COMPARATIVE EVALUATION OF ORGANIC AND INORGANIC COAGULANTS MITIGATION OF WATER TURBIDITY IN FOR CLAY BASED EARTHEN FISH POND

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ABSTRACT

Comparative evaluation of inorganic and organic coagulants in mitigating turbidity of water caused by clay was studied; 25litres of turbid water with clay particles were collected in plastic bowls and physicochemical parameters were determined. Each inorganic coagulant was placed separately into different bowls at dosages of 0.2, 0.4, 0.6, 0.8 and 1.0g/25l while organic coagulants at the rates of 25, 50, 75, 100 and 125g/25l. The contents were stirred vigorously for 1-2 minutes at intervals of 5 minutes for 30 minutes and physicochemical parameters were determined after 30 minutes while scoring for increasing clarity (1-5) by three assessors using Likert scale. Five Juvenile *Clarias gariepinus* were placed in the bowls of different concentration for every coagulant and activities of the fish were observed. The experiments were replicated three times. The data obtained were analysed using descriptive statistics and all the coagulants revealed that the mean values of pH, conductivity and total dissolved solid (TDS) increased with increased rates of application generally. Temperature (29^0C) remains constant in all the treatments. The range values of pH (6.4-7.5), TDS (141-321) and conductivity (220.31-501.56µS). Fish in treated water were active at dosages of Alum (0.2 – 0.8g/25l); Gypsum (0.2, 0.6 and 0.8g/25l); Ash of rice straws (25 and 100g/25l) and were very active for bale of hay of rice straws (100 and 125g/25l). Organic coagulants, readily available as wastes, can replace the inorganic ones by applying 100g/25l of Bale of hay of rice straws. Further research is recommended on dosages of Ash lower than 25g/25l.

Key words: Turbidity, Organic Coagulant, Inorganic Coagulant, Waste Rice Straws, Comparative evaluation

INTRODUCTION

An estimated inland water mass of about 12.5million hectares capable of producing about 512,000 metric tons of fish annually is part of Nigeria's blessings (Ita and Sado, 1985). Turbidity measures the scattering of light as it passes through a solution. This scattering can be caused by many constituents in the water, including clay, silt, finely divided inorganic or organic matter, dissolved colored organic compounds (example, humic acids), and microscopic organisms (Los Alamos, 2005). According to Boyd (1999), coagulation process involves adding iron or aluminium salt such as aluminium sulphate, ferric sulphate, ferric chloride or their polymers to the water. Coagulants carry the opposite charge to the particles and therefore cause the charge to destabilize when added to the water resulting in the particles clinging together. This coagulating process is also known as flocculation. According to Ashish (2013), coagulation is carried out for the filtration and purification of water. The rapid or fast mixing occurs after the addition of the coagulants, which requires turbulent mixing to form a homogeneous solution (Duan and Gregory, 2015). In flotation principle, a lower dosage of the polymer can be used because the agitation creates a well-established suspension of smaller flocs to agglomerate to float (Kyzas and Matis, 2016). The inorganic coagulants are believed to be less costly, readily available and as well effective. Conductivity shows significant correlation with ten parameters such as temperature, pH value, alkalinity, total hardness, calcium, total solids, total dissolved solids, chemical oxygen demand, and chloride and iron concentration of water (Kumar *et al*, 2010).Rice straws are readily available as post-harvest wastes in Nigeria. The wastes when put to use can serve as potential wealth and environmental pollution management strategy. However, this study is to replicate with modifications in concentrations of the organic coagulants such as bale of hay and ash in mitigating fish pond water turbidity of clay based earthen pond as reported by Abdulkarim et al. (2009) and Lawan *et al.* (2022). Also, this study was focused on Juvenile fish unlike Lawan *et al*. (2022) that focused on Adult fish.

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

Samples of turbid water were collected from the farm's earthen pond in labelled plastic containers. Bowl test analysis as described by Hargreaves (1999) was followed to determine the minimum quantity of coagulants that will coagulate the suspended clay particles. Alum and Gypsum 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. Rice straws were used as bales and some were burnt to ash. The bales of hays of rice straws and Ash of rice straws were measured as 25, 50, 75, 100, and 125g using same weighing balance. The coagulants were applied separately into 25 litres turbid earthen pond water in bowls labelled as A, B, C and D for Alum, Gypsum, Bales of hays of rice straws and Ash of rice straws respectively for every concentration with tree replications. 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 and scored for increasing clarity on hedonic scale of 1-5 by three assessors. 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. Three hundred and fifteen **(**315) live juveniles of *Clarias gariepinus* were purchased from Zango Bakin Kura Modern Fish Farm, Bauchi. They were kept in a plastic bowl to acclimatize 12 hours before the experiment. Three hundred (300) fish were used in the experiments. Five Juvenile *Clarias gariepinus* were introduced in the bowl with treated water at five concentration levels; each level with a bowl that has with three replicates for every coagulant and activeness of the fish were observed for 30 minutes in every instance per dose per type of coagulant based on the methods of Lawan *et al*. (2022) and 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.

