PERCH EFFLUENT IN RECIRCULATING AQUACULTURE SYSTEMS

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OBJECTIVE:
Characterize perch effluent water quality from two different but similarly designed recirculating aquaculture systems.

MATERIALS AND METHODS:
Fourteen parameters were analyzed in the first system that consisted of a 3400 liter culture tank, a 1270 liter settling clarifier and a 3200 liter Red Ewald staged, submerged bed biofilter. Water was recirculated from a 450 liter reservoir with a Gould 1/3 hp submersible sump pump. The settling tank was siphoned on a daily basis and once each week the siphonate was collected and analyzed.

The siphonate was agitated to remove a random sample that included the solids. Another sample was collected at this time to remove the solids for analysing chemical properties. The parameters tested were: alkalinity, total ammonia-nitrogen, un-ionized ammonia, carbon dioxide, hardness, nitrate, nitrite, dissolved oxygen, pH, total phosphate, reactive phosphate, settleable matter, temperature and total effluent.

Total ammonia-nitrogen, nitrites, nitrates and total and reactive phosphates were tested using Hach powder pillows and the Hach spectrophotometer. Un-ionized ammonia was calculated from TAN based on pH and temperature. Alkalinity and hardness were calculated from LaMotte Chemical titration kits. Dissolved oxygen and temperature was read from a YSI model 58 oxygen meter. The pH was measured using a Cole-Parmer model 5669-20 pH meter. The settleable matter was read from a one liter imhoff cone and total effluent was estimated from a marked 150 liter container, plus or minus 2 liters.

Twelve parameters were analyzed in the second system that consisted of an 1890 liter culture tank, a 95 liter conical clarifier, a 135 liter trickling biofilter. Water was recirculated with a Gould 1/3 hp submersible pump. The flow was stopped through the clarifier and the solids were stirred into suspension using a small paddle at which time the samples were taken. The clarifier was then drained as it was on a daily basis. The parameters tested were: dissolved oxygen, alkalinity, hardness, pH, nitrate, nitrite, total ammonia-nitrogen, un-ionized ammonia, phosphate, temperature, biological oxygen demand and total dried solids.

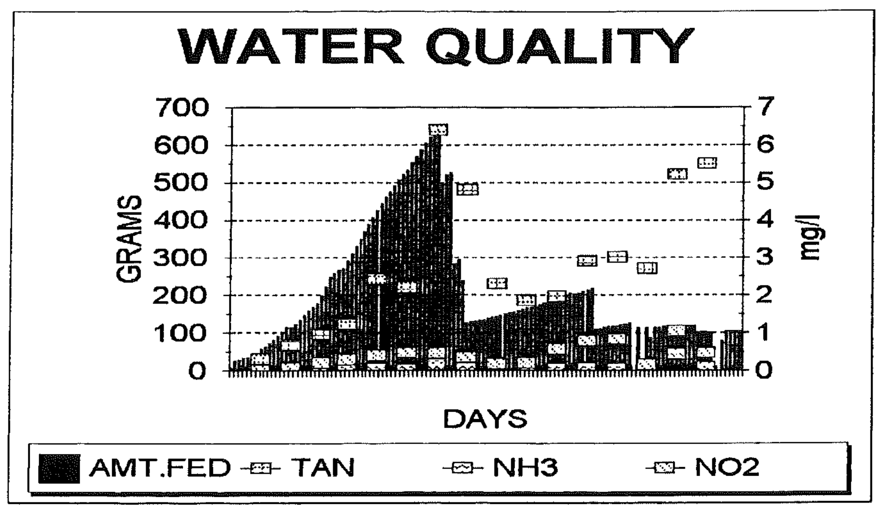
The parameters were measured with the same equipment that was used in the first trial except for the following: BOD was measured using standard methods with an Orion oxygen electrode and Wheaton BOD bottles, phosphates were measured using a diode array spectrophotometer and total dried solids were measured using standard methods in a Stabile-Therm Gravity Oven set at

103-105 degrees Celcius for a minimum of 24 hours.

