rate of 4.60%, 4.482, and 4.998, respectively, for 21 days.

(Carassius auratus, feeding, growth, sewage sludge)

INTRODUCTION

The gold fish *Carassius auratus* is one of the most attractive and economically important among the aquarium fishes. They are marketed all over the world and yield foreign exchange to some extent. The demand for good quality ornamental fish far exceeds the supply. The success of an organism depends mainly on the right choice of food, which provides all the nutrients. Aquarium fishes accept a wide variety of live and formulated feeds. The primary problem in rearing larval fish depends on size, quality and quantity of food. The supplementary feeding is a routine practice in aquaculture to enhance the production of organisms to marketable size in short period [11, 9]. Many authors have studied the effect of nutrition on growth of cultivable fishes and few worked on ornamental fishes [14, 10, 6, 8, 4, 5, and 17].

Sewage is known to contain about 50% protein rich in essential amino acids, which are similar to other dietary sources. The activated sludge could be successfully utilized, as a protein source in the diets of animal and fish [12]. The activated sewage sludge has low energy content rather than poor protein content [2]. Activated sludge produced during the treatment of municipal sewage may be heavily contaminated, such sludge should be treated to remove heavy metals, bacteria and virus, before they are utilized for fish feed preparation [15]. The acid treated coastal sewage sludge would be used as food for common carp [13].The treatment of sewage for the preparation of fish feed [15]. The utilization of processed sewage sludge in the diets of fish feeds reported by [16].

The present paper reports on the effects of processed sewage sludge mixed with different types of ingredients and used as a feed for *Carassius auratus* juveniles.

MATERIALS AND METHODS

Juveniles of *Carassius auratus* (18-days old) were collected from a local aquaculture farm and brought to the laboratory in polythene bags containing aerated water. They were acclimatized to the laboratory conditions for 15 days in two large cement tanks. During acclimatization juveniles were fed *ad libitum* with minced beef liver twice a day. Uneaten food was removed after one hour of feeding and aquarium water was changed once in two days.

The sewage sludge samples were collected from the sea site coastal localities of fishing harbor of Tuticorin town. The collected sewage was acid treated and antibiotic treated by a new method described by [13]. The proximate composition of the processed sludge and the four types of formulated feed viz; D1 (Acid treated), D2 (Untreated feed), D3 (Conventional feed) and D4 (Antibiotic treated feed) were estimated following [1] and the composition of the four different types of feed are presented in Table1.The pelleted diet containing 40% protein was maintained throughout the experimental period, and was prepared adopting the box model of Ali (1982). The water quality parameters such as pH and DO were monitored through out the experimental period in all the treatment of feed. The experimental duration is 21 days.

Table 1. Proximate composition of four types of experimental feed (quantity in g/kg.)

	D1* (Acid treated)	**D2**** (untreated)	**D3***** (Conventional)	**D4****** (Antibiotic treated)
Rice bran	100	-	-	-
Tapioca flour	100	90	90	90
Fish meal	400	455	-	-
Groundnut oil cake	400	227.5	455	455
Vit. mix	500mg	500mg	500mg	500mg
Vegetable oil	5ml	5ml	5ml	5ml
Sewage sludge	-	227.5	455	455
Total	1000	1000	1000	1000
		Nutrient content		
Protein %	37.10	36.92	45.86	40.20
Carbohydrate %	17.31	16.50	28.00	26.13
Lipid %	7.20	9.2	12.88	8.26

Note: * Acid treated feed
** Untreated feed
*** Conventional feed
**** Antibiotic treated feed

The active juveniles of *C. auratus* (0.73 ± 0.002 mg) were selected from the acclimatization tank, and divided into four groups corresponding to four different types of formulated feeds viz, D1, D2, D3 and D4. Individual fish belonging to corresponding pelleted diet were fed *ad libitum* twice a day at 1000 and 1700 hours for two hours and then unconsumed food was collected by a pipette and dried in hot air oven at 80°C.Each group consisted of ten individuals and triplicates were maintained for each diet. Experiments were conducted in circular plastic troughs (0.53×0.46m: 110 liter capacity) containing 90 liters of water. Aquarium water was changed every day to remove the accumulated faeces at the bottom. The weighing of fish during and on termination of the experiment was as described by [7].

RESULTS

The proximate composition of the four types of feeds was estimated to assess the food value (Table 1). Among the four types of feed, D1 had the highest level of protein (45.86 mg/g) and the lowest protein (36.92 mg/g) was recorded in D2. Similar pattern could be observed in the carbohydrate content. The lipid content of the feeds was 9.2 mg/g and 12.88 mg/g in D2 and D3 respectively. In the case of D1 it had lower lipid content of 7.20%. Heterotrophic bacterial counts of the feeds were also analyzed (Table 2). D1 recorded the lowest heterotrophic population (1.6×10^3 CFU/g) and the highest population of heterotrophs (1.0×10^5CFU/g) were recorded in D2.

