BIO-COAGULANTS FOR THE REMOVAL OF METALS FROM DAIRY WASTEWATER INDUSTRY

Abstract

Coagulation is a simple and widely used method of water treatment. Chemical coagulants, on the other hand, not only produce vast volumes of toxic sludge, but they also have negative impacts on living creatures and human health. This study demonstrates the use of neem tree leaf and banana leaf powders as natural coagulants for the treatment of dairy effluent. The jar test was used to determine the pH, turbidity, and metal ion content of the treated samples. For both neem leaf and banana leaf powders, the biocoagulant dosages utilized in the jar test were 100 mg/L, 200 mg/L, and 300 mg/L, with a pH of 5, 6 and 7. The efficiency of the natural coagulants was determined by the reduction of turbidity and the proportion of metals like Na, K, Ca, Ba, Li, and copper that were removed during the treatment process. Turbidity was reduced by 52%, and coagulants at 200 mg/L and 300 mg/L were more successful than 100 mg/L at removing metal ions from dairy effluent. When it came to copper removal, 100 mg/L was shown to be more effective than 200 mg/L and 300 mg/L. In the scattering between adjacent, similarly charged particles, the zeta potential also reveals the strength of repulsive powers. There is more dispersion and suspension rates in the treatment of dairy wastewater using banana and neem leaf biocoagulants. As a result, neem tree leaf and banana leaf powders were effective and cost-effective natural biocoagulants for the treatment of dairy effluent, as they cost less than chemical coagulants.

***Keywords*:** *Dairy Wastewater, Turbidity, Neem leaf, Banana leaf, Jar Test Apparatus.*

1. Introduction

Water is without a doubt the most crucial normal asset. Water is a necessity for all living things, including humans [1]. Water is the premise of life on the planet. Non-industrial nations and third-world nations are confronting consumable water supply issues because of insufficient monetary assets. In non-industrial nations, 15 million newborn children bite the dust consistently due to tainted drinking water, helpless cleanliness, and lack of healthy sustenance [2]. Around 80% of illnesses in agricultural nations are straightforwardly associated with polluted drinking water [3]. Ground water, surface water, and rainwater are frequently the major sources of water accessibility in a community. Consumable water, which is good for drinking, must be liberated from pathogenic creatures, harmful substances, and an overabundance of minerals and natural poisons [4]. It should be dull, tasteless, and unscented in order to be alluring to buyers [5].

Bio coagulation is used to eliminate turbidity from raw water sources before it is used in portable water [6]. The amount of drainage poured into water sources has contaminated the water quality because of fast population increase and industrialization. Water quality can be improved using a variety of sanitation procedures. Primary coagulants are primarily aluminum and iron salt. However, these coagulants are harmful to both the environment and humans. Coagulation and flocculation processes are the most preferred among the large variety of available wastewater treatment technologies [7]. This therapy is widely utilized since it is cost-effective, dependable, easy, and considered to be a low-energy method [8].

This highlights the need to find a natural biocoagulant for easy and inexpensive wastewater treatment. Banana leaf and neem leaf powders are used as natural biocoagulants. Water treatment is very economical when using natural biocoagulants. The objective of the study is to reduce the turbidity level and identify the metal ion concentration in dairy wastewater collected from the dairy industry. This study aims to find out the effectiveness of banana leaf and neem leaf powder as biocoagulants.

2. Materials and Methods

2.1. Preparation of Biocoagulant

The neem leaves and banana leaves were collected from the UTAS-Salalah premises and cleaned with distilled water and dried in sunlight for three days. Then the dried samples were granulated using a grinding tool to obtain fine particles. The powder was then sieved through the standard 90 micron sieve. The dried powder is ready to be used as a biocoagulant. The fine powder was collected and stored in an airtight container to protect it from moisture.

Fig.1. Neem (***Azadirachta indica)*** and Banana Leaf (**Musa acuminate)** Powder (Biocoagulants)

2.2. Chemicals

Wastewater from the local dairy industry was collected. The pH of solutions was adjusted with 0.1 N HCl and NaOH.