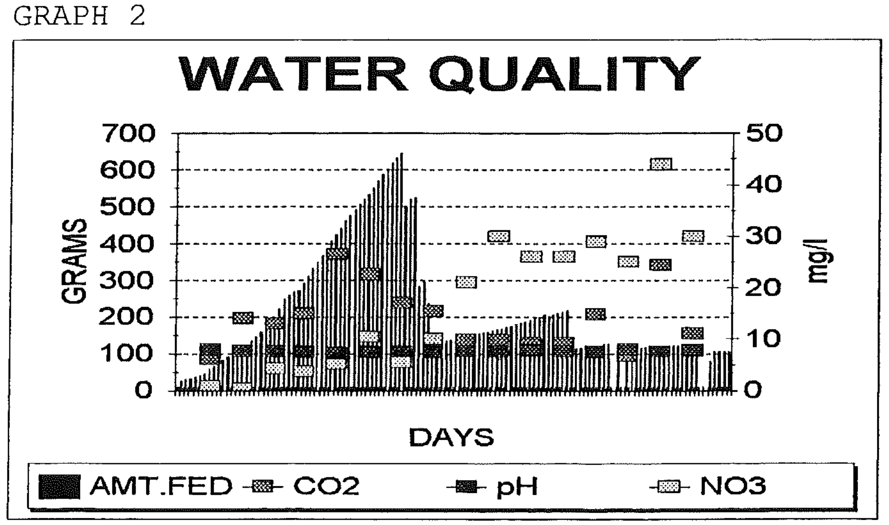
RESULTS:

The first system was stocked 070396 with 1000- 0.1g fingerlings. This system was outside and had no temperature or lighting control. Due to that fact, an algal bloom soon established itself in the system. The fingerlings were fed at an exceptionally high rate for the first eight weeks. A sampling of the fish on 082296 resulted in reductions in estimated size and percent fed per day. The percent fed per day was reduced to three percent and further calculations were based on a gradually decreasing schedule. All data was to be compared to amount of food fed so sampling was not performed until the fish were harvested on 103096. The following graphs describe the relationship between the effluent water quality and the amount of feed added to the system on a daily basis. Graph 1 shows a consistent correlation between the amount fed and increasing TAN levels until the last month or so when water temperatures dropped and the efficiency of the filter and the algal bloom declined. Both the nitrite and un-ionized ammonia followed similar patterns but at much reduced levels. Graph 2 shows the typical increase in NO3

