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Assessment of the Acceptability of Sewage-cultured Fish Using Bacteriology and Social Responses at Gbalahi

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Abstract

This study focused on the suitability of using sewage treatment ponds at Gbalahi, a suburb of Tamale in the northern region of Ghana, to convert residual organic nutrients into quality animal protein through pisciculture. Two tilapia species *O. niloticus* (Linnaeus, 1758) and *S. galilaeus* (Linne, 1758) was evaluated and compared under identical conditions in hapas installed in five sewage treatments ponds. The microbiological enumeration showed that, total coliform bacteria were in higher levels (600-42000 cfu) than faecal coliform bacteria (64-8400 cfu) in all the ponds. The levels of faecal coliforms compared to the safe level (5000 cfu) set by the Environmental Protection Agency (EPA) of Ghana, showed that fish from the ponds are safe for human consumption. However many people (44% of a total of 400) rejected sewage cultured fish because of high bacterial presence which could pose health hazards. Majority (60%) of the 1000 respondents would eat fish from sewage ponds even though about 80% of those who would eat sewage cultured fish were poor. The 40% who would not eat sewage-cultured

fish were the rich.

Key words: sewage-cultured fish, coliform bacteria, social acceptance, religion, education

1. Introduction to the Problem Statement

Recycling of nutrients in sewage is a potential intervention for food and nutrition scarcity and poverty reduction, especially in the developing countries. Untreated sewage may result in the death of people from malnutrition (Dale, 1979). The development of aquaculture using sewage is necessary to curb pollution and promote the development of towns and cities. The use of sewage for fish culture has the potential to defray the costs of sanitation and sewage treatment processes (Hepher *et al.*, 1974). In the light of this, Ghosh (1983) proposed sewage fisheries or aquaculture development as economically feasible means of decreasing river pollution and malnutrition. The achievement of this depends on an integrated approach between Policy makers, Municipal planners, Non Governmental Organization and Researchers.

The ministry of local government and rural development has to construct sewage treatment ponds in every district of Ghana in support of non governmental organizations and donor agencies and also ensure that domestic sewage is transported only to the treatment plants. The ministry of water resources works and housing must allow treated water to occasionally be used to dilute the treatment ponds to ensure that they are conducive for the culture of fish while the ministry of food and agriculture must provide the requisite personal to stock and manage the fishing ponds. The environmental protection agency on its part must do periodic monitoring to ensure that fish reared in sewage ponds are suitable for consumption.

Interest in sewage treatment and reuse is likely to increase as the population of many regions in the world continues to grow (Carpenter *et al.,* 1974, Allen *et al.,*

1979). However, excreta reuse is hampered by deep cultural prejudice or taboos (Cross, 1985). The presence of bacteria and metallic concentration in sewage might be a disincentive to the patronage of sewage cultured fish.

Rapid population growth in Ghana in recent years has transformed Tamale (the capital city of the Northern Region of Ghana) from Municipal to Metropolitan status. This has led to an increase in sewage generation in the city. The Tamale Metropolitan Assembly is struggling to manage the sewage problem in the city. Until February 2004, when a wastewater treatment plant (Fig 1) was built in the city, sewage generated in the metropolis was released untreated into gutters, rivers or farm lands as fertilizer substitute. Out break of cholera was thus common (Chief, 1996). Even though the treatment plant has been built, many inhabitants still compete for the sewage to fertilize their farmlands. The desire to grow fish in the sewage treatment plant requires that the treatment process is efficient enough to ensure production of healthy fish for consumption. Sewage pisciculture could provide an alternative to the wet season farming that is currently being practiced. In this wise many of the youth could be employed even in the dry season. The obvious challenges below necessitated to the research:

- Animal protein including fish is highly costly for the average worker to buy.
- Excreta from humans are assumed poisonous especially when found in water or food.
- Protein related diseases such as 'kwashiorkor' are common among the poor children.

