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UTILIZATION OF BANANA AND PLANTAIN PEELS AS COAGULANTS FOR AQUACULTURE WASTE WATER TREATMENT

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Abstract: This study was aimed at determining the possibilities of utilizing banana and plantain peels as natural coagulants for aquaculture waste water treatment. Banana and Plantain peels were sourced from Kure Ultra-Modern Market, Minna, Niger State. They were air dried, grinded and coagulants active component extracted using methanol. Jar test were carried out using the two bio coagulants, by addition of 0.1ml, 0.2ml, 0.3ml, 0.4ml, 0.5ml and 0.6ml coagulants doses to aquaculture waste water collected from Alrakees Fish Farm, along Shiroro Road, Minna, Niger State. After the jar test, water samples obtained from the optimum doses, untreated water sample were analyzed for their water quality parameters. SPSS 23 was used for the data analysis of water quality parameters obtained, untreated and treated water samples were compared with control sample using Duncan multiple regression test. The turbidity removal effectiveness investigation carried out on bio coagulants, are and found to be 50% and & 73% for banana and plantain peels respectively. While, on data analysis carried out by Duncan method, it shows that there is statistical significance difference between water quality parameters of control, untreated and treated water samples , with exception of temperature that show no significance difference. Conclusively, banana and plantain peels are effective to be used as natural coagulants in aquaculture waste water treatment. It is recommended that for further studies, both bio coagulants should be blended with inorganic coagulants in order to determine their effectiveness.

Keywords: Coagulants, Banana, Plantain, Jar test, Aquaculture, Tannins.

INTRODUCTION

Water is a key substance in all natural and human activities. It regenerates the shape of oceans, seas, rivers, lakes and forests, becoming part of hydrological cycle that is important for the development of ecosystems and human life (Ammar, 2015). Water pollution still poses a serious threat in some part of developed and under-developed nations. Studies show that the major contributors to water pollution are waste from agriculture and agro-based industries such as palm oil processing industries, rubber processing industries, food and beverage processing plants, textile and leather tanneries, and electronic hardware factories etc. Majority of these industries discharge effluents directly into water bodies or formed the major pollutant of the water (Ahmad *et al*., 2003).

Plant-based coagulants (PBC) are broadly utilized for the purification of contaminated water that is in less urbanized, because they seems to be less carrying cost treated coagulates as compared to artificial. PBC coagulants are assumed to treat water showing low-to-medium turbidity range (50–500) NTU. It is unforeseen that a complete decisive analysis of existing PBC is still imaginary in this 21st century. The significance of PBC to ecosystem in the end yield to an instant area for researcher in strengthening the investigation to find inherent resources (Pearse, 2003). Organic polymers (plant and animal based) and inorganic polymers (synthetic like aluminium sulphate $Al_2 (SO4)_3$ and ferric chloride ($FeCl_3$)) may be used as primary coagulants as well as in the more traditional flocculation step of binding already formed small flocs into larger particles in drinking water treatment. Coagulation with inorganic and organic polymers followed by sedimentation can clean up industrial effluent when the flocs formed are dense enough. A major use of organic polymers in water treatment is as a coagulant aid to bridge the coagulated particles formed when aluminum or iron salts have been used as the primary coagulant. Studies have revealed that tannins can be used as an organic polymer that aid in coagulation of waste water particle (Beltrán & Sánchez 2009). Tannins are high molecular weight polycyclic aromatic compounds widely distributed through the plant kingdom, are found in the leaves, fruits, barks, roots and wood of trees (Teh *et al*., 2016).

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Banana and plantain plants are the world's biggest herbs, grown abundantly in many developing countries. Bananas (*Musa sapientum*) and plantains (*Musa paradisiaca*) are one of the most important sources of energy in the diet of people living in tropical humid regions. They belong to the family *Musaceae* and the genus *Musa.* The plant consists of long, overlapping leafstalks and bears a stem which is 1.22 to 6.10 m high, with a life span of about 15 years (Tsado *et al*., 2021).

Musa, a plant genus of extraordinary significance to human societies, produces the fourth most important food in the world today, after rice, wheat, and maize (Scot *et al*., 2006).

The natural coagulants are used in waste water treatments include microbial polysaccharides, starches, gelatin galactomannans, cellulose derivatives, chitosan, glues, and alginate. Coagulants which carry natural characteristics supposed to be harmless for human health, whereas existence of aluminium zest may provoke neurology & pathology diseases. (Rajendran, 2015).