During the feeding trial, the fish readily accepted all the four diets. The growth responses under different treatments are given in Table 3. The acid treated sewage sludge recorded the lowest bacterial count of 1.6×10^3 CFU/g. In the case of antibiotic treated feed, the absence of heterotrophic population was observed (Table 2). Initial body weight of the various dietary groups did not vary significantly, but after 21 days the growth performance significantly ($p<0.01$) (Figure 1) varied in terms of specific growth rate (SGR), food conversion rate (FCR), relative growth efficiency, net growth efficiency, gross growth efficiency, assimilation efficiency metabolism, assimilation, consumption and weight gain. Similarly relative growth efficiency, net growth efficiency, gross growth efficiency and weight gain were also significantly higher ($p<0.01$) in fish fed with D1 than those of other diets groups (Figure 2). The highest SGR (0.685%/d) was observed in fish fed with D1 (Figure 3). FCR% was better among the groups where SGR and dry weight gain of fish were higher (D1). Net growth efficiency showed a similar trend as that of SGR and the highest value of 4.455 was observed in fish fed with D1 (Table 3), followed by the groups fed with diets D4, D3 and D2. Net growth efficiency ranged from 1.499 to 4.455 % and gross growth efficiency showed a similar trend to that of SGR and the best value of 4.232 % was observed in fish fed with D1, followed by the groups fed with diets D4, D2 and D3 respectively. All the significance difference was observed from the ANOVA test.

Table 2. Total Heterotrophic bacterial counts (CFU/g) of the four feeds

Total no of	(D1)	(D2)	(D3)	(D4)
Bacterial count (CFU/g)	1.6×10^3	1.0×10^5	3.12×10^4	NIL

Table 3. Growth Parameters of Juvenile Gold fish (18 days old) fed with four different types of feeds

Parameter	Acid treated feed D_1	Untreated feed D_2	Conventional F D_3	Antibiotic treated feed D_4
Initial dry wt (g,w_1)	0.180±0.007	0.180±0.007	0.180±0.007	0.180±0.007
Final dry wt (g,w_2)	0.324±0.016	0.249±0.013	0.247±0.012	0.309±0.015
Weight gain in dry	0.144±0.009	0.069±0.06	0.067±0.006	0.129±0.008
Consumption[c]	3.402±0.170	4.998±0.249	4.312±0.216	3.174±0.158
Faecal out put [F]	0.170±0.008	0.397±0.019	0.265±0.013	0.132±0.007
Assimilation[A=C-F]	3.232±0.161	4.601±0.230	4.047±0.202	3.042±0.152
Metabolism[R=A-P]	3.038±0.0016	4.482±0.224	3.930±0.196	2.913±0.004
Assimilation Efficiency (%)	95.002±4.750	92.056±4.603	93.854±4.69	95.842±4.792
Gross growth efficiency (%)	4.232±0.002	1.3805±0.005	1.553±0.023	4.064±0.004
Net growth efficiency (%)	4.455±0.002	1.499±0.018	1.655±0.001	4.240±0.004
Relative growth efficiency gm per day	0.040±0.002	0.029±0.001	0.030±0.002	0.038±0.001
FCR (%)	0.027±0.001	0.036±0.002	0.042±0.002	0.026±0.001
Specific Growth Rate(%/day)	0.685±0.002	0.325±0.003	0.319±0.0008	0.614±0.002