RESULTS AND DISCUSSION

The results were as follow.

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

Dose (g/25l)	Treatment (A) with Alum	Treatment (B) with Gypsum	Dose (g/25l)	Treatment (C) with ash	Treatment (D) with Bale of hay	Remark
0.2	4	4.3	25	4	4	All the treatments are significant
0.4	3.7	4	50	4	3	All the treatments are significant
0.6	3	4	75	3.3	1.7	Only treatment D is not significant
0.8	1.3	1.7	100	1	3.7	Only treatment D is significant

1.0		125			Only treatments A and D are significant
	3	2	2	3.3	

*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 0.2g/25l for Alum (A) and Gypsum (B); 25g/25l for ash from burnt rice straws (C) and Bale of hays of rice straws (D). These results agrees with the findings of Lawan et al. (2022) for the inorganic coagulants (Alum and Gypsum) while differed in the minimum dose for bales of hays of rice straws which was reported to be 100g/25l and the non-effective doses of 0.2 -1.0g/25l of ash of rice straws.

Table 2 above revealed that the mean values of pH, conductivity and total dissolved solid (TDS) increased with increased rates of application in concentration levels generally while temperature (29^0C) remains constant in all the treatments. The ranges of values were for pH (6.4-7.5), TDS (141-321) and conductivity (220.31-501.56µS). This agreed with the finding of EPA (2012) that the greater the TDS and conductivity contents the lower the turbidity of the earthen pond water.

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) ±SD		Total Dissolve Solid (mg/l) ±SD		pH ±SD		Conductivity(µS/cm) ±SD	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
Alum (A)	3	0.2	29.0 ± 0.0	29.0± 0.0	147.6667 ± 2.1213	144 ± 4.2426	7.1333 ± 0.2121	6.8333 ± 0.0707	230.7333±3.3163	225.0033±6.6256
	3	0.4	29.0± 0.0	29.0± 0.0	151.3333 ± 0.0	146.3333 ± 4.2426	7.2 ± 0.2121	6.8333± 0.1414	235.94±0.0000	228.6467±6.6327
	3	0.6	29.0± 0.0	29.0± 0.0	149 ± 2.121	148.3333 ± 2.8284	6.9667 ± 0.0707	6.9333± 0.1414	232.8133±3.3163	231.7733±4.4194
	3	0.8	29.0± 0.0	29.0± 0.0	149.6667 ± 1.4142	150.3333 ± 4.2426	6.9 ± 0.2121	6.8667± 0.707	234.2233±2.8496	234.8967±6.6327
	3	1	29.0± 0.0	29.0± 0.0	151.3333 ± 2.8284	153.6667 ± 2.8284	6.7667 ± 0.1414	6.7667± 0.2121	236.46±4.4194	240.1067±4.4194
Gypsum (B)	3	0.2	29.0± 0.0	29.0± 0.0	150.6667±0.70711	148.6667±2.8284	7.0333±0.0707	6.8333±0.4243	232.8167±5.5225	234.8967±2.2062
	3	0.4	29.0± 0.0	29.0± 0.0	153.6667±2.82843	151.3333±0.7071	6.8667±0.0707	6.8±0.2828	234.3767±2.2132	242.19±0.0
	3	0.6	29.0± 0.0	29.0± 0.0	151.3333±3.53553	151.6667±4.9497	6.8±0.0707	6.7±0.2121	236.98±3.3163	236.46±5.5225
	3	0.8	29.0± 0.0	29.0± 0.0	151.6667±1.41421	154±0.0	6.7333±0.0707	6.7333±0.2121	240.1067±4.4194	239.8333±3.3163
	3	1	29.0± 0.0	29.0± 0.0	152.6667±5.65685	153±0.0	6.7333±0.0707	6.6±0.1414	239.5867±5.5225	238.0267±9.9561
Ash of Rice Straw (C)	3	25	29.0± 0.0	29.0± 0.0	152.3333±0.7071	192.3333±0.7071	6.5667±0.0707	7.3±0.0	267.1867±1.1031	271.3533±1.1031
	3	50	29.0± 0.0	29.0± 0.0	152±0.0	197±14.1421	6.5667±0.0707	7.4±0.0	260.9367±0.0	284.3767±22.0971
	3	75	29.0± 0.0	29.0± 0.0	151.3333±0.7071	239±26.163	6.5±0.0707	7.4±0.0	294.2733±1.1031	315.6267±40.8849
	3	100	29.0± 0.0	29.0± 0.0	152±0.7071	293.6667±57.2756	6.6333±0.0	7.5±0.0	354.48±64.7427	371.8733±89.4914