MATERIALS AND METHODS

Preparation of Coagulants Extracts

Coagulants active component for both banana and plantain peels were extracted at the Department of chemistry, Faculty of Natural Sciences, Ibrahim Badamasi Babangida University main campus, Lapai, Niger State, Nigeria. Plant origin material: plantain peel and banana peels were obtained, sun dried, grinded using mortar and pestle into powder form. The grinded components were sieved to remove large particles and 50g of each coagulants was mixed with 200ml of methanol to form 110ml of suspension (approximately 0.25 g/ml concentration). The suspension will be thoroughly mixed using a clean magnetic stirrer for 5 min to extract the active component (tannins), followed by filtration of the solution through a piece of clean white cloth so as to remove solid materials. The filtrate will be centrifuged at 30 rpm for 5 min, followed by filtration using what man filter paper. The obtained stock solutions will be preserved and store until analysis as described by Sunita and Sonal (2014).

Waste Water Sample Collection

Waste water sample from aquaculture ponds was collected from Alrakees Fish Farm, along Shiroro Road, Minna, Niger State. The collected sample was kept in plastic jerry can and store at $0^{o}C$ in laboratory until analysis. Jar tests was conducted for both banana and plantain peels coagulant within 24 hours, after collection of sample.

Jar test Experiment

The jar test experiment was carried out with waste water sample at Water Quality laboratories of Niger State Water and Sewage Corporation, Minna, Niger State. It was carried out using Jar tester machine, which consist of six beakers, mixing paddle gauge at 300 revolutions per minutes (rpm) maximum. The experiment was performed by adding 1000 ml waste water sample (having constant turbidity) and later doses with different concentrations of tannins stock solutions (0.1ml, 0.2ml, 0.3ml, 0.4ml, 0.5ml and 0.6ml) to the six beakers. Firstly, the mixtures were agitated at 300 rpm for 30Secs, then reduced to 100 rpm, 40 rpm and 10 rpm for 2.5, 4 and 14 min respectively. Secondly, followed by Sedimentation for about 45 min, after which 250 ml of samples were collected at approximately 5 cm from the top of water surface for turbidity, pH, conductivity, TDS and temperature.

Determination of Water Quality Parameters of the Untreated and Treated Water Samples

Water Quality Analysis of both untreated and treated waste water sample was carried out at Water Quality laboratories of Niger State Water and Sewage Corporation, Minna, Niger State. After jar test, samples of treated water samples were collected from optimum dosage of both banana (A) and plantain peels (B). These samples together untreated waste water sample as depicted in Plate III, were analyse for water quality parameters: turbidity, pH, temperature, Conductivity, TDS, total hardness, nitrate, phosphate, total coliform and *E.coli* in triplicate, following the procedures described by APHA (2012).

Data Analysis

Descriptive statistic was used to compute for means, standard deviations, minimum and maximum values of data. Analysis of variance (ANOVA) was used to determine significant difference ($P<0.05$). Duncan multiple regression test (DMRT) is used to determine whether such differences occur.

RESULTS

Table 1. Jar Test Result for Six Samples Using Banana as coagulant

Jar Test using Banana Peels

Raw water turbidity:	10.80 NTU
Raw water pH:	8.15
Raw water conductivity:	170.4 µS/cm
Raw water TDS:	255 mg/l
Temperature:	28.8 ^{o}C

Table 1: Jar Test Result for Six Samples Using Banana as Coagulant.

Sample	Dosage (mg/l)	Turbidity (NTU)	pH	Conductivity (µS/cm)	TDS (mg/l)	Temp. (^oC)
1	25	4.39	8.54	185.2	273	28.1
2	50	7.80	8.65	188.5	277	28.2
3	75	6.86	8.36	201	288	28.0
4	100	9.83	8.32	205	294	28.0
5	125	11.1	8.13	212	304	28.2
6	150	12.7	8.04	219	316	28.1

Table 2: Jar Test Result for Six Samples Using Plantain as Coagulant

Jar Test using Plantain Peels

Raw water turbidity: 10.80 NTU

Raw water pH: 8.15

Raw water conductivity: 170.4 µS/cm

Raw water TDS: 255 mg/l

Temperature: 28.8 ^oC

Table 2: Jar Test Result for Six Samples Using Plantain as Coagulant.

Sample	Dosage (mg/l)	Turbidity (NTU)	pH	Conductivity (µS/cm)	TDS (mg/l)	Temp. (^oC)
1	25	2.88	8.58	194.5	278	28.6
2	50	5.17	8.46	195.6	280	28.7
3	75	3.87	8.10	203	288	28.3
4	100	4.52	8.06	205	291	28.8
5	125	5.64	7.90	208	298	28.1
6	150	5.57	7.81	212	307	28.6

Water Quality Analysis

Water Quality Analysis was carried out at Water Quality Control department Laboratory of Chanchaga Water Works and Central laboratory of Niger State Water and Sewage Corporation. Water Quality Analysis of untreated, treated aquaculture water samples obtained from optimum dosages of banana and plantain peels as coagulants, using jar test were presented in Table 3 & 4 respectively.