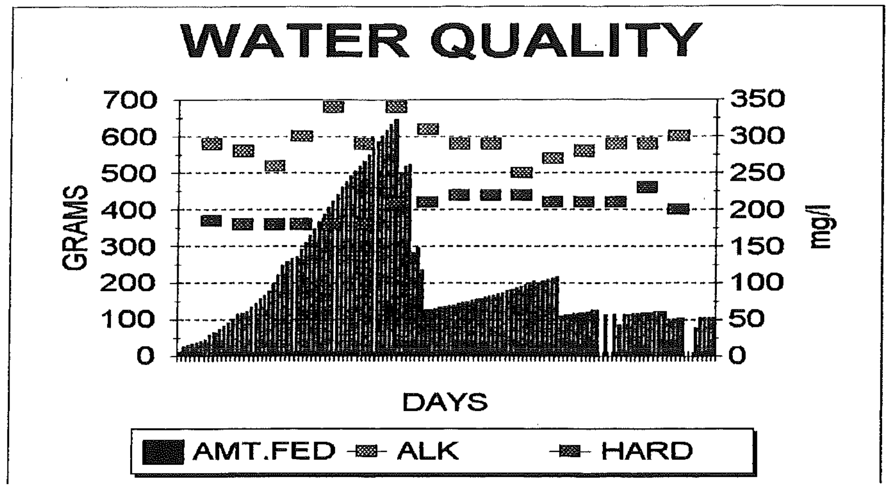
GRAPH 1



GRAPH 2

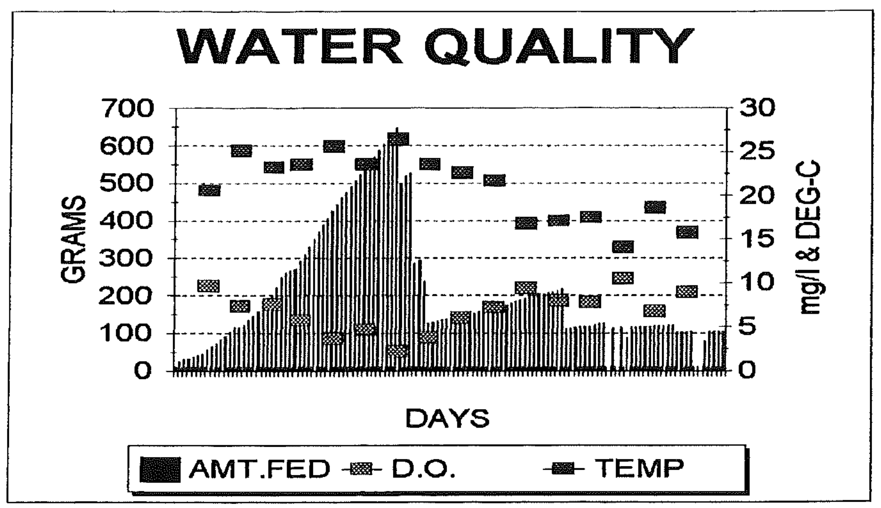


GRAPH 3



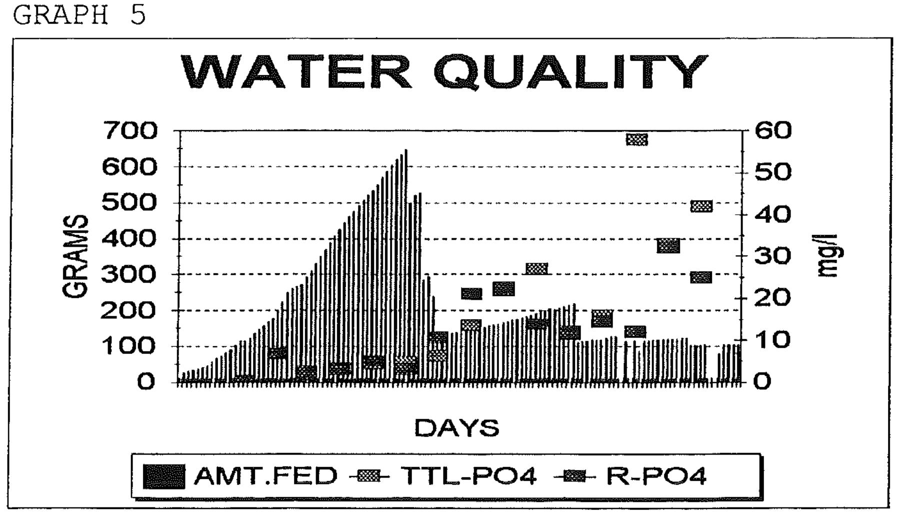
that occurs in closed systems with low exchange rates. The CO_2 rates fluctuated due to varying levels in the alkalinity(see Graph 3) and temperature. The CO_2 is a calculated number based on pH, alkalinity and temperature. The pH levels remained very consistent throughout the study, mostly between 7.5-8. Graph 3 gives the data on alkalinity and hardness during the study. There doesn't appear to be a correlation between the amount fed and either of these two parameters. Graph 4 depicts the

