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# Evaluation of Potential of Activated Locust Bean Pod as a Coagulant for Domestic Sewage Treatment

**Akpenpuun, T. D., Adeniran, K. A.**
Department of Agricultural and Biosystems Engineering, University of Ilorin, P.M.B. 1515, Ilorin, Nigeria

**Akinyemi, B. A.**
Department of Agricultural and Biosystems Engineering, LandMark University, Omu-Aran, Nigeria

**Sulaiman, M. F., Adelodun, B.**
Department of Agricultural and Biosystems Engineering, University of Ilorin, P.M.B. 1515, Ilorin, Nigeria

**Corresponding author:** akpenpuun.td@unilorin.edu.ng
Department of Agricultural and Biosystems Engineering, University of Ilorin, P.M.B. 1515, Ilorin, Nigeria

An investigation was carried out on the coagulation potential of the activated locust bean pod in comparison with aluminium sulphate (alum) in the treatment of domestic sewage. The treatments included control culture (water without alum and activated locust bean pod treatment), 3.5 g/L of the activated locust bean pod, 4.5 g/L of the activated locust bean pod and 4.5 g/L of alum. All the treatments were cultured in 16-litre buckets. Physical, chemical and bacteriological properties of domestic sewage were determined before and after the application of the coagulants on a weekly basis. The result showed that 1.14 NTU of turbidity was removed from an initial value of 6.34 NTU using 4.5 g/L of the activated locust bean pod. For the samples treated with 4.5 g/L of alum, turbidity reduced to 0.36 NTU, while 0.46 NTU was removed from the control experiment. pH values show that the pH of the samples decreased from6.83 to 4.05, 6.83 to 6.00and 6.83 to 6.15 for the activated locust bean pod, alum and the control tanks, respectively. The result shows that the activated locust bean pod acidified waste water. The result showed that 3.5 g/L and 4.5 g/L of the activated locust bean pod and alum removed about 0.98% and 1.90% of $BOD_5$, respectively, while $BOD_5$ in the control experiment reduced by 0.26% from the initial value of 6. A significant removal of coliform counts activated locust bean pod was observed. The study shows that the activated locust bean pod can be used in place of alum, which is dependent on the end use of treated water.

**Keywords:** coagulation, activated locust bean pod, aluminium sulphate, wastewater.

## Introduction

The African locust bean tree (*Parkiabiglobosa*) is a vascular and deciduous perennial tree legume, belonging to the sub-family Mimosodeae and family leguminosae. *Parkiabiglobosa* is an important multipurpose tree from the savannah zone of West Africa. The plant increases soil fertility, grows to about 20 to 30 m in height and has dark, evergreen, pinnate leaves. Its fruit is a brown, leathery pod of about 10 to 30 cm long and contains gummy pulp of an agreeable sweet taste, in which there is a number of seeds (Aguwa *et al.,* 2016). It is found in a wide range of environment in Africa and primarily grown for its pods that contain both sweet pulp and valuable seeds. The tree is fire resistant and is characterized by a thick dark grey brown bark (FAO 2017, Orwa *et al*., 2009, Sina *et al.,* 2002). The pods commonly referred to as the locust bean are pink at the formation stage of development but become dark brown at maturity. The pods are about 30 to 40 cm long and contain about 30 seeds. The seeds of the locust bean are used for food seasoning in almost all parts of Nigeria and are popularly known as Dawadawa in northern Nigeria while the Yorubas call it iru. The seeds are used extensively as seasoning and nutritious additives to soups and stews as well as a good source of essential amino acids (Aguwa *et al.,* 2016). Every part of the plant (leaves, flowers, seeds, roots and bark) can be used as food and have been found to be medicinal and therapeutic in nature (Okuda *et al.,* 2000). The pod also has been investigated and it has been shown that when activated it can be used as a primary coagulant in drinking water clarification, wastewater treatment and the removal of nitrogen and phosphorus. Several chemical coagulants have been used in conventional water treatment and these chemicals include inorganic, synthetic organic polymer and naturally occurring coagulants (Okuda *et al.,* 2000, Akpenpuun *et al*., 2016). Generally, alum (aluminium sulphate), a chemical coagulant and its synthetic polymeric derivatives are widely used in water treatment. On the other hand, there is evidence that the uses of extracts from plant species possessing both coagulating and antimicrobial properties are safe for human health (Ali *et al.*, 2004, Adeniran *et al.,* 2016). Using coagulants from biodegradable sources like plants, animals and microorganisms have attracted interest in finding a replacement for alum and have reduced dependency on alum usage. Other chemicals used in the purification of water due to have some level of a negative effect on human and agricultural product. As a result, biological coagulants are preferred to chemical coagulants. The main objective of this study was to investigate the coagulating potential of the activated locust bean pod as alternative and cheap local coagulating material in treating domestic wastewater. However, the performance of the bio-coagulant is dependent on activation, dosage and the level of pollution of domestic wastewater.

## Materials and methods

### Experimental location

A series of laboratory tests were carried out in order to compare the effectiveness of activated carbon from the African locust bean pod and aluminium sulphate (alum) in wastewater treatment. There is a need to conduct laboratory analysis on the activated locust bean pod and alum to identify the similarity in them. The analyses carried out on the wastewater samples included physiochemical and bacteriological tests. The study was carried out at the Department of Agricultural and Biosystems Engineering, University of Ilorin, Ilorin, Nigeria. The study was in a screened environment where parameters like human activities, rainfall, solar intensity, and other effects that may affect the outcome of the experiment were avoided.