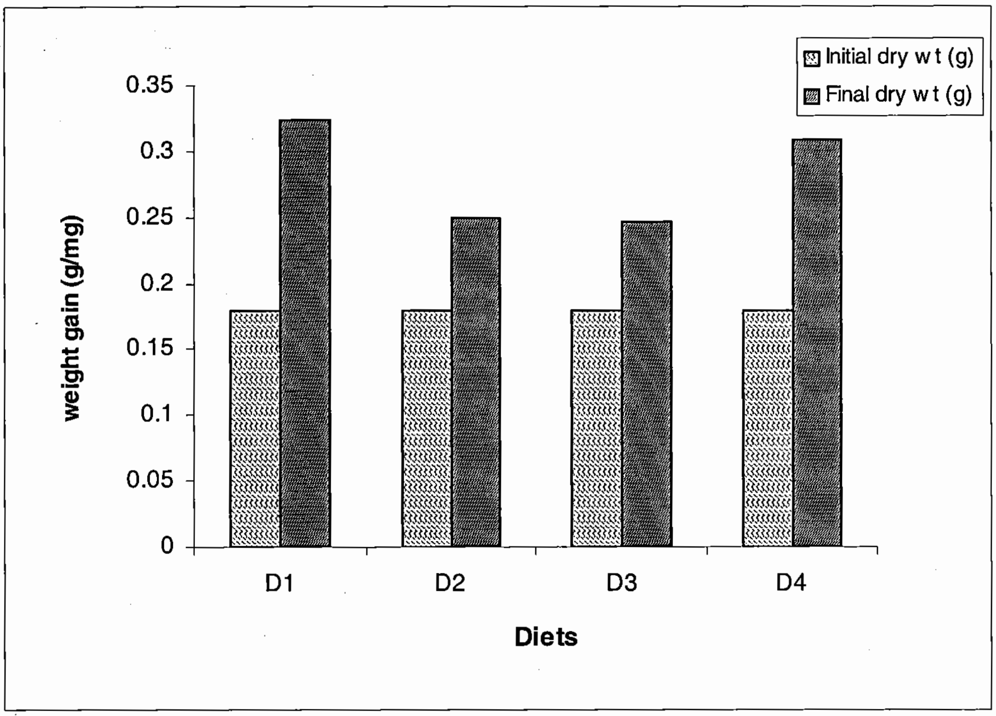

Figure 1. Weight gain of gold fish fed on different diets

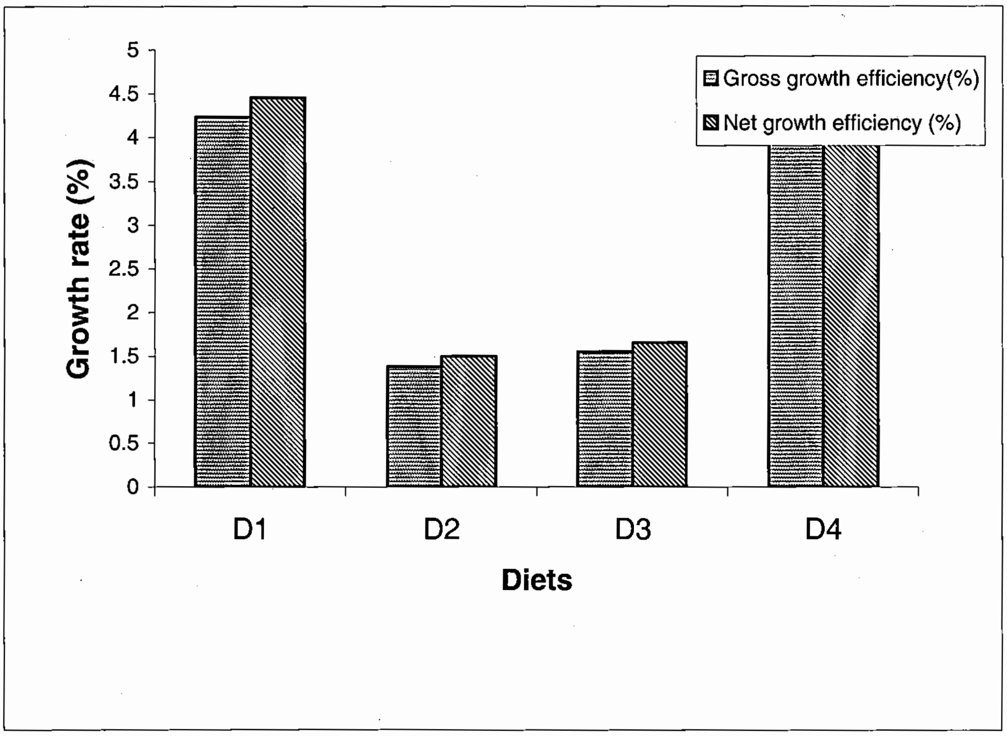

Figure 2. Gross growth efficiency and Net growth efficiency of gold fish fed on different diets