All the experiments were carried out again, and the average results were published. Blank trials were also carried out to guarantee that no coagulation occurred on the walls of the apparatus.

2.3. Apparatus

The Jar test method was implemented to determine the best operating conditions for wastewater treatment. A flame photometer was used for the determination of Na, K, Ca, Ba, and Li concentrations, and for the copper concentration, a UV-Vis Spectrophotometer was used. The values of turbidity were measured by a digital turbidity meter.

(a) **(b)** **(c)**

Fig. 2. Apparatus used: (a) Jar Test (b) Turbidity Meter (c) Flame Photometer

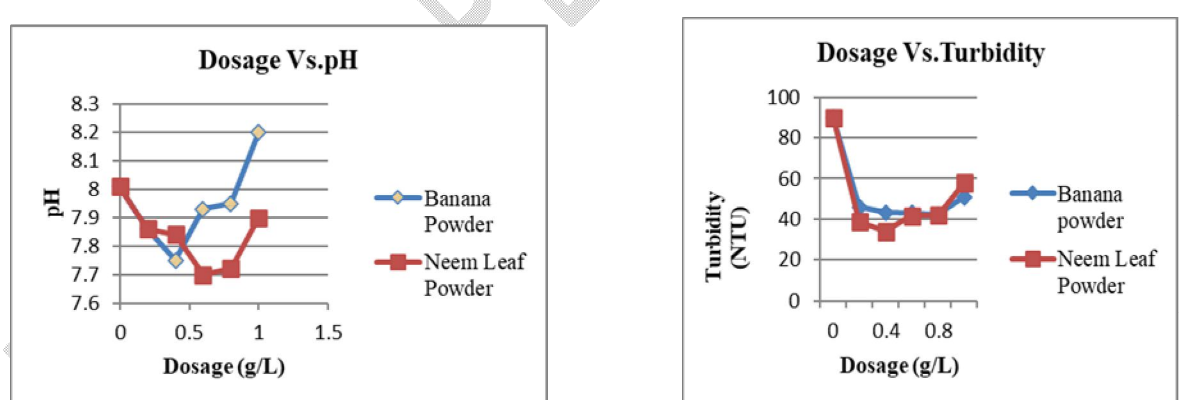
2.4. Batch Coagulation Experiment

Color, turbidity, germs, suspended matter, and odor-producing elements are all removed using the coagulation process. The coagulant is added to break down the small-destabilized particles into big matter, which is subsequently decanted and separated from the effluent by gravity. Different doses of neem leaf powder are added to the effluent. Rapid mixing for 3 minutes at 100 rpm is done first, followed by gentle mixing for 25 minutes at 20 rpm. Allow 30 minutes for the samples to rest. The supernatant water was then filtered, and various turbidity, pH, and metals parameters were measured using a flame photometer and a UV Spectrophotometer. The coagulant of banana powder solution is treated in the same way.

3. Results and Discussion

3.1. Effect of Biocoagulant Dosage on pH and Turbidity

The outcomes of the jar test coagulation experiment revealed that a dosage of 0.4 g/L of neem leaf and banana leaf powder coagulant was sufficient to maintain a pH of 7.8 (Fig. 3.a) and a turbidity of 34 NTU (Fig. 3.b) [9,10]. It delivers that the pH values decreased from 8 to 7.84 and then started increasing as the dosage of coagulant increased from 0 to 1 g/L. Similarly, the turbidity values decreased up to the dosage of 0.4 g/L coagulant and then started increasing as the coagulant dosage was increased further. Therefore, the optimum dosage of the biocoagulant was considered to be 0.4 g/L.