1.2 Conceptual Framework of the Research

The major objective of the research was to assess the acceptability of the sewage cultured fish for human consumption and suggest recommendations based on

lessons learnt for development policy directions. The specific objectives were to assess:

- The bacteria load in the sewage ponds
- The effect of religion on the consumption of sewage cultured fish
- The perceptions of people in the Tamale Metropolis about the culture of fish in sewage ponds with high bacteria load for consumption.

2. Methods of Sampling and Data Analyses

2.1 **Methodology**

The membrane filtration technique (APHA, AWWA, WEF, 1998) was used in determining total coliform and faecal coliform bacteria in the water samples. Three replicates of the samples were cultured and their mean value calculated. This method gives a direct count of total and faecal coliforms. Each sample was diluted differently depending on the pollution load before filtration. A measured volume (100 ml) was filtered under vacuum through a cellulose acetate membrane with pore size of 0.45 µm. Bacteria retained on the surface of the membrane were incubated on sterile Endo agar at $36^{o}C \pm 1^{o}C$ (for total coliforms), or on sterile MFC agar at $44^{o}C \pm 0.5^{o}C$ (for faecal coliforms). Incubation time was 24 hours. Dark red colonies with metallic shine were considered total coliform bacteria while blue/green colonies were considered faecal coliform bacteria. The presence of coliforms was confirmed using MacConkey broth. All the coliform bacteria were counted by their coliform forming units (cfu).The acceptability of fish from sewage ponds for human consumption was assessed by interviewing 1000 people in the Tamale Metropolis from randomly selected schools, market places, churches, mosques, and village communities near the treatment plant with a standard questionnaire. Statistical Package for Social Scientists, Version 11 was used for the data analyses.

2.2 **Map of the Treatment Ponds**

The Tamale Metropolitan Assembly (TAMA) sewage treatment plant is located at Gbalahi, a village about 5 km away from Tamale and serves a total population of about 240,000 people (GSS 1993). The sewage treatment plant consists of two units of three ponds each: a 2,432 m^2 an aerobicpond (4m deep), a pair of 1, 216 m^2 of both primary and secondary facultative ponds (3m deep each) in series, which are connected to a common 4, 464 m^2 aerobic pond (2 m deep) (Fig 1). The system design allows for both units to operate in rotation such that one side can be closed while the other is in operation.

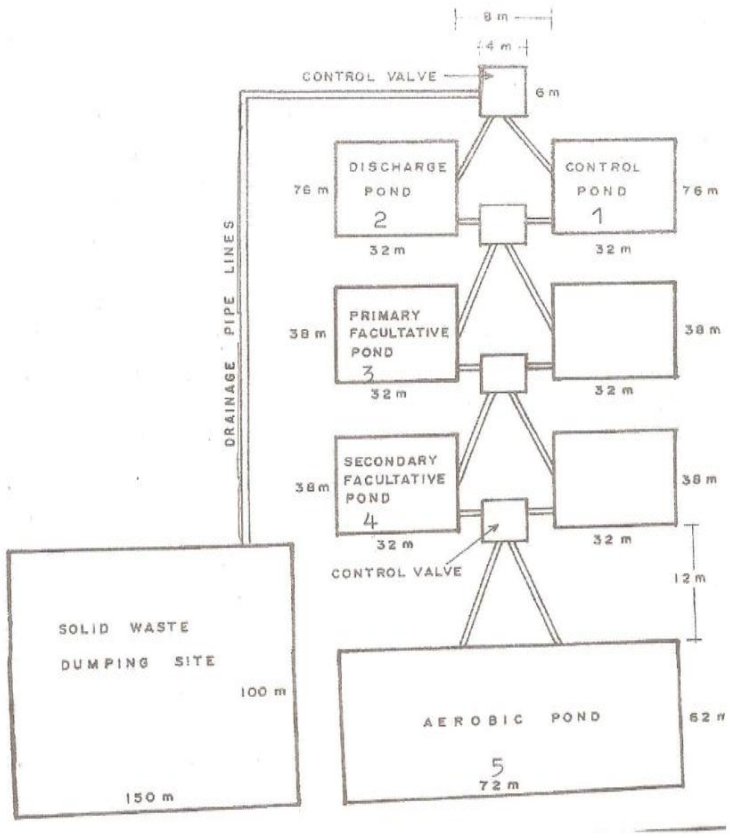

Figure 1.A map of the study area at Gbalahi a suburb of Tamale showing the treatment ponds.