The procedure of the locust bean pod activation was as follows:

a the raw locust bean pods were ripped open while the yellowish pulp and seeds were removed from the pods; the empty pods were the raw material needed;

b the pods were washed with water to remove impurity and then dried in the open for 48 hours;

c the pods were then placed in a crucible and charred in a furnace at 400 to 450$^{o}$C for 10 hours;

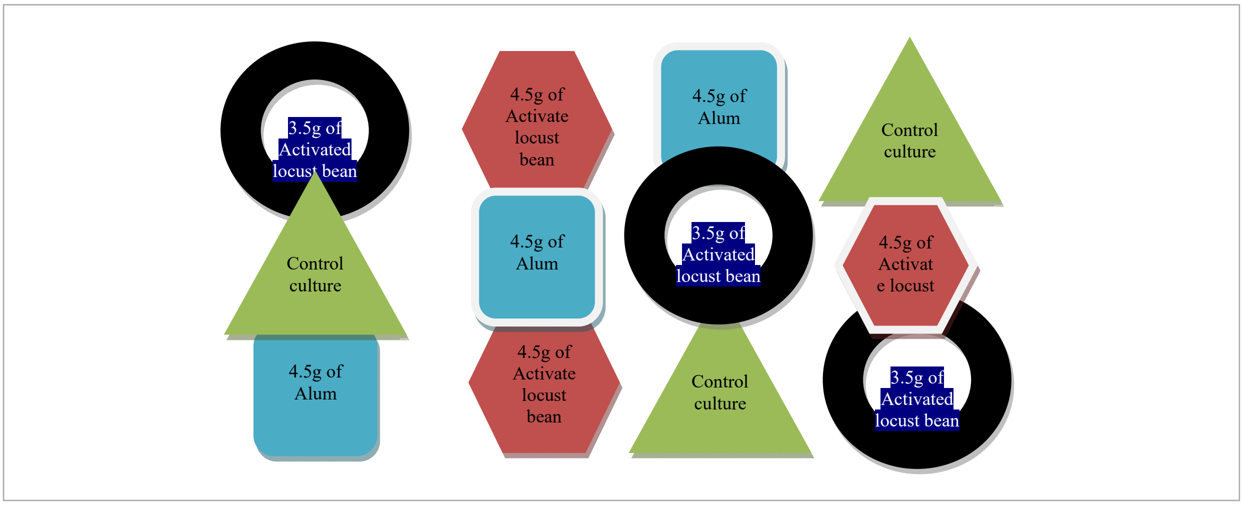
d the furnace was allowed to cool for 24 hours before the charred pods were removed;

e the charred pods were activated using phosphoric acid after being soaked for 18hours;

f the activated charred pods were dried in the oven at emperature of 105°C for 3hours and then kept in the desiccators.

**Fig. 1**

A completely randomized design experimental setup of wastewater treatment




### Sewage sampling

The sewage sample for the test was collected from the University of Ilorin School Canteen, Ilorin, Kwara State, Nigeria. The physical, chemical and bacteriological properties were determined using the procedures recommended by ISO 5815-1 (2003), ISO 5814 (2012), ISO 6060: (1989), IS 3025 (2009), (Part 21) and ISO 7027-1, (2016).

### Experimental design

The experimental design used for this study was completely randomized design (CRD) replicated 3 times. The experimental layout is shown in Figure1. Domestic sewage water was collected into twelve 25-litre capacity plastic containers. Four plastic containers were used for the control, while 3 plastic containers each were activated with 2.5g and 4.5g of the locust bean pod, and 4.5g of alum was introduced to 3 containers.

### Sample collection

Two-litre samples were dished out from each of the twelve 25-litre capacity plastic containers into which the activated locust bean pod and alum were introduced after every 7 days. The sample bottles were labelled with date and time of collection, and initial volume. The 2-litre samples were stored in a cool dry dark place and physiochemical parameters were determined after 2 hours of collection in accordance to APHA (2006). The physiochemical parameters considered included hardness, alkalinity, total suspended solids, total solids, dissolved oxygen, total dissolved solids, electrical conductivity, acidity, pH, turbidity, chemical oxygen demand (COD), biochemical oxygen demand ($BOD_5$) and bacteriological parameters.

## Results and discussions

### Physio-chemical parameters

Tables 1 to 9 are the analysis of variance of the physiochemical and bacteriological analysis performed on the sewage samples collected during the period of study (9 May – 27 June 2016).

### Hardness

Table 1 and Figure 1 show the analysis of variance

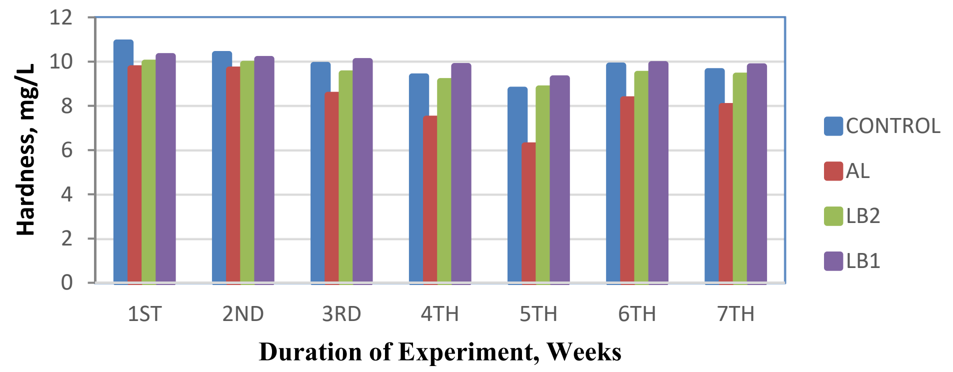
**Table 1**

ANOVA for hardness

| | Sum of squares | df | Mean square | F | Sig |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Treatments | 13.78 | 4 | 4.72 | 2.17 | 0.14 |
| Errors | 35.44 | 22 | 2.16 | | |
| Total | 49.2226 | | | | |