GRAPH 4

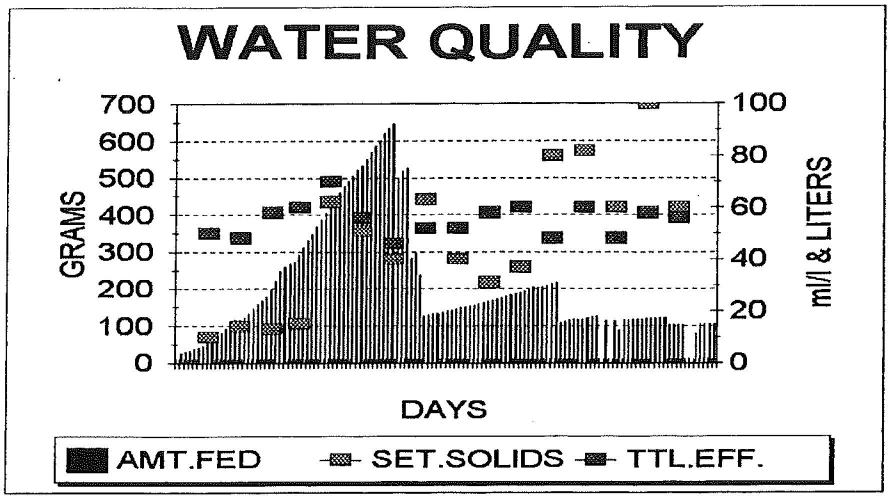


relationship between dissolved oxygen and temperature and at the same time the relationship between the amount fed and the corresponding increase in the consumption of oxygen. The data presented in Graph 5 would have you believe there is an

GRAPH 5



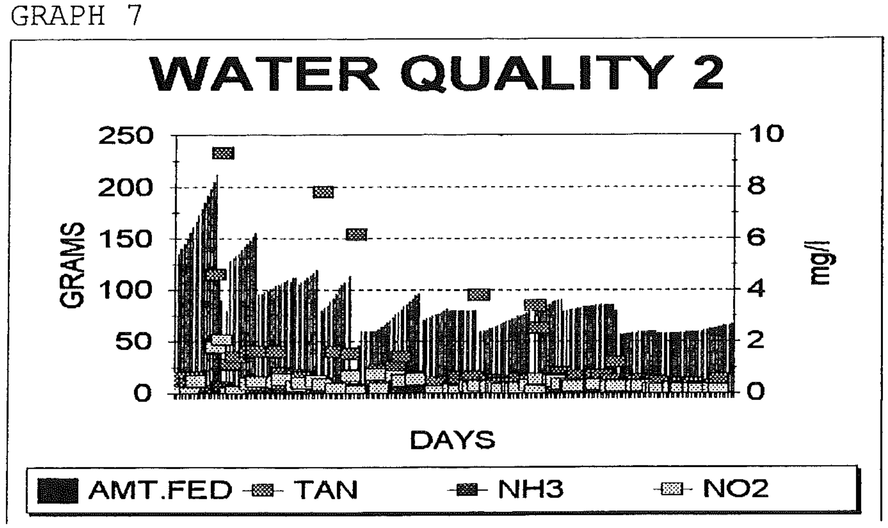
GRAPH 6



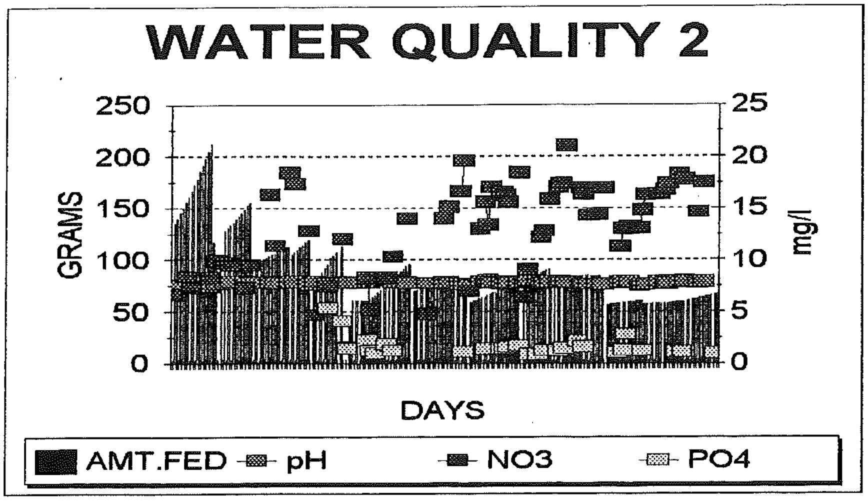
inverse relationship between the amount fed and phosphates in the system. It is assumed that with the low exchange in the system that the phosphate levels increase over time much like the nitrate levels. The data presented in Graph 6 depicts the consistent low level of effluent volume from the system. The settleable solids data seems to show more of an inverse relationship between amount fed and volume of settleable solids. This can be attributed to the amount of algal floc toward the end of the study.

