

Impact of Treated Faecal Sludge on Fish Growth and Associated Health Risks

WASH | Bangladesh



Faecal sludge (FS) is the waste product collected from on-site sanitation systems, which in most cases remains untreated and is generally discharged into surrounding open spaces such as roads, drains and waterbodies. This unhygienic practice of faecal sludge management (FSM) creates an unhealthy living and environmental situation. However, FS contains high levels of valuable nutrients that could be used in many different ways. Other countries have successfully reused FS in aquaculture, and as aquaculture plays a significant role in Bangladesh's economy the country has the opportunity to examine the use of FS as a nutrient source for this industry. The Fisheries and Marine Resources Technology (FMRT) Discipline at Khulna University has therefore examined the use of FS as a nutrient source in aquaculture.

Research project brief

The fundamental premise of this study is that faecal sludge can be viewed as a valuable resource that is worth recycling, rather than a waste product that should be disposed of (such as in landfill) with its own adverse environmental effects.

Research context

In Khulna, the third-largest coastal city of Bangladesh, nearly 1.6 million people reside in an area of 45 sq. km, which includes a large number of slums. The majority of city dwellers use septic tanks without functional soak pits and release raw effluent into open drains. Similarly, the FS that accumulates in the septic tanks is manually pumped out and left untreated on the side of the drains or dumped elsewhere. This FS seriously pollutes local waterbodies and the living environment. In this context, SNV aims to develop a pro-poor, market-based solution for faecal sludge management in Khulna and two other cities.

On-site FSM can be made affordable through the adoption of suitable technology. The reuse of FS could increase revenue throughout the FSM service chain, making FS collection and transport services more financially viable and reducing costs at the household level.

For centuries, people have used human excreta to fertilise agricultural lands and fishponds¹. In particular, many Southeast Asian countries continue to produce fish and aquatic vegetables in ponds fertilised with human excreta. In Bangladesh, the intentional use of human excreta in fishponds is not allowed due to socio-cultural and export-driven food safety reasons. However, conventional wisdom suggests that a considerable niche market for FS-based products still exists among fish farmers growing particular finfish species for domestic markets.

It is assumed that fish feed on plankton species growing on the nutrients from FS, although research shows contradictory results². It is not clear whether fish directly consume the sludge materials, and if so, whether there is any effect on the growth of the fish. It is also not clear what consumer health risks are associated with the use of treated FS in fish ponds; what the viable treatment options are; what the possible contamination pathways are; and to what extent these pathways can be minimised. It is therefore necessary to undertake action research to examine the impact of treated FS in fish production and its associated health risks.



Policy and legal frameworks

The water supply and sanitation sector (WSS) policies in Bangladesh do not necessarily refer to the reuse of FS in aquaculture or other agricultural activities. For example, the Environmental Conservation Rules (1997) do not suggest any specific measures for FSM, while the National Policy for Safe Water Supply and Sanitation (1998) calls for decentralisation and greater private sector involvement in the provision of WSS services. This policy does not specifically address FSM from septic tanks or pit latrines, although it highlights the need to recycle waste materials. Subsequently, the National Sanitation Strategy (2005) and the Sector Development Plan (2011-15) stressed the need for resource recovery, recycling as well as safe handling and disposal of sludge collected from septic tanks but did not make any reference to the reuse of sludge, nor the possible area of application of the recovered resources.

The National Strategy for Water Supply and Sanitation (2015), however, specifically calls for action research into recycling FS, including composting for use as fertiliser. It also stresses that the private sector should be involved in FSM, as well as the recycling and selling of compost.

Due to deep-rooted socio-cultural prejudices in Bangladesh, the use of raw FS in aquaculture has traditionally been unintentional. Recently, even any unintentional practice has come under strict monitoring by the Department of Fisheries (DoF), particularly in export-oriented shrimp farms. This has been due to a recent increased focus of the major importing countries on food safety issues. However, a critical evaluation of the aquaculture sector-specific rules and regulations reveals that the use of FS in any form or prohibition thereof is not explicit in legal terms³. It seems that treated FS-based products are not the concern. Instead, the major concern is the use of raw human excreta, intentionally or unintentionally, which might increase the risk of contamination by pathogenic bacteria.

Research goal

The goal of this study is to provide empirical data to support policy-making decisions about the reuse potential of treated faecal sludge in aquaculture.

Research objectives

The following are the specific knowledge objectives, which are expected to help achieve the above-mentioned goal.

- State of affairs regarding safe use of co-compost FS;
- Major nutrients in co-compost FS;
- Pathogenic profile of co-compost FS;
- Effect of direct feeding of co-compost FS pellets on fish growth and quality;
- Effect of co-compost FS on growth and quality of pond-reared fish.

Research questions

The research questions of this study are:

- Do fish directly consume co-compost FS?
 - o Do they survive?
 - o Do they maintain comparable growth?
 - o Does co-compost FS feeding change the pathogen profile for fish skin, gills and gut?
- What are the fertilising effects of FS on the pond plankton community?
 - o What are the changes in physicochemical parameters of water and soil before, after and during different treatments?
 - o Do fish grow better in co-compost FS-treated ponds?

Research approach & methodology

The experiment will be conducted with nursery reared tilapia fingerlings as shown below. Co-compost, which is FS mixed with kitchen waste compost, will be used at different doses in aquariums and ponds as feed and fertiliser, respectively.