**Fig. 2**

Effect of coagulants on hardness




LB1=4.5mg/L of activated carbon, LB2=3.5mg/L of activated carbon, AL=4.5mg/L of alum

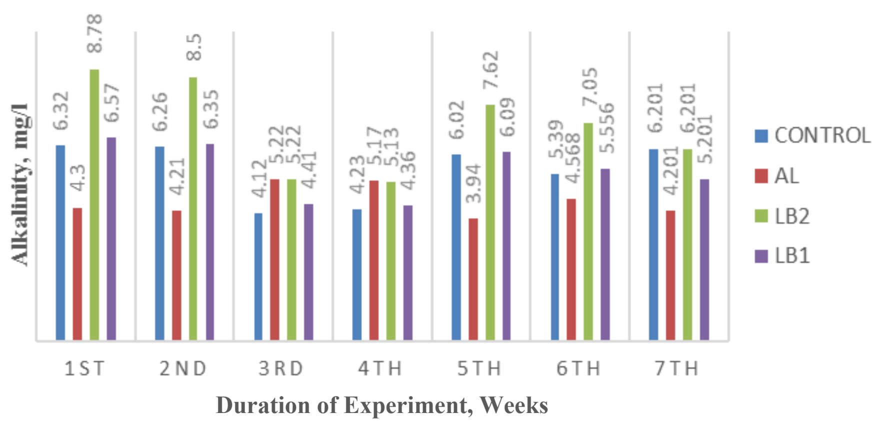
of the physiochemical and bacteriological analysis, and the level of hardness, respectively. Total hardness at the point of collection was 12.8 mg/L but reduced to 8.73 mg/L, 8.52 mg/L, 8.79 mg/L and 7.21 mg/L for the control, 3.5g activated locust bean pod, 4.5g activated locust bean pod and 4.5g alum treatments, respectively. The result shows that alum was more effective in hardness removal than the locust bean pod activated carbon. The ANOVA result in Table 1 shows that the treatment with alum was significant with a *p* value of 0.14 and F-statistics of 2.17 at a significance level of $p$=0.05.

### Alkalinity

The alkalinity at the point of collection was 6.50 mg/L for all treatments, which was in line with what has been established by other researchers that the alkalinity of raw domestic wastewater is slightly higher than that of potable water. As seen in Figure 3, alkalinity decreased to 6.02 mg/L, 6.09 mg/L, 7.62 mg/L, and 5.94 mg/L for

**Fig. 3**

Effect of coagulants on total suspended solid




LB1=4.5 mg/L of activated locust bean pod, LB2=3.5 mg/L of activated locust bean pod, AL=4.5 mg/L of alum

**Table 2**

Statistical analysis of alkalinity using ANOVA

| | Sum of squares | df | Mean square | F | Sig |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Treatments | 14.19 | 4 | 4.07 | 29.34 | 0.00 |
| Errors | 2.42 | 24 | 0.14 | | |
| Total | 16.6126 | | | | |

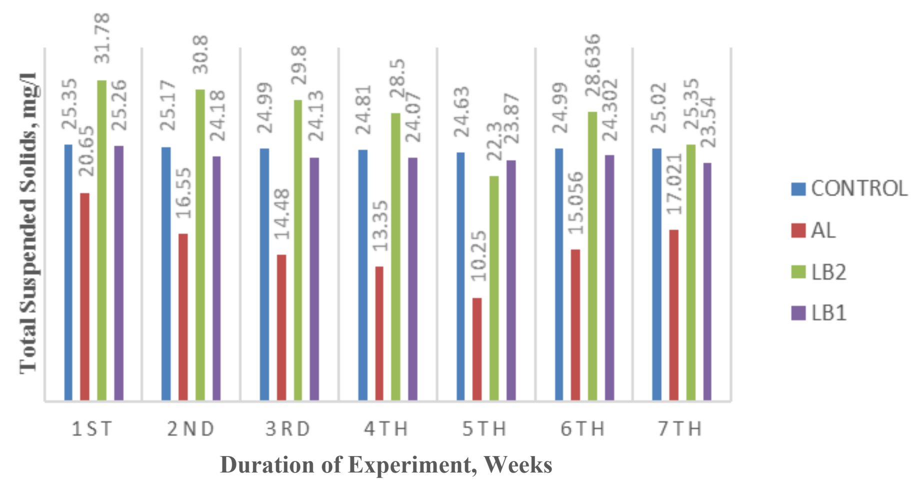
the control culture, 3.5g and 4.5g activated locust bean pod, and alum, respectively. The ANOVA Table2 shows also that the removal of alkalinity by alum was significant at the significance level of 0.05 ($F_{statistics}$=29.34).

## Total Suspended Solids

The permissible total suspended solid (TSS) in effluent recommended by the WHO is 50 mg/L. The total suspended solids level of the sample at the point of collection (25.50 mg/L) of the samples was lower than the permissible level recommended by the WHO standard. TSS after treatment with 4.5g of alum, 3.5g and 4.5g of activated locust bean pod reduced to 23.87 mg/L, 22.30 mg/L and 18.25 mg/L, respectively, as shown in Figure 4. For the control experiment, TSS was 24.63 after the seventh week of the experiment. It was observed that the treatment with alum was significant at $p$ = 0.05 ($F_{statistics}$=13.32) as shown in Table 3.