The second system was stocked 012997 with 1020, 2.6 gram fingerlings. Early water quality problems created stress on the fingerlings that left them vulnerable to bacterial (*Columnaris*) infections and significant mortalities. Due to these mortalities, we treated the fish on two occasions (seven days on treated feed (Oxytetracycline)) and numerous occasions with formalin baths. This system is more typical of a recirculating system in that there was better control of temperature and there was no algal production in the system. The data in Graph 7, while depicting the effluent, shows the higher than normal TAN and NO2 levels in the system also. These levels would not have affected fish such as *Tilapia* to the extent it did the perch. This graph depicts a typical relationship between amount fed versus the

GRAPH 7

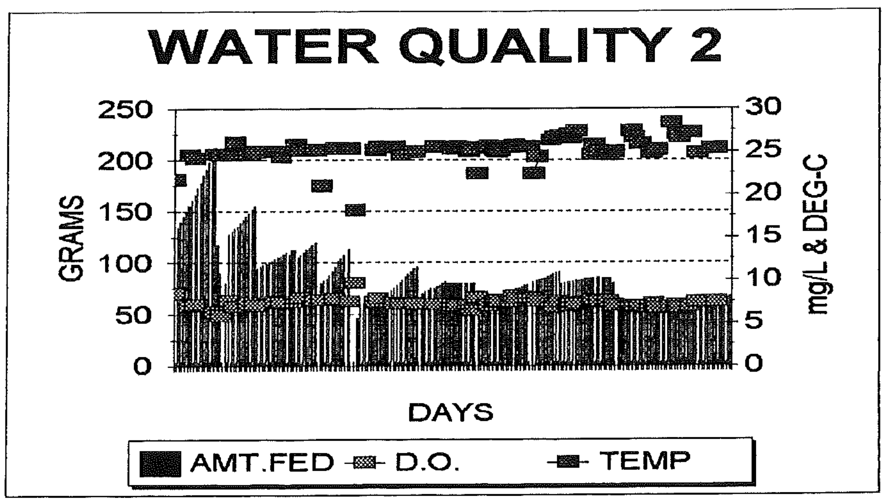


GRAPH 8



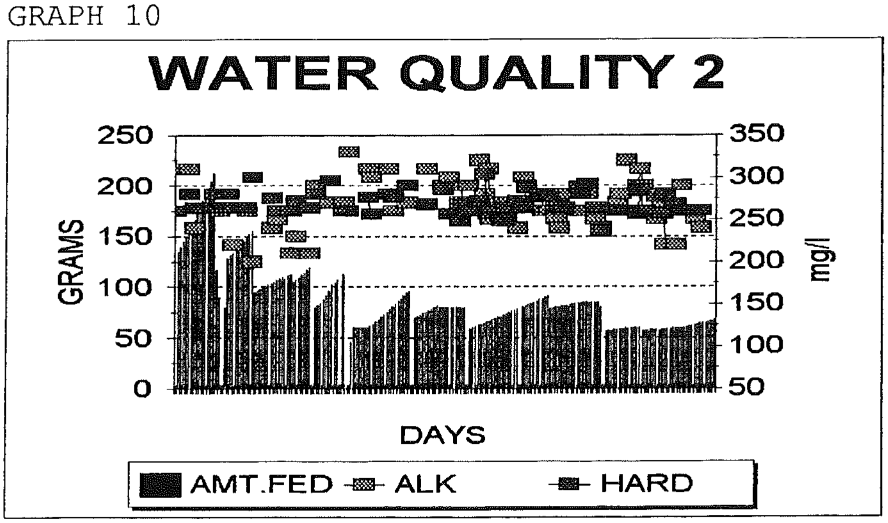
nitrogen cycle in recirculating systems. Graph 8 again shows a very consistent pH level throughout the study. Nitrate levels fluctuated and dropped significantly each time we exchanged large volumes during formalin treatments. This mostly consisted of draining to 380 liter level and treating at 150 ppm for an hour then refilling the system. Phosphate levels stayed at consistently low levels throughout the study unlike the previous study. Again that can probably be accounted for by the large water changes done throughout this study.