Source: Abdul-Rahaman, University of Ghana, 2007

3. **Results and Discussion**

1.1 Coliform Bacteria

Faecal coliform values obtained from the aerobic pond was within the EPA standard of 5000 cfu and implied that sewage-cultured fish from the aerobic pond was good for consumption. The respective mean populations of total coliform bacteria in the control, discharge, primary facultative, secondary facultative and the aerobic ponds were 6000, 36000, 15000, 10000 and 5000 cfu (Fig 2a). The coliforms in the control pond were higher than that of the aerobic pond because waste water from the solid waste was discharge into the control pond. This implied that municipal solid waste contains excreta.

The decrease in the population of coliforms from the discharge pond to the aerobic pond is a reflection of the cleansing effect of the treatment plant. Significant differences in the populations of faecal coliform bacteria were observed between the ponds (Fig 2b). The control pond and the secondary facultative ponds however, had similar mean values. The populations ranged from 60-8300 cfu. The population was higher in the control pond (800 cfu) than in the aerobic pond (300 cfu). The presence of coliforms in the ponds is an indication of disease causing organisms (Holden, 1970) which influences the acceptability of sewage cultured fish. Chapman (1992) noted that, coliform bacteria occur in faeces of humans in large numbers. The survival of faecal coliform bacteria outside the intestine may depend on the physical or chemical environment (Jeremy *et al.*, 1995). It is therefore possible that bacterial could be found in the muscles of fish. This might be a possible cause for the rejection of sewage cultured fish by the inhabitants of Tamale.

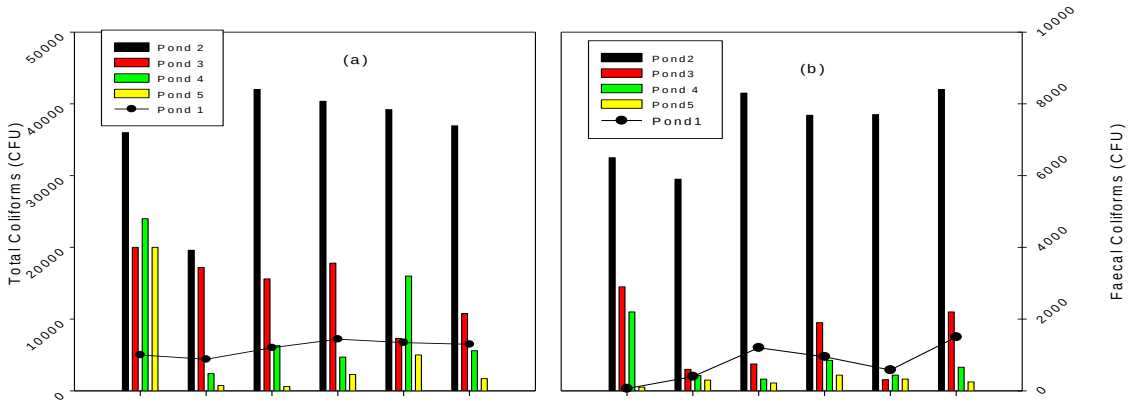

Figure 2 Monthly distributions of total coliform (a), faecal coliform (b) from the sampling ponds

Source: Abdul-Rahaman, University of Ghana, 2007.