**Fig. 4**

Effect of coagulants on Total Suspended Solids




LB1=4.5 mg/L of activated locust bean pod, LB2=3.5 mg/L of activated locust bean pod, AL=4.5 mg/L of alum

**Table 3**

ANOVA of Total Suspended Solids

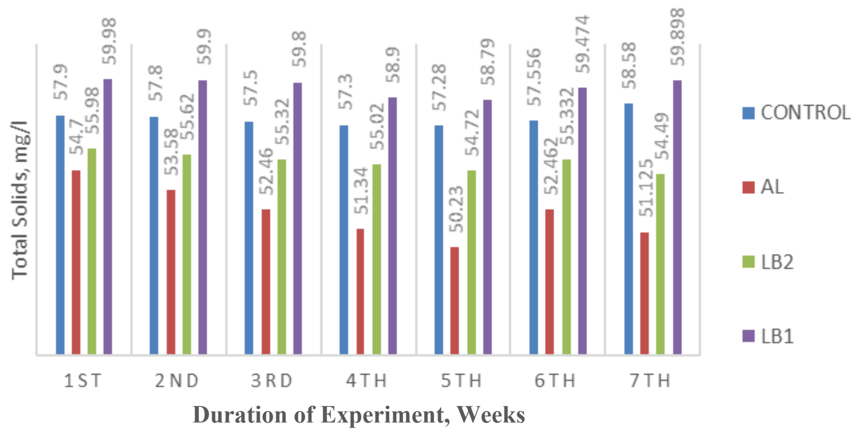
| | Sum of squares | df | Mean square | F | Sig |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Treatments | 173.534 | 4 | 57.46 | 13.32 | 0.00 |
| Errors | 68.58 | 22 | 4.36 | | |
| Total | 242.12 | 26 | | | |

## Total Solids

Total solid (TS) at the point of collection was 59.8 mg/L. The average drop of total solid after the seventh week of the experiment was 58.79 mg/L, 57 mg/L and 54.72 mg/Land 50.23 mg/L for the control culture, 3.5g and 4.5g activated locust bean pod and 4.5g alum, respectively. Figure 5 shows that the alum treatment in this treatment against TS also stood out. Table 4 further shows that alum was effective in the removal of TS.

### Figure 5

Effect of coagulants on Total Solids




LB1=4.5 mg/L of activated carbon, LB2=3.5 mg/L of activated carbon, AL=4.5 mg/L of alum.

### Table 4

ANOVA of Total Solid

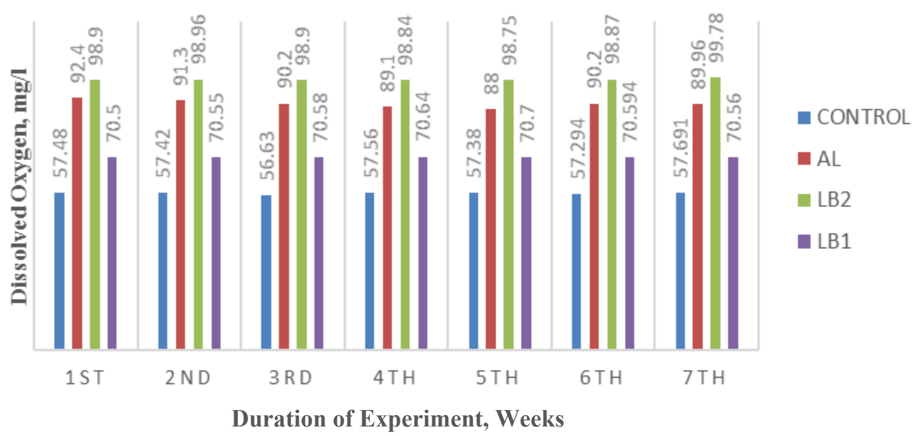
| | Sum of squares | df | Mean square | F | Sig |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Treatments | 116.59 | 4 | 38.34 | 17.13 | 0.00 |
| Errors | 36.98 | 22 | 2.35 | | |
| Total | 153.57 | 26 | | | |

## Dissolved Oxygen

The initial dissolved oxygen recorded before the experiment commenced was 98.90 mg/L as shown in Figure 6. The treatment with 3.5g and 4.5gof activated locust bean pod carbon resulted in the level of DO from 57.48 mg/L to 99.780 mg/L and 70.56 mg/L, respectively. However, the treatment with 4.5g of alum resulted in 89.96 mg/L. At the end of the seventh week, it was observed that there were somesmall organisms in the water during the course of the experiment. The

### Fig. 6

Effect of coagulants on dissolved oxygen



presence of organisms in the water samples signified an increment in the level of DO. The water sample treated with 4.5mg/L of the activated locust bean pod recorded a lower DO level than 3.5 mg/L of the activated locust bean pod and 4.5 mg/L of alum. This could be attributed to the fact that this particular sample had a higher bacterial activity. The ANOVA test result in Table 5 further shows that the comparison of the means was significant ($p$ = 0.008) at $p$ = 0.05.

**Table 5**

ANOVA for Dissolved Oxygen

| | Sum of squares | df | Mean square | F | Sig |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Treatments | 18.653 | 4 | 6.32 | 5.81 | 0.00 |
| Errors | 17.132 | 22 | 1.08 | | |
| Total | 35.785 | 26 | | | |

### Total Dissolved Solids

Total dissolved solid (TDS) at the point of collection was 39.82 mg/L, which shows that wastewater was at the minimal level of pollution. However, there was a significant reduction in its level at the end of the experiment to 34.50 mg/L for the control culture, 24.20 mg/L and 22.64 mg/L for 3.5g and 4.5g of the activated locust bean pod, respectively, and to 34.05 mg/L for 4.5g of alum. The treatment with the activated locust bean pod showed a significant decrease in total dissolved solids in the course of the experiment as shown in Figure 7, the WHO permissible level being at 500 mg/L. The ANOVA test result in Table 6 further shows significant differences in the mean values ($p < 0.05$) at $p$ = 0.05.