(a) (b)

Fig. 3. Effect of Bio coagulant Dosage on (a) pH and (b) Turbidity

3.2. Effect of Bio Coagulant Dosage on Removal of Various Metals

It is understandable that the effect of the quantity of bio coagulant shows various effects on the removal of various types of metal ions. The initial concentrations of the metal ions such as Na, K, Ca, Ba, and Li present in the dairy wastewater were found by using flame photometry, and the concentration of Cu was measured by UV-VIS Spectrophotometer. The initial concentrations are 152, 21, 10.3, 11.6, 0 ppm and 1029 ppm, respectively. It was found that the 100 mg/L (Fig. 4) of both neem and banana leaf powder coagulant at a pH value of 5 showed the highest removal of Na, K, Ca, Ba, Li, and Cu. Similar trends were observed at the bio coagulant dosage values of 200 and 300 mg/L (Fig. 5 and Fig. 6). It was found that the removal of the above metals for Na, K, Ca, Ba, and Li was found to be maximum at the bio coagulant concentration of 300 mg/L and 100 mg/L for Cu for both neem (Table 1, Fig.7) and banana leaf (Table 2, Fig.8) due to the mechanism of coagulation.

The absorption and neutralization of colloidal positive charges that attract negatively charged contaminants in water are the functions of neem leaf and banana leaf powder [11]. Coagulation is insufficient if the bio coagulant quantity is too low, resulting in a reduced coagulation impact. When the bio coagulant concentration is too high, the particles in the initial wastewater are encased in too much bio coagulant, and their surfaces become saturated, resulting in a decrease in particle coagulation and stability, making it difficult for the particles to coagulate [12,13].