Table 3: Water Quality Parameters of Control, Untreated with Treated Sample using Banana Peels (A)

Parameter	Control	Untreated	Treated
Turbidity (NTU)	$1.49 \pm .08^a$	$10.78 \pm .15^c$	$4.38 \pm .01^b$
pH	$8.03 \pm .03^a$	$8.14 \pm .01^a$	$8.52 \pm .02^b$
Temp (^oC)	27.90±.95	28.70±.10	28.13±.15
Cond (µS/cm)	50.93 ± 1.28^a	$169.87 \pm .68^b$	$185.40 \pm .20^c$
TDS (mg/l)	76.17 ± 1.62^a	256.33 ± 1.53^b	272.67 ± 1.53^c
TH (mg/l)	47.67 ± 1.15^a	$142.33 \pm .58^b$	146.67 ± 1.15^c
Ni (mg/l)	$1.56 \pm .00^a$	$9.42 \pm .00^b$	$8.06 \pm .00^b$
Phos (mg/l)	$.01 \pm .00^a$	$.05 \pm .00^b$	$.042 \pm .00^b$
TC (CFU/100 ml)	4.70 ± 1.57^a	2209.43 ± 216.94^c	977.23 ± 126.27^b
E.coli (CFU/100 ml)	$.00 \pm .00^a$	$95.67 \pm .15^c$	$65.23 \pm .21^b$

Value tend mean ± SD; minimum towards a maximum (range) means carrying superscript letter into the same row tend significantly different at $p \leq 0.05$

Table 4: Water Quality Parameters of Control, Untreated with Treated Sample using Plantain Peels (B)

Parameter	Control	Untreated	Treated
Turbidity (NTU)	1.49±.08[a]	10.78±.15[b]	2.94±.07[a]
pH	8.03±.03[a]	8.14±.01[a]	8.59±.01[b]
Temperature (^{o}C)	27.90±.95	28.70±.10	28.57±.15
Cond (µS/cm)	50.93±1.29[a]	169.87±.68[b]	194.67±.57[c]
TDS (mg/l)	76.17±1.62[a]	256.33±1.53[b]	275.67±2.08[c]
TH (mg/l)	47.67±1.15[a]	142.33±.58[b]	144.33±.58[b]
Ni (mg/l)	1.56±.00[a]	9.42±.00[c]	6.79±.29[b]
Phos (mg/l)	.01±.00 [a]	.048±.00[b]	.02±.00[a]
TC (CFU/100 ml)	4.70±1.57[a]	2209.43±216.94[c]	462.77±7.28[b]
E.coli (CFU/100 ml)	.00±.00[a]	95.67±.15[b]	19.47±1.45[c]

Value tend mean ± SD; minimum towards a maximum (range) means carrying superscript letter into the same row tend significantly different at p≤0.05

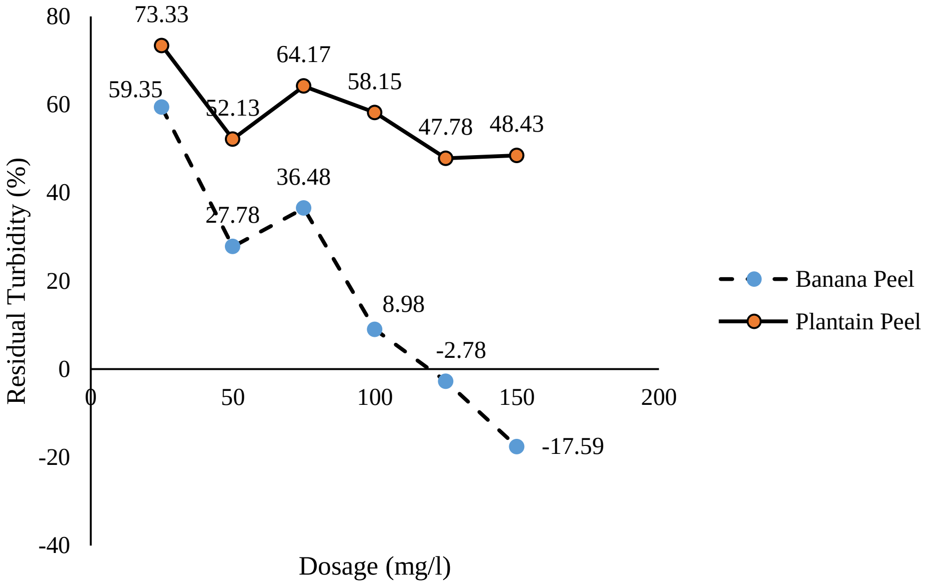

Figure 1: Rate of Residual Turbidity Removal against Different Doses of Coagulants