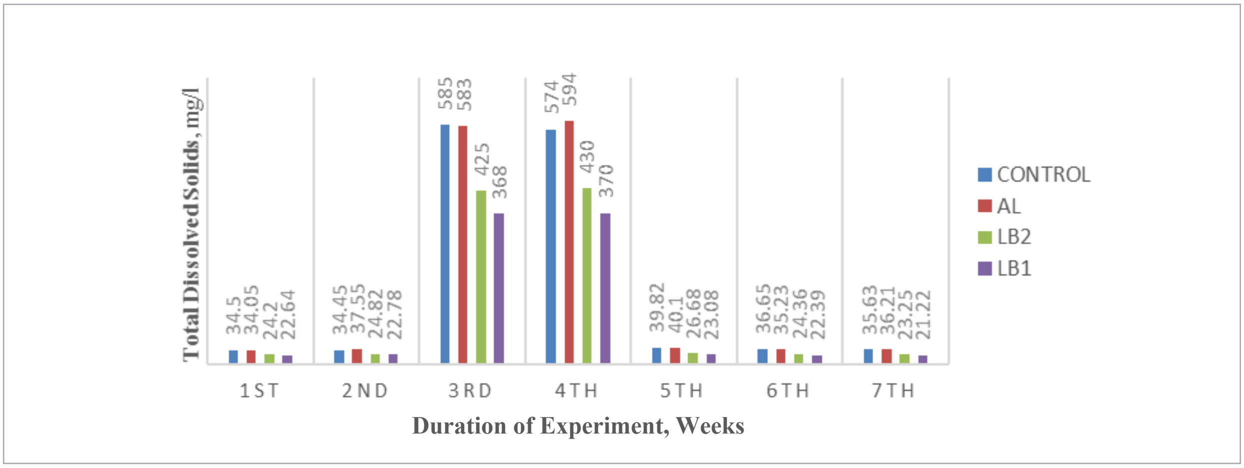
**Table 6**

ANOVAof Total Dissolved Solid

| | Sum of squares | df | Mean square | F | Sig |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Treatments | 19.652 | 4 | 6.23 | 5.81 | 0.00 |
| Errors | 16.133 | 22 | 1.07 | | |
| Total | 35.785 | 26 | | | |

**Fig. 7**

Effect of coagulant on total dissolved solid




### Electrical Conductivity

Electrical conductivity (k) is a measure of the ability of an aqueous solution to carry an electric current. This ability depends on the presence and concentration of ions, mobility and valence, and on the temperature at which it is measured. Molecules of organic compounds that do not dissociate in an aqueous solution conduct current poorly, if at all. It is on record that the conductivity is affected by acidity. In this context, at the point of collection, electrical conductivity was 595 ɥs$^{-1}$ and it decreased to 565 ɥs-1, 379 ɥ$^{s-1}$, 435 ɥ$^{s-1}$and 583 ɥ$^{s-1}$for the control, 3.5g activated locust bean pod, 4.5g activated locust bean pod and4.5g alum, respectively. These readings are far below the recommended WHO standard of 1,400 ɥs$^{-1}$. The ANOVA test analysis in Table 7 shows that the treatments had an effect on the level of electrical conductivity of the effluent.

### Table 7

ANOVA of Electrical Conductivity

| | Sum of squares | df | Mean square | F | Sig |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Treatments | 4,323.80 | 4 | 1,440.93 | 4.10 | 0.03 |
| Errors | 5,532.40 | 22 | 352.40 | | |
| Total | 9,856.20 | 26 | | | |

## Acidity

The quantitative capacity of water to react with a strong base given a particular pH is its acidity. The level of acidity reflects a change in the quality of the water source. In this experiment, it was recorded that the acidity of the samples was 5.32 mg/L at the point of collection. At the end of the experiment, which lasted for 7 weeks, 3.5gof the activated locust bean pod and 4.5g of the activated locust bean pod resulted to a drop in the acidity of the wastewater by 3.22 mg/L and 3.25mg/L, respectively, while 4.5g of alum caused a rise in the acidity of the wastewater by 5.69 mg/L. The ANOVA result in Table 8 shows that the treatments were significantly different ($p$ = 0.004) at 0.01 (Fcal=8.172).

### Table 8

ANOVA for acidity

| | Sum of squares | df | Mean square | F | Sig |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Treatments | 1.349 | 4 | 0.45 | 8.172 | 0.004 |
| Errors | 0.884 | 22 | 0.06 | | |
| Total | 2.233 | 26 | | | |

## pH

The pH at the collection point was 7.20, which is between the WHO standard range of pH for wastewater (6.5–7.5). The pH for the control experiment was 6.10after the duration of the experiment, 4.05 and 6.83 for 3.5g and 4.5 gactivated locust bean pod and 6.00 for 4.5galum. At the end of the experiment, the sample treated with 3.5g of the activated locust bean pod was acid, while the sample treated with 4.5g of the activated locust bean pod remained neutral and within the WHO standard range. The sample treated with 4.5g of alum, however, became slightly acid and fell below the WHO standard range. The ANOVA test in Table 9 shows the mean values with $F_{cal}$=23.762 and with significant values at $p$=0.009.