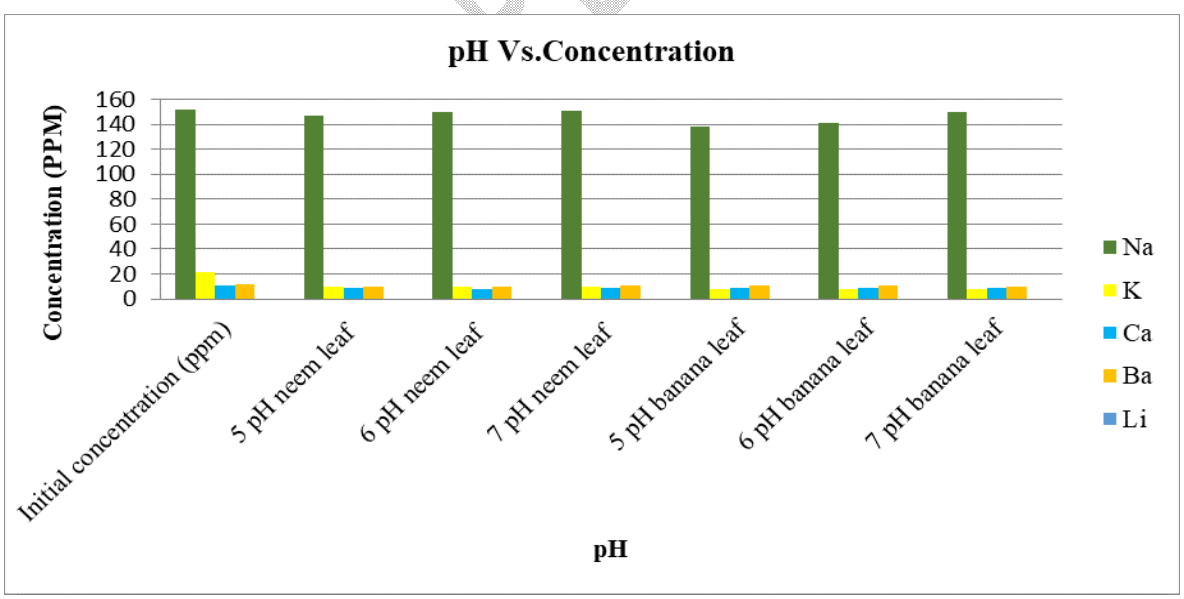


Fig.4. Flame Photometer Analysis for 100 mg/L of Neem and Banana Coagulants

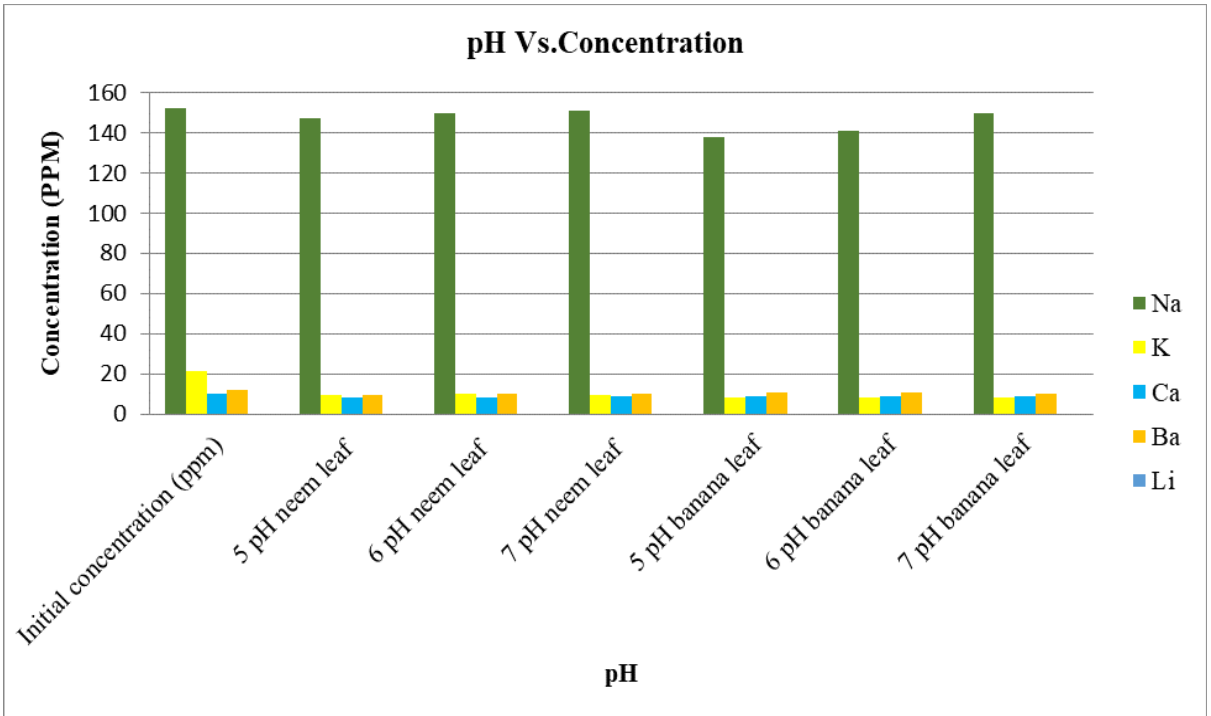


Fig.5. Flame Photometer Analysis for 200 mg/L of Neem and Banana Coagulants

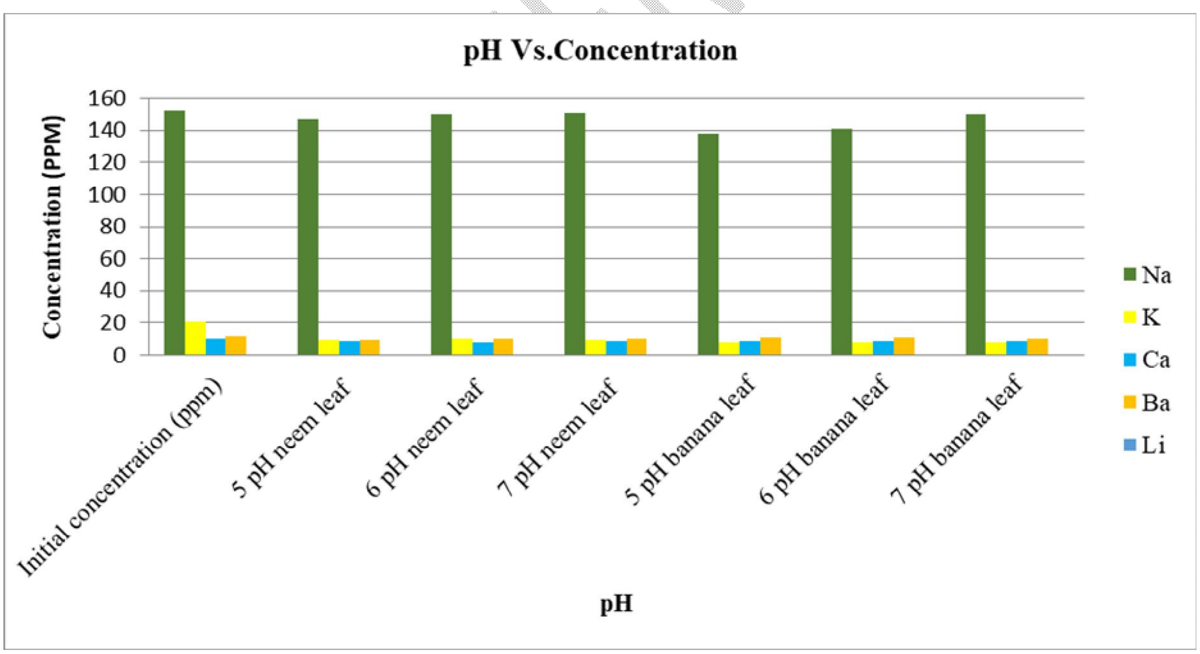


Fig.6. Flame Photometer Analysis for 300 mg/L of Neem and Banana Coagulants

Table 1. UV-Spectrophotometry analysis for copper ion at 100,200,300 mg/l of neem leaf biocoagulant.

Initial concentration (ppm)	100 ppm			200 ppm			300 ppm		
	pH 5	pH 6	pH 7	pH 5	pH 6	pH 7	pH 5	pH 6	pH 7
1029	139.5	204.7	238.5	349	395	445.6	307.8	338	379