	3	125	29.0±0.0	29.0±0.0	152±0.7071	302.3333±5.6569	6.7±0.0	7.5±0.0	318.75±1.1031	391.1467±8.8388
Bale of Hay of Rice Straw (D)	3	25	29.0±0.0	29.0±0.0	164.6667±2.8284	173.3333±0.0	6.4±0.0	6.4333±0.0707	257.2967±4.4194	270.8333±0.0
	3	50	29.0±0.0	29.0±0.0	162±1.4142	173±0.7071	6.5±0.1414	6.4667±0.0	253.1267±2.2062	270.3133±1.1031
	3	75	29.0±0.0	29.0±0.0	164±0.0	175±1.4142	6.4333±0.0	6.5±0.0707	256.25±0.0	273.44±2.2132
	3	100	29.0±0.0	29.0±0.0	163±1.4142	187.6667±3.5355	6.5±0.0707	6.5667±0,1414	254.69±2.2132	293.23±5.5225
	3	125	29.0±0.0	29.0±0.0	164.6667±0.0	188.6667±2.8284	6.4333±0.0707	6.5333±0.0707	257.2933±0.0	294.7967±4.4194
Range	Min		29	29	146	141	6.4	6.4	228.13	220.31
	Max		29	29	166	321	7.4	7.5	321	501.56

Also, in all the treatments the mean values of physicochemical parameters were relatively higher after treatment of the turbid water compared to before the treatment were applied thus corroborating with EPA (2012) which implied that the treatments can mitigate turbidity. Similar trends were observed and reported in by Abdulkarim *et al.* (2009) and Lawan et al. (2022).

Table 3: Bioassay of Juvenile *Clarias gariepinus* in the Treated Pond Turbid Water

Doses (g/25L)	Inorganic Coagulants		Doses (g/25L)	Organic Coagulants	
	Alum	**Gypsum**		**Ash**	**Bale of hay of rice**
0.2	Active	Active	**25**	*Active	Inactive
0.4	Active	Inactive	**50**	Inactive	Inactive
0.6	Active	Active	**75**	Inactive	Inactive
0.8	Active	Active	**100**	*Active	Very Active
1	Inactive	Inactive	**125**	Inactive	Very Active

It has been elucidated in Table 3 that juvenile catfish were active at doses of Alum (0.2– 0.8g/25l) but were inactive at dose of 1.0g/25l. This only agrees with the findings of Lawan et al. (2022) in doses of 0.4 and 0.6g/25l but while 0.2g/25l might be okay for juveniles such dose might not be good to mitigate turbidity for adult fish this could be the reason the adult fish were reported to be weak physically (Lawan *et a.,l.* 2022). Similarly 1.0g/25l might be high dose for juveniles as found in this research but still compatible dose to the adult fish as reported by Lawan *et al.* (2022). Juvenile *Clarias gariepinus* were active at doses of Gypsum (0.2, 0.6 and 0.8g/25l) but adult fish tend to be weak at lower doses while active at higher dosages based on the findings of same authors. Conversely, Juveniles clarias were active for Ash of rice straws (25 and 100g/25l) but the inactiveness at 50 and 75g/25l needs further investigation as they tend to be active at higher dose of 100g/25l. The juveniles were very active at bale of hay of rice straws (100 and 125g/25l) which were within the dosages for which adults *Clarias gariepinus* were active as reported by Lawan et al. (2022).

CONCLUSION AND RECOMMENDATIONS

In order to convert readily available post-harvest wastes of rice straws to wealth it is concluded that rice straws can be used as organic coagulants and can replace the inorganic ones by applying 100g/25l of Bale of hay of rice straws to mitigate turbidity of fish pond water caused by clay particles. This dose is appropriate for juvenile and adult fish. Conversely, further research is recommended for investigating doses lower than 25g/25l of Ash of rice straws.

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