### Fig. 8

Effect of coagulation on pH

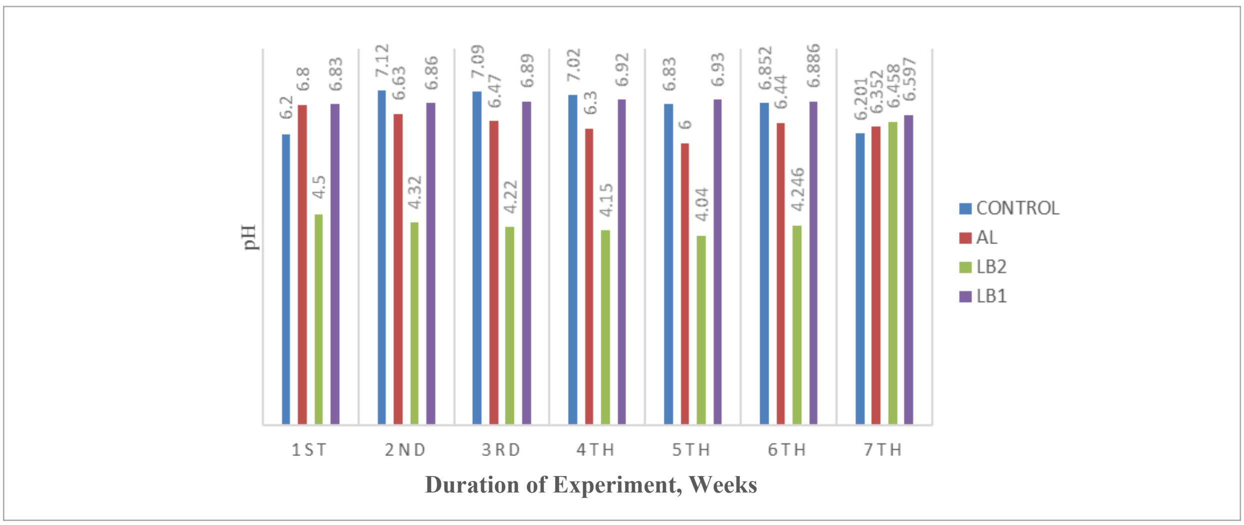


**Table 9**

ANOVA for pH

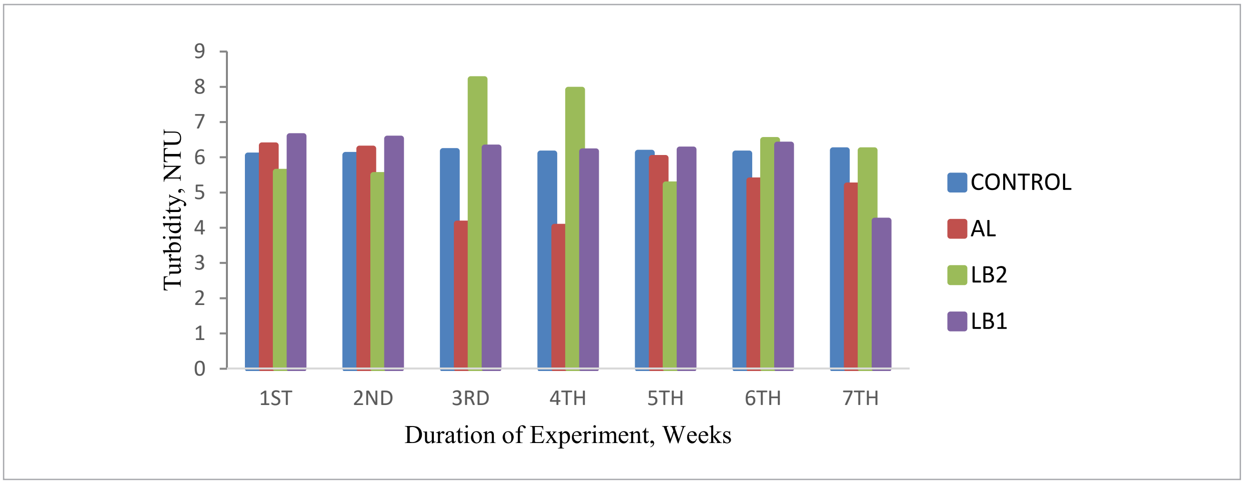
| | Sum of squares | df | Mean square | F | Sig |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Treatments | 17.938 | 4 | 5.98 | 3.762 | 0.009 |
| Errors | 4.055 | 22 | 0.25 | | |
| Total | 21.993 | 26 | | | |

## Turbidity

Turbidity in water is caused by suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter, and other microscopic organisms. Turbidity at the point of collection was 6.06 NTU. At the completion of the experiment as shown in Figure 9, turbidity was reduced to 4.70 NTU and 5.98 NTU by 3.5g of the activated locust bean pod and 4.5g of alum, respectively, but increased to 6.40 NTU by4.5g of the activated locust bean pod. The control sample and the sample treated with 4.5g of the activated locust bean pod had the same reading of 6.40 NTU at the end of the experiment. This shows that an increment in the dosage of the activated locust bean pod beyond 3.5g will have no significant effect on the removal of turbidity, but rather will increase the total number of suspended solids. All the readings recorded in all the experimental samples were above the WHO standard value of 5 NTU.