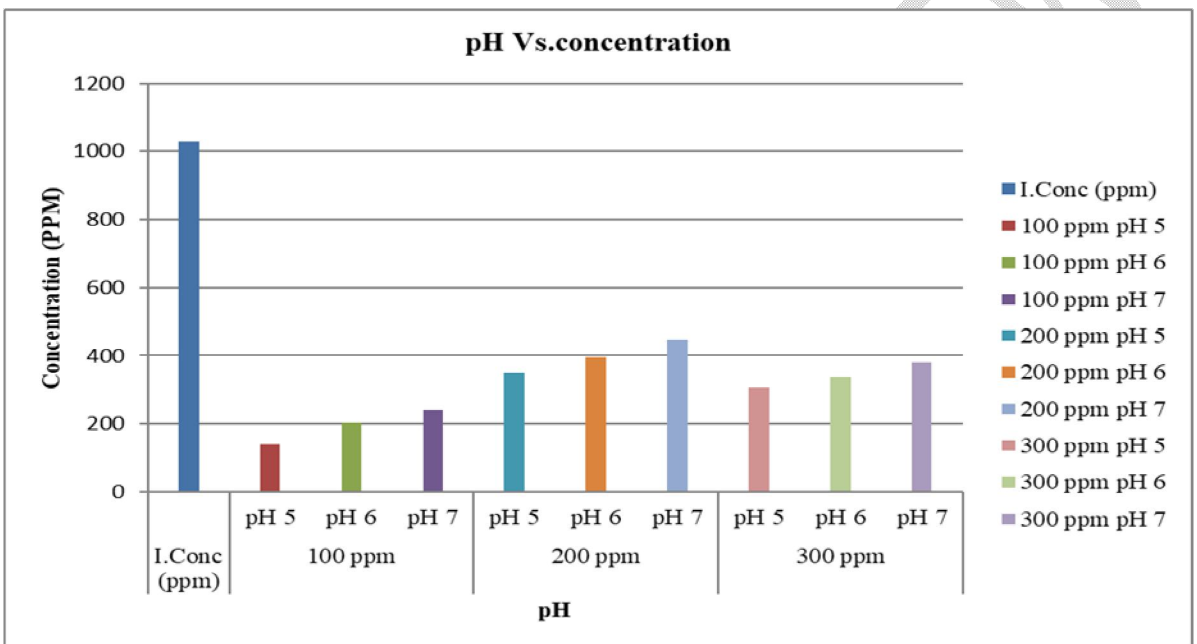


Fig.7. UV-Spectrophotometry analysis for copper ion at 100,200,300 mg/l of neem leaf biocoagulant.

Table 2. UV-Spectrophotometry analysis for copper ion at 100,200,300 mg/l of banana leaf biocoagulant.

Initial concentration (ppm)	100 ppm			200 ppm			300 ppm		
	pH 5	pH 6	pH 7	pH 5	pH 6	pH 7	pH 5	pH 6	pH 7
1029	206.7	208	238.5	354.2	382.7	422.2	314.9	352.9	505.8

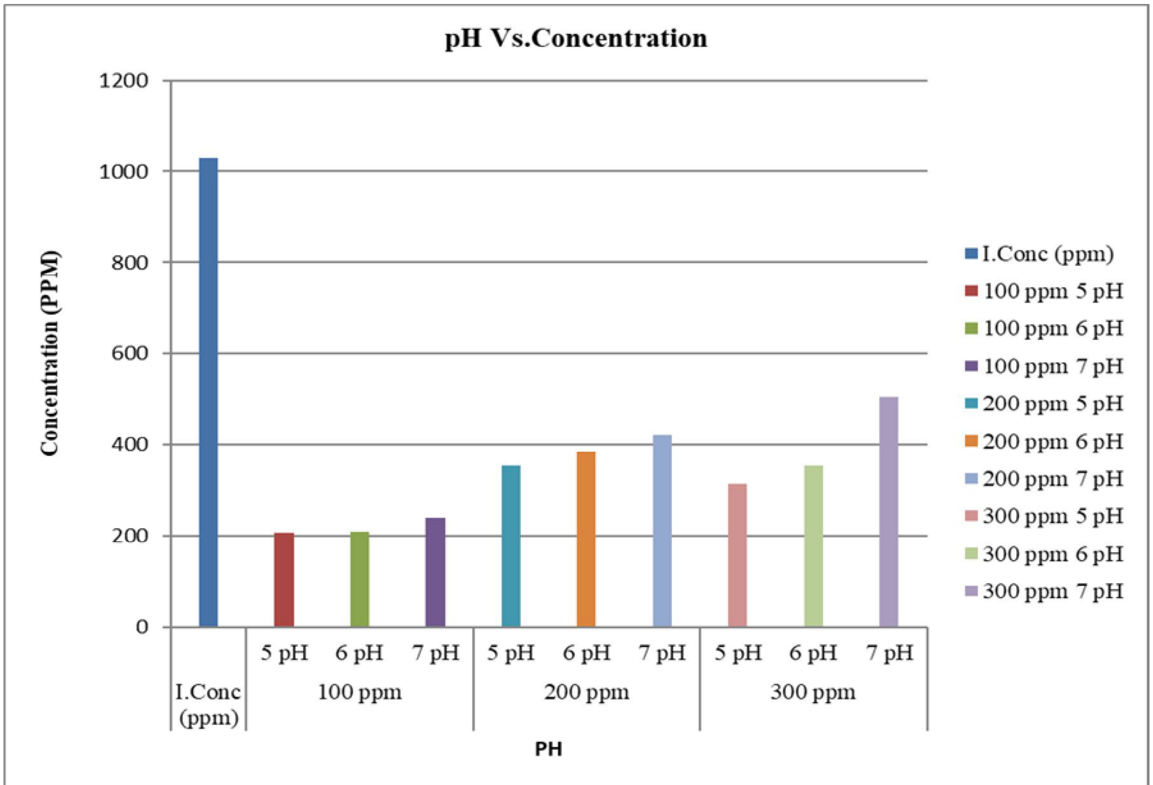
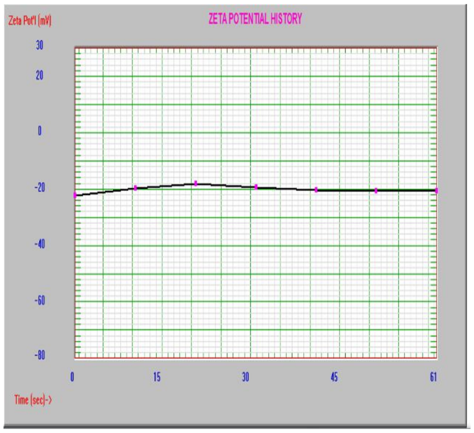