Discussion

From both Table 1 and Table 2, sample 1 gave best clarity (lower turbidity), therefore the optimum coagulant dose (25 mg/l) for banana and plantain peel. The optimum coagulants doses were discovered at turbidity of 4.39 NTU and 2.88 NTU. Also, Figure 1, shows optimum rate of residual turbidity removal for banana, plantain peel, which are 59.35 %, 73.33 %, while the least are at -17.59% and 47.78%. Therefore conclusively, percentage effective optimum turbidity removal using both banana and plantain peels are 59.35 % and 73.33 % respectively. These shows that using plantain peels as coagulant performed better in turbidity removal than banana peel.

Also, it is noticed from Table 1 & 2, that TDS and Conductivity values for banana peels increases from 273, 277, 288, 294, 304 to 316 mg/L and 185.2, 188.5, 201, 205, 212 to 219 µS/cm. Similarly for plantain peels increases from 278, 280, 288, 291, 298 to 307 mg/L and 194.5, 195.6, 203, 205, 208 to 212 µS/cm. While the pH values for both coagulants, at all doses fall within Nigerian Standard for Drinking Water Quality of 6.5-8.5, this results are in agreement with the findings of (Ahmed, 2022).

The results from this research findings are also in conformity with several review literature in reference to turbidity removal efficiency using natural coagulants by jar test, this was seen in studies carried out by: (Tasneembano & Arjun 2013), (Saravanan et al., 2017), (Priyatharishini et al., 2019), (Nur Aina et al., 2020), (Azamzam et al., 2022). Depending on the dosing rate, it is discovered that turbidity removal efficiency range from 15%-92%, with mean value of 61.18%. While considering banana peel as coagulants it range from 15-88% with mean value of 61.33 %. For present study it range from 59.35-73.33% with mean value of 66.34%. The turbidity removal efficiency determine in the present study shows consistence with the ones in the literature.

Table 3 shows physicochemical properties of untreated and treated aquaculture waste water using banana as coagulant. It is noticed for turbidity, pH, temperature, conductivity, TDS, total hardness, nitrate values for treated water sample range from 4.37- 4.39 NTU, 8.52-8.54, 28-28.1oC, 185.2-185.6 µS/cm, 271-274 mg/l, 146-148 mg/l, 8.055-8.059 mg/l fall within Nigerian Standard for drinking water quality (NSDWQ) 5 NTU, 6.5-8.5, ambient, 1000 µS/cm, 500 mg/l, 150 mg/l, 50 mg/l, with exception of total coliform and

E. coli (1111.2 CFU/100 ml, 65 CFU/100 ml) which are above (10 CFU/100 ml, 0 CFU/100 ml). This finding was also reported by (Ahmed, 2022).

Similarly, Table 4 shows physicochemical properties of untreated and treated aquaculture waste water using plantain as coagulant. It is noticed for turbidity, pH, temperature, conductivity, TDS, total hardness, nitrate values for treated water sample (range from 2.88-3.01 NTU, 8.58-8.6, 28.4-28.6oC, 194.2-195.3 µS/cm, 274-278 mg/l, 144-145 mg/l, 6.5-7.072 mg/l) fall within Nigerian Standard for Drinking Water Quality (NSDWQ) [5 NTU, 6.5-8.5, ambient, 1000 µS/cm, 500 mg/l, 150 mg/l, 50 mg/l), with exception of total coliform and E .coli (2419.6 CFU/100 ml, 95.5 CFU/100 ml) which are above NSDWQ value (10 CFU/100 ml, 0 CFU/100 ml).

CONCLUSION

Using banana and plantain coagulants in aquaculture show promising performance. The effectiveness of turbidity removal is in consistence with the ones obtained in the literature. It also observed, using plantain peel as coagulant perform better than banana peel. Also data analysis SPSS on control, untreated and treated water samples shows that there is significance difference among water quality parameters, except for temperature.

Recommendation

Blending of both coagulants with inorganic coagulants and studying their effectiveness. Untreated and treated water samples, should be analysed for wider water quality parameters such as fluoride, chloride and iron.

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