REDUCTION OF FISH CULTURE EFFLUENT TURBIDITY USING MAIZE SEED POWDER AS COAGULATION AGENT

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Abstract
Aquaculture wastewater, containing solids and organic metabolites, is often released directly into water bodies without treatment leading to pollution. The use of environmentally friendly tested plant based flocculants should be encouraged in the treatment of rawwater and wastewaters. The use of Maize seed powder was investigated as coagulation agent for reduction of turbidity in fish culture effluent. The coagulating action of Maize seed powder was investigated at 0, 20, 40, 60, 80, 100 and 120mg/l, added to wastewater from earthen fish pond used to raise *C. gariepinus*. The standard jar test apparatus utilizing four stirring spindles, was used to evaluate the effectiveness at three mixing intensities; 100, 150 and 200rpm (revolution per minute) The mean turbidity value for Maize seed was 76.00 ± 1.73NTU at dosage 100mg/l at 200rpm. This corresponded to a decrease of 68.20% in influent turbidity value. The pH obtained for the water treated with Maize seed powder was between 7.2-7.6. Maize seed powder was thus effective at 100mg/l in the treatment of fish culture wastewater. Further studies should be carried out on Maize seed powder on its effectiveness in the treatment of other farm generated wastewater.

Keywords: Natural polymer, fish culture, effluent treatment, flocculants
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Introduction

Maize is the most important cereal in the world after wheat and rice with regard to cultivated areas and total production (Osagie and Eka, 1998) Maize is a major important cereal crop being cultivated in the rainforest and the derived savannah zones of Nigeria, not only on the basis of the number of farmers that engaged in its cultivation, but also in its economic value. Maize has now risen to a commercial crop on which many agro-based industries depend on as raw materials (Iken and Amusa, 2004). It is an important source of carbohydrate, highly yielding, provides useful quantities of Vitamin A and C when eaten in immature state, easy to process, readily digested, cost less than other cereals and grows across a range of agro ecological zones (IITA, 2001). Maize thrives best in a warm climate and is now grown in most of the countries that have suitable climatic conditions. There are various types of Maize with various commercial uses including foods, cooking oil, bio-plastics, adhesives, pharmaceuticals and bio-fuel. They can also be used to remove colour from textile wastewater (Patel and Vashi, 2012; Ranganathan *et al.*, 2007) and also in the improvement of water quality (Raghuwanshi *et al.*, 2002).

Aquaculture wastes are often released directly into the water and pollution comes from the fish and the feed that the fish receive (Timmons *et al.*, 2001). Wastewater from aquaculture systems employing nitrification systems are often rich in nitrate-N, so it may be desirable to further treat the effluent prior to discharge. If there is a significant discharge of waste into lakes, rivers, and estuaries or any other receiving waters, it may cause adverse environmental impacts. Sediments discharged into receiving waters can adversely affect habitat leading to alteration of the types and abundance of species that use those habitats, dissolved oxygen depletion leading loss of aquatic lives while suspended sediment can also clog fish gills, reduce growth rates, decrease resistance to disease, and prevent egg and larval development. When suspended solids settle at the bottom of a water body, they can smother the eggs of fish and aquatic insects, as well as suffocate newly hatched insect larvae. In addition, solids suspended in rearing areas can affect fish health and may lead to conditions such as environmental gill disease. The decrease in water clarity caused by total suspended solids can affect the ability of fish to see and catch food. An estimated twelve million people each year, mostly in developing countries die from unclean water and if the situation persists, it may cause great loss to human lives unless it is seriously dealt with at all levels (Ghebemichael, 2004). In order to reduce these adverse impacts from occurring, regulations on discharges into receiving waters have been or are in the process of being established (Mitchell and Stapp, 1992). The choice of flocculant chemical depends upon the nature of the suspended solids to be removed, the raw water conditions, the facility design, and the cost of the amount of chemical necessary to produce the desired result. Polymers (natural flocculants) are effective over a wider pH range than inorganic coagulants. Natural polymers can be applied at lower doses, and they do not consume alkalinity. They produce smaller volumes of more concentrated, rapidly settling flocs, cheap and non-toxic in nature. These natural coagulants are highly effective for treatment of waters with low turbidity but may not be feasible in the case of wastewaters with extreme high pH. Therefore, considerations must be given to required effluent quality, effect upon downstream treatment process performance, cost, method and cost of sludge handling and disposal, and net overall cost at the dose required for effective treatment

Natural polymers such as Maize seeds (Zea mays), *Moringa oleifera* seeds, potatoes and legume seeds, had been used as flocculants in industrial water treatment (Addai-Mensah, 2007). Natural flocculants are attractive if their flocculation performances and efficacies can be demonstrated to be good enough for a range of particulate matter found in aqueous suspensions. Recently, there has been marked interest in the development of bio-flocculant from maize seeds in the treatment of domestic water because it is not sensitive to pH, can coagulate very fine particles, based on natural polymers, non- toxic to human, cheap and bio-degradable, easy to store, readily available, not carcinogenic in nature and can easily be processed into usable form (Addai-Mensah, 2007; Raghuwanshi *et al.*, 2002). Some evidence gathered indicates that the seed extracts have beneficial flocculating and coagulating properties for water clarification. Hence, this research was carried out to evaluate the performance of maize seed powder in the removal of suspended solids in fish culture effluent

Materials and Methods

Sample collection

Fresh and matured Maize seeds were obtained at Ajibode Road, Ibadan, a location in Oyo state, dried until a constant weight (55g per 200 pieces) was obtained. The dried seeds were then finely crushed and grounded, and sieved using 0.15mm mesh size netting. Effluent water sample used were collected from an earthen pond of African catfish (*Clarias gariepinus*) grow out system. As at the time of collection the fish were nine months old, fed with Topfeed® at 5% body weight, twice daily. The wastewater sample were collected fresh daily from outlet of the pond with two five-litre plastic containers.

Turbidity measurement

This was determined by using turbidity meter (LP 2000®) measured in Nephelometric Turbidity Unit (NTU). Cuvette bottle containing the standard distilled water to serve as blank was inserted in the place provided and covered, the knob pushed to set until it shows 0.00 on the screen. The sample water is filled into the second cuvette bottle and use to replace the one containing the distilled water. The knob is then pushed to normal. The knob range is used to adjust the readings.

Experimental procedure

An electronic jar test apparatus (FP4 Portable, Velp Scientifica®) as shown in plate 1,with four stirring paddles attached to it and four 1000ml (1 litre) capacity transparent beaker was used for the experiment. 1 litre of the water sample was poured in each of the beakers. The flocculation aids in form of powder at 20mg/l were measured using Analytical balance (Ohaus Precision Standard®) in two replicates into the beakers and then the stirring paddles were lowered into the beakers and mixed at 3 different mixing speeds of 100, 150 and 200rpm each at 31mins of 1min fast stirring to initiate thorough mixing of the flocculation aids and waste water and 30mins slow stirring to allow flocs to form and also prevent them from breaking. At the end of the stirring time, the stirring paddles were lifted off the flocculated waste water and then allowed to settle for about 30-60mins after which a metre rule (ruler) was used to measure the settled flocs at the bottom of the beaker. Finally, the supernatant water was then carefully decanted into another clean beaker which is then used to determine the quality parameters mentioned earlier to evaluate the effectiveness of the flocculation aids. The process was repeated for the other dosages (0mg/l as control, 20mg/l, 40mg/l, 60mg/l, 80mg/l, 100mg/l and 120mg/l).

Plate 1: The Standard Jar Test Apparatus used for this study

Results and Discussion

The percentage reduction in turbidity mean values of treated wastewater by Maize seed powder was highest at dosage 100mg/l with 68.20% decrease at 200rpm. Although dosages 20mg/l at 100rpm and 120mg/l at 150rpm were able to reduce with 65.22% and 67.36% decrease respectively.

Table 1: The mean turbidity values at different evaluated dosages

Dosages (mg/l)	Initial turbidity(NTU)	Final turbidity(NTU)	% reduction
20	207.00 + 1.73^{+}	66.00+ 1.73	68.12
40	135.33+ 3.02	101.33+ 2.31	24.63
60	168.00 + 0.00	108.00+ 4.92	35.71
80	168.00 + 0.00	81.00+ 2.73	51.79
100	238.67 + 1.73	76.00+ 1.73	68.20
120	238.67 + 1.73	117.00+ 2.73	51.05

$^{+}$mean ± SD of the three replicates

Effect of dosages

This study showed that at low dosage (20mg/l), a high percentage modification was obtained for Maize seed powder before a drop in reduction at 40 and 60mg/l and above

60mg/l, however there was continuous increase in the percentage for turbidity. This implies that maize seed powder can be used at both low and high concentration in the removal of turbidity. Appreciable differences were observed in the mean turbidity values at various dosages applied. According to Akinwole and Jioke (2006), the highest reduction in turbidity of fish culture effluent from intensive re-circulatory system was attained at 120mg/l, 150rpm with 39% reduction using *Moringa oleifera* seed while for Maize seed, all the dosages used in this study except dosages 60mg/l (150rpm) and 40 and 60mg/l (both 200rpm) gave reductions greater than 39%. The pH observed, agreed with the report of Raghuwanshi *et al.* (2002), that the pH obtained for the water treated with Maize seed powder was between 7.2-7.6.

Effect of mixing intensities

It was observed that the fish culture effluent varied slightly day by day due to some factors like changes in feed consumption, make up water addition, biomass among others. There were significant differences in the mixing intensities for turbidity. According to Akinwole and Jioke (2006), it was observed for *Moringa* seed powder that 150rpm worked highest for turbidity reduction in fish culture effluent, while this study revealed that 200rpm, will work highest in turbidity reduction using Maize seed powder. Raghuwanshi *et al.* (2002),working with regular turbid streamwater reported that maize seed powder at 100rpm worked highest in reduction of turbidity ,the 200 rpm in this study might be due to the difference in wastewater composition.

Conclusion

The use of tested plant based flocculants which are environmentally friendly should be encouraged in the treatment of raw water and wastewaters from various sources. Also, further studies should be carried out on Maize seed powder on its effectiveness in the treatment of other wastewater and various dosages and mixing intensities.

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