1.2 Educational level, Religion and Income of Respondents

In general, majority (about 75%) of the respondents with high education (senior secondary and above) would eat sewage-cultured fish (Fig 3) and meant that they were not deterred by the presence of the bacterial in sewage ponds. Rresidents' in Tamale are predominantly Moslems (GSS, 1993). In this survey, higher proportion (56%) of the 490 Moslems would eat sewage cultured fish as compared to 36% of the 410 Christians who accepted to consume sewage-cultured fish if their health and safety were guaranteed (Fig 4). Thus, this confirms the opinion that the use of sewage for fish culture is socially acceptable by both Christians and Muslims under conditions whereby the water quality is closely monitored and regulated (Edwards, 2000).

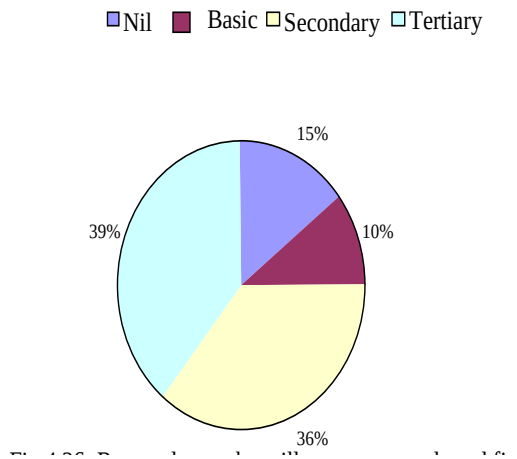

Figure 3 Respondents who would eat sewage cultured fish according to their educational level

Source: Abdul-Rahaman, University of Ghana, 2007.

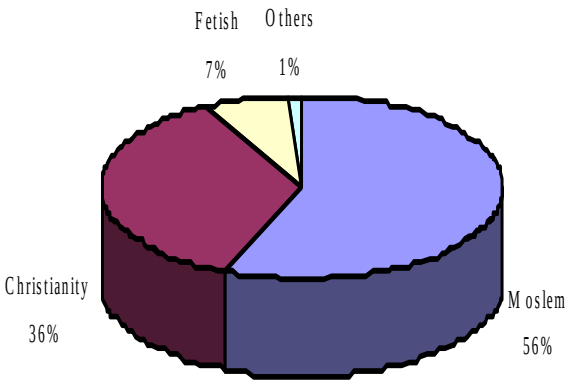

Figure 4 Religion of respondents willing to accept sewage cultured fish from the survey in 2007

Source: Abdul-Rahaman, University of Ghana, 2007.

It was noted that those with high education, secondary (36%) and tertiary (39%) would consume more sewage cultured fish on condition that it is well prepared and cooked (Fig 3). Educational institutions would therefore patronize such fish if their safety is guaranteed. This would enhance the nutritional values of boarding schools and the school feeding program in Ghana.

The people in Tamale are predominantly poor (GSS, 1993). And the larger proportion (65%) of the sample population that had no income confirmed this assertion (Fig 5).