**Fig. 9**

Effect of coagulant on turbidity




## Chemical Oxygen Demand (COD)

The COD at the time of collection was 8.92 mg/L, while the recommended WHO value for COD is 10 mg/L. It was observed that 3.5g of the activated locust bean pod recorded the lowest COD value of 6.78 mg/L, while 4.5g of the activated locust bean pod recorded the highest value of COD of 9.50mg/L after the treatment. The readings for the control experiment and 4.5g of alum were 8.85 mg/L and 8.37 mg/L, respectively. Shown in Figure 10 and Table 10 are the result and a range of COD for various kinds of water. It can be observed that all the readings recorded during the experiment were below those listed in the table. This goes to show that the effluent from this experiment could be discharged in any water course.

**Table 10**

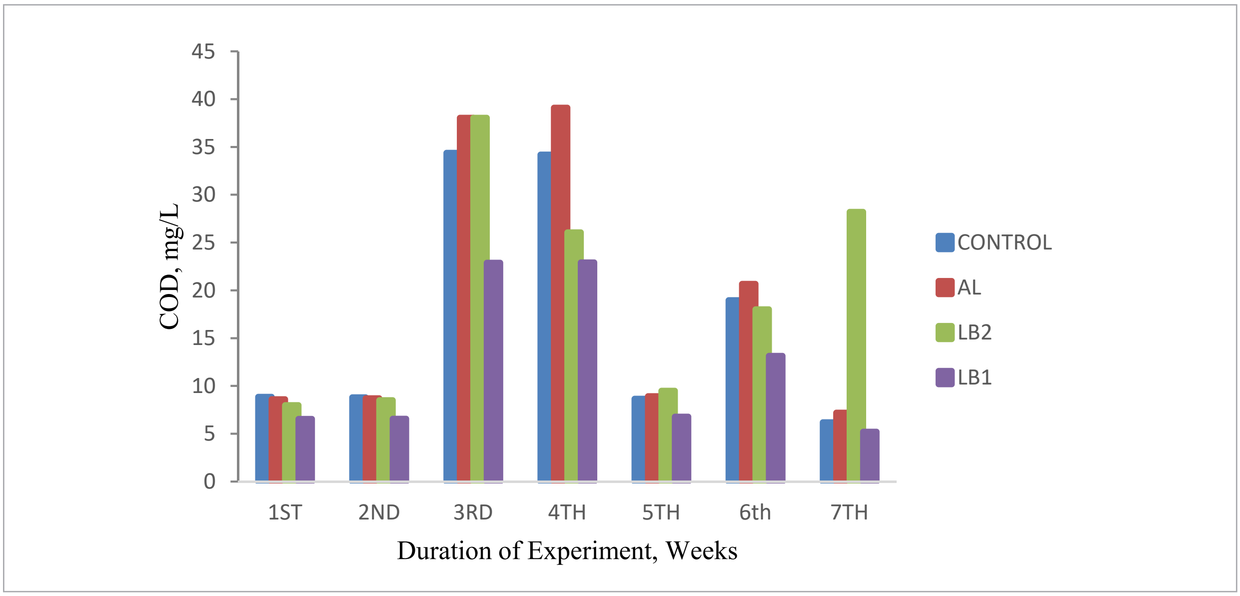
Range of COD found in various domestic wastewaters

| Sources | Normal COD range, mg/L |
|---|---|
| 1 | 2 |
| Plant effluent | 300–700 |
| Primary effluent | 200–400 |
| Trickling filter effluent | 45–130 |
| Activated sludge | 30–70 |
| Activated waste treatment | 5–15 |

Source: American Water Association and Water Environmental Federation (1998)

**Fig. 10**

Effect of coagulation on chemical oxygen demand

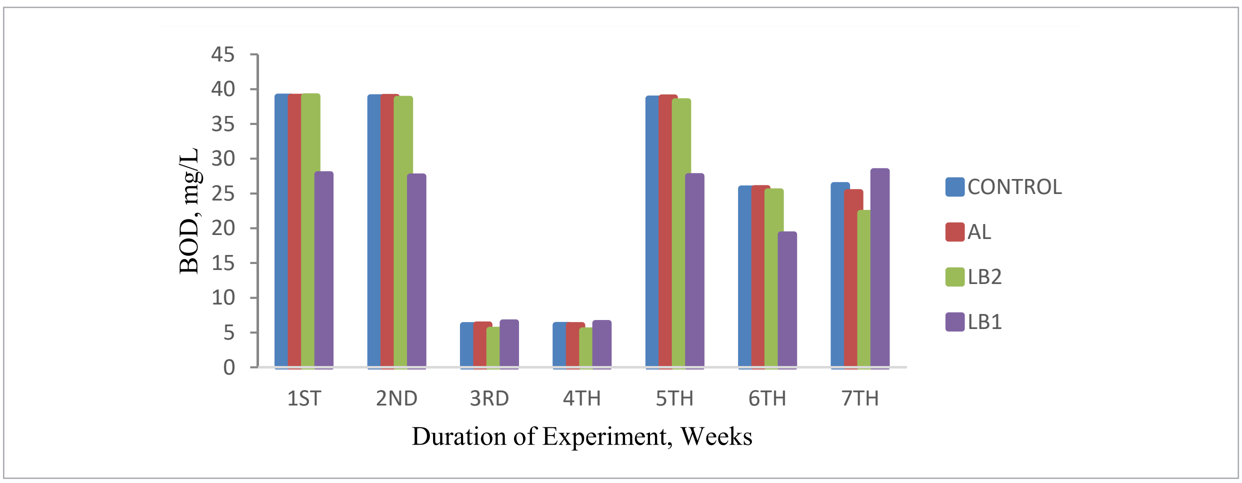



## Biochemical Oxygen Demand ($BOD_5$)

The Biochemical Oxygen Demand (BOD) has its widest application in measuring waste loadings to treatment plants and in evaluating the efficiency of such treatment systems. Shown in Figure 11 is the result of the $BOD_5$ obtained in the course of the experiment. From the collection point, the BOD level of wastewater was 38.92 mg/L; in the process, it became 38.82, 27.49 and 38.25 mg/L for the control culture, 3.5g and 4.5g activated locust bean pod. $BOD_5$ in the 4.5g alum treated sample was 38.82 mg/L, the WHO permissible level being at 50 mg/L. The implication of the result is that 3.5g of the activated locust bean pod is the optimum dosage for BOD treatment. The response of the sample to treatment for $BOD_5$ follows the same trend as the treatment for turbidity. It was also

**Fig. 11**

Effect of coagulation on Biochemical Oxygen Demand



observed that the treatment with 4.5 g of alum had no significant effect on the level of $BOD_5$.