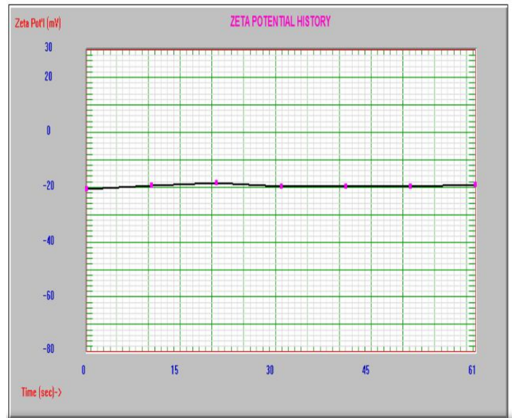
Fig.8. UV-Spectrophotometry analysis for copper ion at 100,200,300 mg/l of banana leaf biocoagulant.

3.3. Zeta Potential of Banana and Neem Leaf Coagulant

The stability of colloidal suspension was investigated using zeta potential analysis for banana and neem natural coagulants to measure the degree of electrostatic repulsion in the dispersion between the natural coagulants nearest equally charged particles, as illustrated in Figure 9. The zeta potential of particles typically ranges from +100 mV to -100 mV. Well-scattered NPs have a Zeta potential of greater than +30 mV or less than -30 mV. The zeta potential of neutral NPs ranges from -10 to +10 mV. The zeta potential of banana and neem is (-20.77 mV and -19.22 mV, respectively) [14].

Dispersions, emulsions, and suspensions are frequently improved using zeta potential analysis. The zeta potential value of both natural coagulants (banana and neem) describes the degree of repulsive forces in the dispersion between contiguous, equally charged particles [15]. Its findings disclose detailed diffusion, aggregation, and flocculation principles that can be used to improve dispersions, emulsions, and suspension formulations between dairy wastewater pollutants and natural coagulants [16].





(a) **(b)**

Fig. 9. Zeta potential of (a) *Banana leaf powder* and (b) *Neem leaf powder*

4. Conclusion

From the foregoing experiment, we have concluded that the turbidity reduction by the usage of neem and banana biocoagulants is 55% and 65%, respectively. When it comes to metals, the amount of Na and Ca increased as pH decreased, but there was a minute change in the case of K and Ba, and there was no change in the case of Li. In the case of copper removal, it was found that the removal was high at a pH of 5 with a biocoagulant concentration of 100 mg/L for both the bio coagulants. When using banana leaves as a coagulant, we noticed that the lower the pH, the lower the copper percentage.

The zeta potential also showed the degree of repulsive forces in the dispersion between contiguous, equally charged particles. It was identified that the more dispersion and suspension rates in the treatment of dairy wastewater by banana and neem leaf bio coagulants, the better. Neem and banana powder were found to be nontoxic and eco-friendly ways for the treatment of wastewater and can be used as an alternative coagulant in water treatment plants.

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