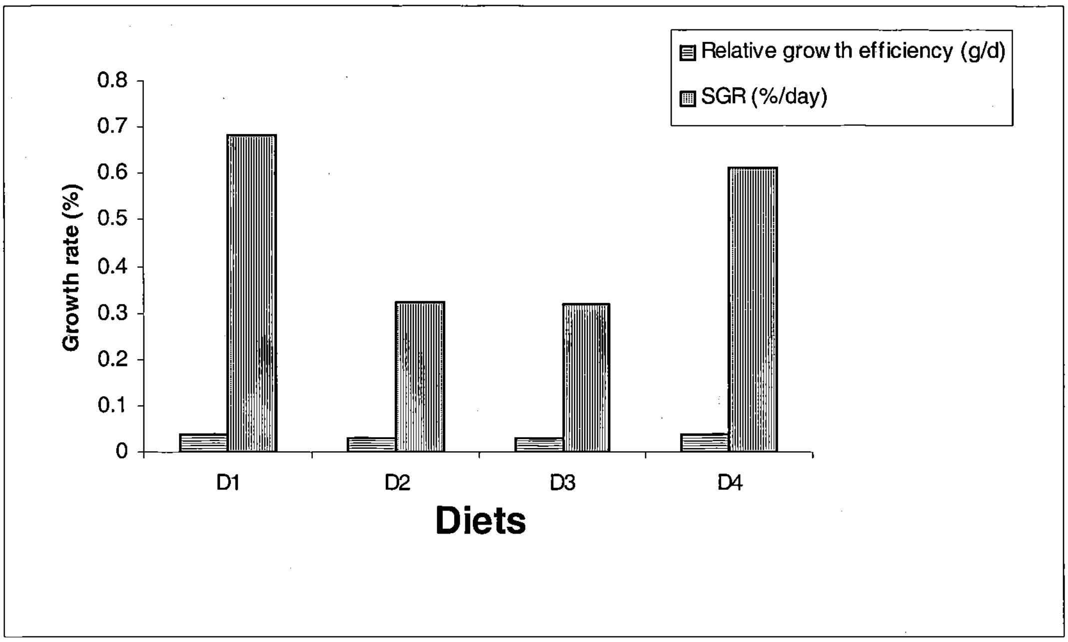

Figure 3. Relative growth efficiency and specific growth rate of gold fish fed on different diets

DISCUSSION

Sewage sludge has been reported to contain 21 to 38.5% protein [16]. The conventional feed used in the present study had a protein level of 37.10%. But in the feed with antibiotic treated sewage sludge a slight increase in protein content of 40.20% was recorded that the protein contents of raw and acid treated sewage sludge were 36% and 50% respectively [13]. It is well known that the sewage sludge used contains large quantities of insoluble metallic sulphides. Due to anaerobic condition prevailing in the sewage because of heavy organic load, denitrification occurs, and the nitrate present in water is converted into gaseous nitrogen. Following denitrification, sulphate reduction occurs in sewage water. Due to sulphate reduction, hydrogen sulphide is formed which reacts with metallic ions to form insoluble metallic sulphides. When acid treatment is given to sewage sludge, these insoluble metallic sulphides are converted into their respective chloride salts, which are soluble in water. Thus the removal of metallic sulphide from the sewage sludge might have been the major reason for the relative enhancement of the level of protein. The food value of sewage sludge has been attributed to the higher level of protein rich in essential amino acids, which are similar to other dietary sources and used as sewage sludge as trout feed [16]. The activated sewage sludge had a low energy content rather than protein content reported by [2]. Similar results were also obtained in the present study. The low energy content was primarily due to insoluble metallic sulphide which can be removed using 0.5 N HCL. Such removal of metallic sulphides will not only enhance the protein level, but will also improve the quality of the sludge as a fish feed. [13]. The acid treatment and consequent attack on metallic sulphides invariably resulted in a 14% increment in protein content [13]. In our present study the recorded increment in protein content due to acid treatment was 45.86%. In the case of acid treated feed the recorded percentage contribution values of protein, lipid and carbohydrate were slightly higher than that of antibiotic treated feed. The acid treated sewage sludge recorded the lowest bacterial count of 1.6×10^3 CFU/g. In the case of antibiotic treated feed, the absence of heterotrophic population was observed.

Although sewage sludge has been used for feeding of animals and fishes [16, 3]. The acid treated and antibiotic treated sewage sludge have not been tested extensively for suitability as a total fish feed. The sewage sludge used as a component of fish feed and recorded higher gross and net growth efficiencies than untreated sludge incorporated feed and the control feed [13]. In the present study vital growth parameters viz: weight gain, consumption, faecal output, assimilation, metabolism, net growth efficiency and relative growth efficiency of the test animal varied significantly ($p<0.01$). However no information is available regarding the utilization of sewage sludge as a total feed. The growth was highest when fed with acid treated sewage sludge. Sewage sludge treated with antibiotic ranked next to acid treated sewage sludge. The main problem with the antibiotic treated sludge was that despite the eradication of the microbial population present in the feed, the feed itself may eliminate the natural microbes present in the gut of the test animal. Further studies on how to improve the quality of the acid treated feed by adding important trace micronutrients and an essential amino acid is needed.

CONCLUSION

The utilization of sewage sludge for fish culture appears to be the best economically viable methodology of bioprocessing of municipal sewage sludge for animal protein. It is also imperative that it is an efficient way of utilizing waste nitrogen for protein production at low cost.

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