GRAPH 9



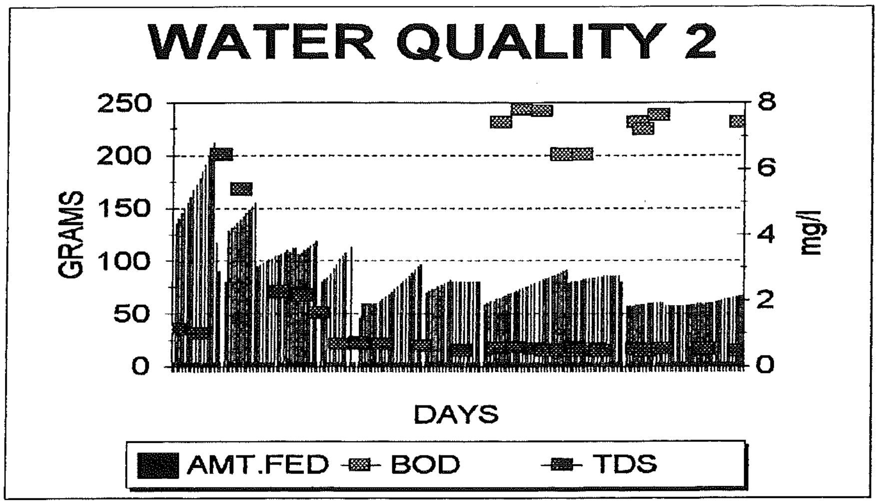
Graph 9 shows the consistent oxygen and temperature readings typical of recirculating systems. However, due to the low feeding rates and continuing loss of biomass through mortalities,

GRAPH 10



there was no obvious drop in dissolved oxygen content with an increasing amount of food. The few fluctuations in the temperature can be attributed to the water exchanges during the formalin treatments. Once again the data in Graph 10 shows small fluctuations in the alkalinity and hardness but no relationship to the amount fed. This a atypical of high density recirculating systems that will show a continual drop in alkalinity levels as the feed levels increase. The data in Graph 11 depicts the levels of BOD and total dried solids throughout the study. The BOD equipment was unavailable during the start of the experiment. This data can be useful in determining effluent solids levels based on amount of feed added to recirculating systems. This graph shows an obvious correlation between amount fed and amount of effluent solids.

GRAPH 11



CONCLUSIONS: Neither system proved to be indicative of typical high density recirculating technology. The first system could be compared to greenhouse/greenwater recirculating systems raising *Tilapia*. These systems tend to have very low rates of water exchange. At almost 8000 liters in this system and an average of around 50 liters lost per day in effluent, that is less than 1% exchange daily. As long as the phytoplankton remains in a healthy growth mode it acts as a biofilter in addition to the actual biofilter. There are two concerns in low exchange systems; more concentrated levels of certain parameters, i.e. nitrates, phosphates and solids, but in smaller volumes and there will be the addition of the phytoplankton as an added oxygen consumer in the effluent.

The second system, while designed closer to a typical recirculating system, had such high mortalities that the data does not provide an accurate depiction a high density system would produce as far as levels of effluent. While volume of effluent was constant throughout this trial, with normal survival rates and higher feed levels this system might have needed a second drain of the clarifier. This would completely change the composition of the effluent and the two separate drainings would probably have their own typical parameter levels. Of note in this trial were the consistently low levels of phosphates versus the buildup seen in the first trial and the decision to measure the solids in a dried manner versus the first trial in a wet volume measurement. These two methods provide data on different ways to deal with aquaculture solid waste.

There will need to be further testing of effluent from commercial sized recirculating systems raising perch to accurately discern the most efficient way to deal with the effluent and its composition.