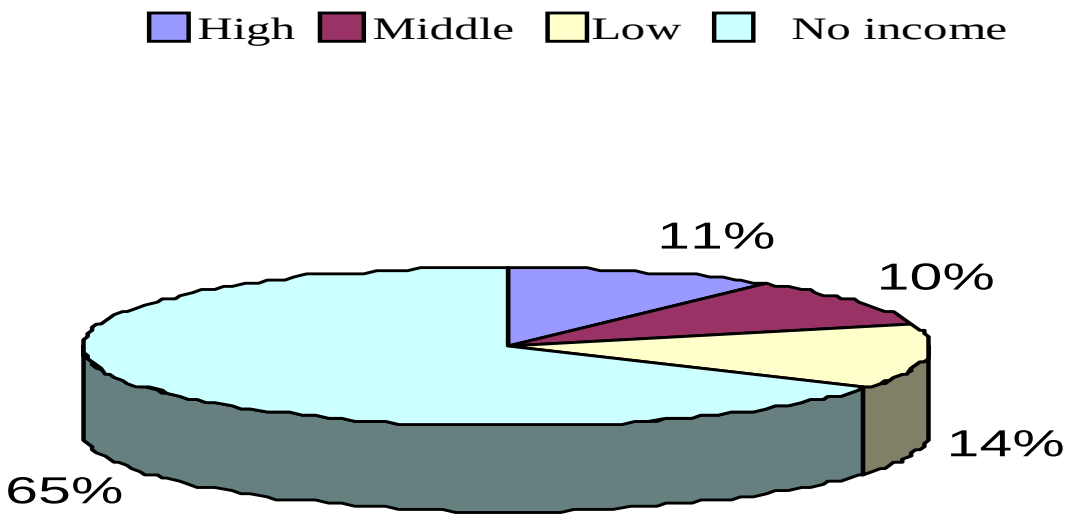

Figure 5 Financial status of respondents willing to accept sewage cultured fish in the survey in 2007

Source: Rahaman, University of Ghana, 2007

Both low-income earners (Fig 5) and students (Fig 3) would accept sewage cultured fish because they could be cheaper although some of the respondents claimed sewage cultured fish might be harmful (Edwards 2005). Fish cultured in sewage do not differ from any other fish (Table 1) and could therefore be very safe for consumption (Edwards *et al.*, 1990).

Table 1 Some reasons that influences the choice of sewage cultured fish

Perception on sewage-cultured fish	Percent of respondents
Could be harmful due to bacterial load	44.0

Objectionable odour	2.8
Not hygienic	4.5
Food supplement	9.4
Could be cheaper and increase income	4.3
Could be as good as other fish	24.8
Could be bigger	3.1
Others	7.1

It appears the environment in which fish is produced would not significantly influence the fish eating habits of people once about 60% of the respondents would eat sewage grown fish compared to 40% who were rejecting it from this study.

The respondents expressed various concerns or views about the consumption of fish raised in sewage ponds (Table 1). The major concern was that the fish could pose potential health risks to consumers because of the presence of bacteria in the sewage ponds. As many as 44% of the respondents shared this concern. However, about 25% of the respondents were of the view that fish from sewage-fed ponds could be as good as fish from other sources including the wild, reservoirs and conventional ponds. Another positive view was that fish from sewage-fed ponds could be cheaper and has the potential to benefit the poor.

It was noted that respondents were not aware that certain factors such as metallic contamination in sewage could also be dangerous to their health. In this wise education is needed to sensitize potential consumers of sewage cultured

fish about the consumption of such cultured fish without the approval of the relevant environmental and health agencies. The concentration of metals such as P, K, S, Zn, Cu, Fe, Mn and Ni are likely to be low in domestic sewage than in industrial sewage. As such metallic concentration varies from treatment plant to treatment plant depending on the source of generation.

2. Conclusion

Sewage-cultured fish is acceptable by the poor and students at least in the Northern region of Ghana and should be encouraged in order to control pollution and increase the protein requirements of the various district assemblies. In communities where sewage cultured fish is not acceptable, fish could be used as poultry feed. The success of sewage pisciqualture depends on the collaboration of the ministry of water resources, works and housing, the ministry of food and agriculture, the ministry of local government and rural development and the environmental protection agency of Ghana in collaboration with non governmental agencies.

3. Recommendations and Comments on Lessons Learnt:

- Pathogenic bacterial populations in the aerobic pond were lower than the acceptable standard (5000 cfu) set by the EPA of Ghana.
- Out of the 1000 people interviewed in Tamale metropolis in the survey 600 (60%) accepted to eat sewage-cultured fish and 80% of them were poor.
- About (40%) of the rich in the metropolis would not eat fish from sewage ponds, because of potential health hazards due to bacterial presence.
- Fish should be cooked well and possible contamination through handling and processing should be avoided.
- More research is needed to access bacterial load in the muscle of fish to

guarantee consumer safety.

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