Specific steps are:

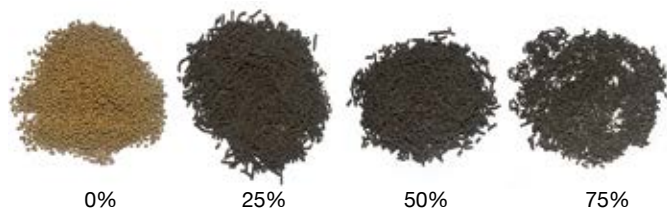
- i) Analysis of co-compost FS, preparation of feed pellets and feeding to fish in a controlled aquarium environment for a period of four months;
- ii) Application of co-compost FS as fertiliser in ponds and related data collection for a period of five months; and
- iii) Analyses of experimental co-compost FS, feed, fish and water for major nutrients, growth, water quality and pathogen load.

Progress and preliminary findings

Starting in June 2015, this action research has already completed its preliminary activities.

Sand-bed-dried FS, co-composted with household waste (1:3) for several months, was collected from a facility operated by Kushtia Municipal Authority. The co-compost was analysed for protein (micro-Kjeldahl), lipid (acetone extraction), ash (muffling at 550°C) and moisture (105°C) following AOAC protocols.

Ground-sieved co-compost was used to prepare four experimental diets containing 0 (T1), 25 (T2), 50 (T3) and 75% (T4) co-compost (Fig. 1).



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Tilapia fingerlings at 20 sites were fed in triplicate at satiation level and the growth data was taken at weekly intervals. In addition, fish were also sampled at the beginning to determine the proximate composition and pathogen load.

The formulated feed contained about 30% crude protein, whereas the co-compost contained about 10% crude protein. Understandably, the ratio of crude protein and other nutrients decreased as the percentage of co-compost inclusion increased in the experimental diets (Table 1).

Table 1. Proximate composition (dry wet basis) of co-compost and experimental feed

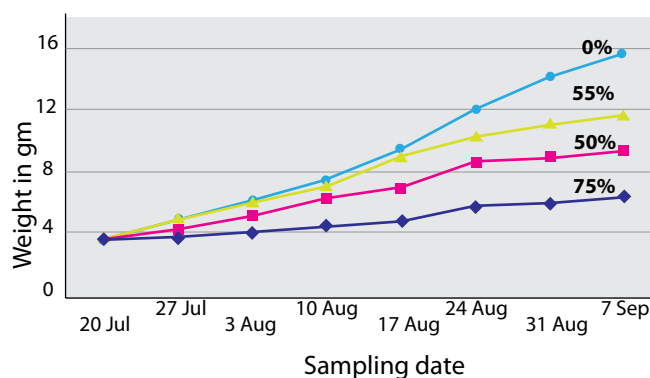
FS co-compost level (%)		Protein (%)	Lipid (%)	Ash %
FSC	Commercial feed			
0	100	29.94	4.63	15.27
25	75	23.69	3.50	33.63
50	50	18.41	3.01	45.55
75	25	12.02	1.35	62.33
100*	0	9.7	1.2	67.73

* 100% co-compost was not used as an experimental feed as it was not possible to prepare pellets at this concentration

Fish growth data up to eight weeks reveal that fish fed with co-compost showed growth inversely in a dose dependent manner (fig. 2).

Total aerobic plate count (TPC), total coliform (TC), faecal coliform (FC) and Escherichia coli were determined using selective agar media or broth and most probable number (MPN) method as appropriate, following EPA guidelines based on the APHA protocol. The TPC of fish fed with co-compost did not reveal any specific pattern (fig. 3), while the TC and FC in fish gut increased in a dose dependent manner (fig. 4).

Fig.2. Growth of fish fed with different levels of FS co-compost.



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Demonstration of Pro-poor Market-based Solutions for Faecal Sludge Management in Urban Centres of Southern Bangladesh

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Fig.3. TPC (log cfu/gm) in fish gills

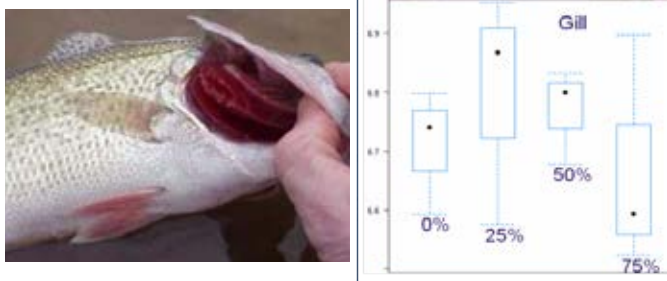
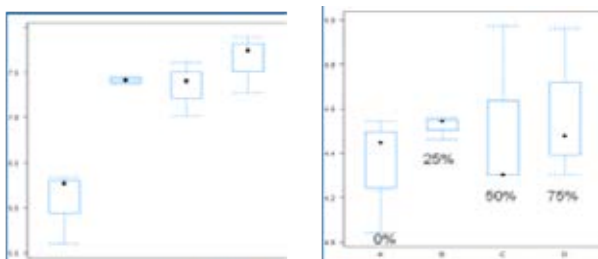


Fig.4. TC and FC (log cfu/gm) in fish gills



Interestingly, no *E. coli* was found in either co-compost feed or in fish gut fed with co-compost. To rule out the possibility of experimental error, the *E. coli* content was also checked in septic effluent and in the water of the Mayur river receiving almost all septic effluents of Khulna city corporation through more than 50 drains (Fig. 5).

The study is designed to run for a period of 17 months. The findings given above only draw on results observed during the initial three months from June to August 2015. It is expected that by the end of the actual study period, it will provide much-needed empirical evidence of the potential and actual benefit and/or risk of using FS in fishponds.

Fig.5. Representative plates showing growth of *E. coli* (blue colony) in septic effluent and Mayur river water but not in co-compost samples.

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Led by Prof. Dr. Md. Nazmul Ahsan, the study involves technical experts and research associates in the fields of fish microbiology, fish nutrition and planktology. WorldFish, a reputed research and development organisation, will also provide technical support for this action research.

Project partners:

