NSAP 47th Annual Conference (JOS 2022) CONFERENCE PROCEEDINGS
THEME: SECURING ANIMAL AGRICULTURE AMIDST GLOBAL CHALLENGES

EVALUATION OF ORGANIC AND INORGANIC COAGULANTS IN MITIGATING WATER TURBIDITY OF CLAY BASED EARTHEN POND

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ABSTRACT

The study was to evaluate the effects of organic and inorganic coagulants in mitigating turbidity in earthen pond water due to clay. Turbid water was collected from Pacific farm. Plastic bowls were filled with 25litres of turbid water with clay particles. Alum, Gypsum, Ash of rice straw each were placed separately into the bowls at dosages of 0.2,0.4,0.6,0.8 and 1.0g/25l while bale of hay of rice straw (BHR)was applied separately at the rates of 100, 150, 200, 250 and 300g/25l. The contents were stirred vigorously for 1-2 minutes at intervals of 5 minutes for 30 minutes, allowed settling and readings of physicochemical parameters were taken after 10 minutes. The same experiments were replicated three times. Thedata obtained were analysed using non-parametric ANOVA. Alum, Gypsum, and BHR revealed that the mean values of pH, conductivity and total dissolved solid (TDS) increased with increased rate of application generally. However, the results for Ash revealed that the mean values of the physicochemical parameters decrease with increased dose. Temperature (25^0C) remains constant in all the treatments. The range values of pH (6-8.7667), TDS(830-1198) and conductivity (1296.9-1871.9µS) across the treatments; Bioassay of catfish in treated water showed that fish were active at dosages of Alum (0.6-1.0g/25l);Gypsum (0.8 and 1.0g/25l) and BHR (100-300g/25l). Turbidity of water could be mitigated by applying appropriate dosages of Alum, Gypsum, BHR. Further research is recommended for lower and higher dosages of BHR and Ash respectively to convert waste rice straws to wealth.

Key words: Turbidity, Organic Coagulant, Inorganic Coagulant, Waste Rice Straw

INTRODUCTION

Nigeria is blessed with an estimated inland water mass of about 12.5million hectares capable of producing about 512,000 metric tons of fish annually (Ita and Sado, 1985). Efforts should be made by all stakeholders in harnessing all available resources in the country to optimize fish production. It has long been recognized that other substances that are dissolved or suspended in the water can affect water quality and number of impurities of concern in water has continued to increase, and smaller and smaller concentration of many substances are becoming of interest (Wilson, 1982). Coagulants are very important in mitigation of water turbidity in clay based earthen pond. Coagulants do not affect the survival of fish in earthen pond (Boyd 1990).Judging from the importance of water as medium for the growth and survival of fish, its quality parameters such as turbidity, pH, temperature, dissolved oxygen and pollutants should be assessed to enhance fish growth and development, so that fish can attain its optimal growth potential (Eyo, 1988). Different types of inorganic coagulants have been used by researchers to control turbidity in fish earthen pond, some of which are; aluminium sulphate, gypsum, Ferric sulphate, ferric chloride and sodium aluminate which are expensive to the farmers. However, this study is to replicate use of inorganic coagulants such as application of bale of hay and ash in reducing fish pond water turbidity based of clay based earthen pond as reported by Abdulkarim *et al.* (2009). This is believed to be less costly, cheaper and effective.

MATERIALS AND METHODS

Description of the Study Area

The study was conducted at Pacific farm at Fadaman Mada of Bauchi local government in Bauchi state of Nigeria. Bauchi state occupies a total land area of 49,119km^2 (18,965sq mi) representing about 5.3% of Nigeria's total land mass and is located between latitudes 9^0 3^1 and 12^0 3^1 north and longitudes 8^0 50^1 and 11^0 east (National Bureau of Statistic [NBS], 2017).

Experimental Procedures and Data Collection Techniques

Sample of turbid water were collected from the farm earthen pond in labelled plastic bottles. The pH of the turbid water was measured before and after experiment using digital pH meter. Bowl test analysis as described by Hargreaves (1999) was followed to determine the minimum quantity of Alum that will coagulate the suspended clay particles. Alum, Gypsum and Ash of Rice Straw were weighed separately as 0.2g; 0.4g; 0.6g; 0.8g and 1.0g using top loading electronic digital weighing balance model BSA3202S-CW. Also bales of hays of rice were measured as 100, 150, 200, 250 and 300g using same weighing balance. The coagulants were applied separately into 25 litres turbid earthen pond water in bowls labelled as A, B, C, D and E respectively. Water parameters were measured before and after applying coagulants. The water was constantly stirred rigorously for 1 – 2 minutes at intervals of five minutes for 30 minutes and finally left for 30 minutes to observe the clarity of the water. The conductivity and total dissolved solid (TDS) were measured with conductivity/TDS meter model HI96301DIST1. The pH of the water was measured with pH meter model PH-009(1); also, temperature was measured with field thermometer.

Bioassay of fish

Bioassay was carried out to determine the effects of the inorganic coagulants (Alum and Gypsum) and organic coagulants (bale of hay of rice and ash of rice straw) on fish. One hundred **(**100) life *Clarias gariepinus* were purchased from Pacific farm at Fadaman Mada, Bauchi. They were kept in a plastic bowl with capacity of 36 litres of water to acclimatize and starved a day before the experiment. The fish were subjected to all doses of each coagulant one by one and the fish activeness was observed for 30 minutes in every instance at the rate of five fish per dose per type of coagulant by introducing them into bowls containing the treated water based on the method of Abdulkarim *et al*. (2009).

Data Analysis

The data collected using hedonic scale were assessed using Likert scale as described by Joshi *et al*. (2015). The five points hedonic scale were scored as 1 = Poor, 2= Fair, 3= Moderate, 4 = Good, 5 = Excellent and were processed using a non-parametric analysis of variance (Kruskal Wallis).

RESULTS AND DISCUSSION

Table 1: Likert Scale of Mitigation of Turbidity Means of Four Treatments in Earthen Pond Water

Dose(g/25l)	Treatment (A) with aluminium	Treatment (B) with Gypsum	Treatment (C) with ash	Dose (g/25l)	Treatment (D) with Bale of hay	Remark
0.2	1.3	1.3	1.0	100	3.0	Only treatment D is significant
0.4	3.0	1.6	1.3	150	3.3	Treatment A and D are significant
0.6	3.3	1.6	1.3	200	3.3	Treatment A and D are significant
0.8	4.6	4.0	2.6	250	5.0	Only treatment C is not significant
1.0	5.0	3.6	2.0	300	5.0	Only treatment C is not significant

* Mean score (x ≥3.0) implied significant on a scale of 1-5 for all the treatment.

From Table1, the minimum doses of coagulants that coagulate clay particles in turbid water were 0.4g/25l, 0.8g/25l and 100g/25l for Alum (A), Gypsum(B) and Bale of hay of rice straw (D) respectively. None of the doses tested was effective for ash from burnt rice straw (C) to coagulate the clay particles.

Table 2: Mean Values of Physicochemical parameters of Earthen Pond Water Treated with Coagulants

Treatments	No of samples (N)	Rates of Application (g/25l)	Physical properties		Chemical properties	
			Temperature (°C)	Total Dissolve solid(mg/l)	pH	Conductivity (µS/cm)
Alum (A)	3	0.2	25.000	830.00	6.2000	1296.9
	3	0.4	25.000	838.33	6.2667	1309.9
	3	0.6	25.000	860.33	6.3000	1344.3
	3	0.8	25.000	913.00	6.3667	1426.6
	3	1.0	25.000	933.67	6.4667	1458.9
SE ±			0	4.70373	1.43878	4.70428
Gypsum (B)	3	0.2	25.000	1100.0	6.1000	1718.8
	3	0.4	25.000	1062.3	6.2000	1665.9
	3	0.6	25.000	1085.0	6.3000	1680.2
	3	0.8	25.000	1120.7	6.4000	1751.1
	3	1.0	25.000	1136.7	6.4000	1776.0
SE ±			0	2.3746	1.85699	2.41384
Ash of Rice Straw (C)	3	0.2	25.000	1100.0	6.2000	1814.1
	3	0.4	25.000	1062.3	6.2000	1813.9
	3	0.6	25.000	1085.0	6.1000	1796.3
	3	0.8	25.000	1120.7	6.1000	1777.6
	3	1.0	25.000	1136.7	6.0000	1767.4
SE ±			0	2.3746	1.22276	1.05232
Bale of Hay of Rice Straw (D)	3	100	25.000	1165.7	6.400	1821.3
	3	150	25.000	1172.3	6.8333	1831.8
	3	200	25.000	1188.0	7.633	1856.3
	3	250	25.000	1192.0	8.133	1862.5
	3	300	25.000	1198.0	8.7667	1871.9
SE ±			0	1.03137	11.3323	1.03277
Range	Min		25	830	6.000	1296.9
	Max		25	1198	8.7667	1871.9

Table 2 above shows that the mean values of pH, conductivity and total dissolve solid (TDS) in treatment A, B, and D are increasing with increasing rates of application and the values of temperature remain constant. This agreed with the finding of EPA (2012) that the greater the TDS and conductivity content the lower the turbidity of the earthen pond water. The standard error (SE) values of pH, conductivity and TDS in treatments A, B, and D were increasing with increasing dosages while the values of temperature remain constant at zero (0) and in treatment C were decreasing with increasing dosages while the values of temperature remain constant, thus corroborating with EPA (2012) that reported that the greater the turbidity the lower the TDS and conductivity content of the earthen pond water. The trends observed and reported in this research were consistent with similar research that was conducted and reported by Abdulkarim *et al.* (2009).

CONCLUSION AND RECOMMENDATIONS

Effects of various coagulants assessed indicated that more doses of organic coagulants are needed than inorganic. Turbidity of earthen pond water due to clay could be mitigated by applying appropriate dosage of Alum (0.6g/25l), Gypsum (0.8g/25l) and Bale of hay of rice straw (100g/25l). Further research is recommended for testing effectiveness of doses lower than 100g/25l and higher than1.0g/25l for Bale of hay and Ash of rice straws respectively as rice straws are readily available as wastes that could be converted to wealth.

Table 3: Kruskal Wallis ANOVA of Effectiveness of Doses Used for Mitigating Turbidity Water of Earthen Pond among Four Treatments

Treatment (A) (g/25l)	Treatment B(g/25l)	Treatment (C) (g/25l)	Treatment D (g/25l)
0.2^{a}	0.2^{a}	0.2^{b}	100^{a}
0.4^{a}	0.4^{a}	0.4^{b}	150^{a}
0.6^{a}	0.6^{a}	0.6^{b}	200^{a}
0.8^{a}	0.8^{a}	0.8^{b}	250^{a}
1.0^{a}	1.0^{a}	1.0^{b}	300^{a}

In Table 3: doses with same alphabets as superscripts across rows and columns indicated that they are not significantly different statistically (P>0.05) based on non-parametric multiple comparison using Kruskal Wallis test from values of Likert scale. The dosages of 0.2 to 1.0g/25l of Alum and gypsum, and doses of 100 to 300g/25l of bale of hay (treatments A, B and D) were not significantly different statistically (p>0.05) based on non-parametric multiple comparison Kruskal Wallis test from values obtained from Likert scale but the doses of 0.2 to 1.0g/25l of ash (treatment C) were different from all other treatment statistically

Table 4: Bioassay of *Clarias gariepinus* Activeness in the Four Treated Earthen Pond Water (5 fish per dose per coagulant: N = 100)

Coagulants/ Doses	**0.2 g/25l**	**0.4 g/25l**	**0.6 g/25l**	**0.8 g/25l**	**1.0 g/25l**
Alum	Weak	Weak	Active	Active	Active
Gypsum	Weak	Weak	Weak	Active	Active
Ash of Rice Straw	Weak	Weak	Weak	Weak	Weak
Dose	**100 g/25l**	**150 g/25l**	**200 g/25l**	**250 g/25l**	**300g/25l**
Bale of Hay	Active	Active	Active	Active	Active

Table 4 showed that catfish were active in all doses of bale of hay, in 0.6 to 1.0g/25l doses of Alum and in 0.8 and 1.0g/25l doses of Gypsum. Catfish were weak in all doses of ash, in 0.2 to 0.4g/25l of Gypsum and 0.2 and 0.4g/25l of Alum.

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