### Bacteriological parameters

E-coli count was very high due to growth and multiplication of micro organisms in all the treatments. At the time of collection, E-coli count was 391 per Cc, while at the end of the experiment 348 per Cc, 217 per Cc and 241 per Cc were recorded for 3.5g activated carbon, 4.5g activated locust bean pod and 4.5g of alum, respectively, as presented in Table 11. By the fifth week, the total viable counts (TVC) reduced greatly in the alum treatment tank and the activated locust bean pod.

**Table 11**

Average bacterial count

| Description | Colonies on nutrient agar (Cc) | Coliform organism (100 Cc) | E.coli per (100 Cc) |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| Point of collection | >300 | 180+ | 391 |
| 3.5g activated carbon sample | >300 | 180+ | 348 |
| 4.5g activated carbon sample | >300 | 180+ | 217 |
| Alum sample | >300 | 180+ | 241 |

## Conclusion

The following conclusions were drawn from the study:

1. activated locust had an effect on the pH of the water as compared with alum since the pH value was within the WHO range;
2. the activated locust bean pod caused a reduction in the bacteriological parameters because the total viable counts were significantly reduced due to high adsorption of bacteria.

## Recommendations

1. The activated locust bean pod (*pakiabiglobosa* pod) can be used to replace alum or can be used in combination with alum in wastewater treatment. Using the activated locust bean pod in combination with alum will reduce the quantity of alum, which will invariably reduce the cost of treatment.
2. Instead of wasting the pod of *parkiabiglobosa* as done in most rural communities in Nigeria, the use of the locust bean pod as activated carbon should be encouraged since it is cheap and abundant in Nigeria. This will also reduce environmental pollution.

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# Saldžiavaisio pupmedžio ankšties potencialo įvertinimas kaip koaguliantas buitinėms nuotekoms

**Akpenpuun, T. D., Adeniran, K.A.**
Žemės ūkio ir biologinių sistemų inžinerijos katedra, Ilorin Universitetas, Nigerija

**Akinyemi, B. A.**
Žemės ūkio ir biologinių sistemų inžinerijos katedra, LandMark Universitetas, Nigerija

**Sulaiman, M. F., and Adelodun, B.**
Žemės ūkio ir biologinių sistemų inžinerijos katedra, Ilorin Universitetas, Nigerija

Buvo atliktas tyrimas su saldžiavaisio pupmedžio ankštimis, kurio metu buvo įvertintas jo kaip koagulianto potencialas buitinėms nuotekoms valyti su aliuminio sulfatu. Nuotekų apdorojimo metu buvo numatytos tokios medžiagos: (vanduo be aliuminio sulfato ir be aktyvuotos saldžiavaisio pupmedžio ankšties), 3,5 g/L saldžiavaisio pupmedžio ankštis, 4,5 g / l aktyvintos saldžiosios pupelės ir 4,5 g aliuminio sulfato. Visas nuotekų apdorojimas buvo atliekamas 16 litrų kibiruose. Buitinių nuotekų fizinės, cheminės ir bakteriologinės savybės buvo nustatomos kas savaitę prieš ir po koaguliacijos. Rezultatas parodė, kad 1,14 NTU drumstumas buvo pašalintas iš pradinės vertės 6,34 NTU, naudojant 4,5 g/l aktyvinta saldžiavaisio pupmedžio ankštis. Mėginiams, apdorotiems 4,5 g / l aliuminio sulfatu, drumstumas sumažėjo iki 0,36 NTU, o kontrolinis eksperimentas buvo pašalintas 0,46 NTU. pH reikšmės rodo, kad mėginių pH sumažėjo nuo 6,83 iki 4,05, nuo 6,83 iki 6,00 ir nuo 6,83 iki 6,15, atitinkamai naudojant aktyvintas saldžiavaisio pupmedžio ankštis, aliuminio sulfatą kontrolinėse talpyklose. Rezultatai parodė, kad aktyvuota saldžiavaisio pupmedžio ankštis nuotekų rūgštingumą padidino. Rezultatai parodė, kad 3,5 g / l ir 4,5 g / l aktyvinta saldžiavaisio pupmedžio ankštis ir aliuminio sulfatas pašalino apie 0,98% ir 1,90% $BOD_5$ atitinkamai, o $BAD_5$ kontroliniame eksperimente sumažėjo 0,26% nuo pradinės vertės 6. Pastebėtas reikšmingas koaguliacijos aktyvumas su saldžiavaisio pupmedžio ankštimis. Tyrimas rodo, kad vietoj aliuminio sulfato gali būti naudojama aktyvuota saldžiavaisio pupmedžio ankštis, priklauso nuo galutinio apdoroto vandens naudojimo paskirties.

**Raktiniai žodžiai:** koaguliacija, aktyvuotas saldžiavaisio pupmedis, aliuminio sulfatas, nuotekos, vanduo.