Utilization of Natural Coagulants to Reduce Turbidity and Total Dissolved Solids in Domestic Water and Diary Wastewater

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***Abstract*— Natural waterways are becoming contaminated due to industrialization, urbanization, population development, and other factors, reducing their quality. Channels that are contaminated pose significant risks to human health and the environment. As a result, it is critical to remove pollutants. Coagulation is one of the effective basic chemical treatment techniques that could employ to address such pollutants. Natural coagulants have gained appeal in the water and wastewater treatment industries due to their advantages over chemical coagulants. Plants, animals, or microorganisms can all be sources of natural coagulants. This study examined the use of corn and orange peel powder as natural coagulants in the wastewater treatment process. The effectiveness of orange peel powder and corn powder in lowering wastewater parameters and enhancing the quality of treated wastewater is demonstrated. The fundamental goal of this review is to improve understanding of the potential usage and optimization of the effectiveness of eco-friendly and sustainable natural coagulants. The results showed that orange peel works as a better coagulant than corn powder in reducing turbidity and total dissolved solids (TDS) from diary waste water and household water.**

Keywords*— *Coagulation, orange peel powder, corn powder

I. INTRODUCTION

Water is a vital necessity for all biological and human activities. It serves as the primary element in the hydrological cycle. Due to numerous environmental degradation activities, climate change [1], population expansion [2], rising standards of living, and urbanization [3], the world's water supplies are continuously depleting. The looming water problem results from careless trash disposal and rapid population increase. Numerous procedures and technological advancements are being studied to raise the quality of water to meet the demand for it [4]. These innovations can be divided into three primary groups: physical, chemical, and biological treatment techniques. These innovations can be divided into three primary groups: physical, chemical, and biological treatment techniques. Adsorption [5], settling, medium, and membrane filtration, as well as UV treatments [6], are examples of physical approaches. Some of the chemical processes used in wastewater treatment include coagulation [7], disinfection [8], ion exchange [9], catalytic reduction [10,11], oxidation [12], and softening processes [13].

Biodegradation by microorganisms [14], phytoremediation [15], bioreactor processes [16], artificial wetlands [17], and other biological techniques are examples of biological procedures. Coagulation is one of the most often utilized procedures in the initial treatment of water and wastewater for eliminating suspended particle matter and colloids in wastewater [18].

Coagulation is one of the most fundamental processes for efficiently removing suspended particles and pollutants from water. Inorganic and synthetic organic chemical-based coagulants and natural coagulants can be used to achieve successful coagulation [17,18]. Natural coagulants are recognized for their historical use in local water cleaning [18,19]. In comparison to chemical coagulants, naturally occurring coagulants are more environmentally responsible, sustainable, and safe [20]. Natural coagulants have attracted the scientific community's attention in recent decades due to their enormous health and environmental benefits, and they alleviate most of the usual concerns connected with chemical coagulants. Different sources, including microbes, animals, and plants (non-plant-based and plant-based), are used to create or extract natural coagulants. Several potent coagulants with botanical origins are now being discovered. The disadvantages of chemical coagulants have led to the search for eco-friendly and sustainable natural coagulants in their use and manufacturing. Natural coagulants provide several benefits, including renewability, biodegradability, nontoxicity, and affordability. These research [18,21] have already demonstrated the efficacy of natural coagulants in wastewater treatment applications. However, the industrial use of natural coagulants in wastewater treatment applications is limited. The high processing costs and inconsistent performance of the natural resource extraction chemicals mainly cause this. To maximize the benefits, researchers frequently alter natural coagulants [22,23]. To improve our understanding of natural coagulants and make coagulants more effective in wastewater treatment, it is essential to identify relevant research gaps. According to the literature, the following variables affect how effectively the coagulation or flocculation process works: the source and nature of the naturally occurring coagulant, such as its molecular weight; the type of equipment used; the type of

reagent used in conjunction with it; the dosage of the coagulant; the residence time in the jar test apparatus; and the rate of rotation; the solution's characteristics such as temperature, pH, the zeta potential, the colour, the concentration of colloidal particles, and the presence or absence of impurities (i.e., dissolved salts or trace elements such as ions and chemicals) are taken into consideration.
In this work, the utilization of orange peel powder and maize powder as natural coagulants in the wastewater treatment process was investigated. Sewage from the dairy industry and home was gathered for our research, and the efficiency of Turbidity and TDS removal from this wastewater by using orange peel powder and corn powder was studied.

II. MATERIALS AND METHODOLOGY

COAGULANTS USED

a)Orange Peel Powder

Orange peels were purchased from the neighbourhood market and repeatedly rinsed with tap water to get rid of any colloidal particles. Orange peels were manually cut into little pieces and allowed to dry in the sun for a week before being ground into a fine powder and sieved. As a natural coagulant, it aids in the formation of a low-cost coagulant agent in the coagulation process in the wastewater treatment plant. It is also a significant environmentally friendly and economically beneficial product.

b)Corn Powder

Maize was acquired locally and cleaned with water to remove dirt and other minute particles. After being physically separated, the corn balls were allowed to dry in the sun for a week before being pounded into a fine powder and sieved.

JAR TEST

Studies on coagulation and sedimentation are typically conducted using a jar test. A jar test is the most typical scientific process used to determine the ideal amount of coagulant. It involves the processes of coagulation and sedimentation. A pilot-scale laboratory test known as the "jar test" replicates coagulation or flocculation using various chemical dosages. The jar test is used to determine the minimal coagulant dose necessary to meet specific water quality objectives. The four- or six-place gang stirrer used in jar tests can be used to imitate the mixing and settling conditions in a clarifier. Jar testing aids in determining the proper dosage of treatment chemicals: the dose of chemicals used to treat the water is the lowest which produces adequate settling. In the jar test, we let the coagulant be added to the jar to settle. The setup will be constructed for the flocculation procedure utilizing a 1-liter jar of six numbers that will be arranged appropriately.

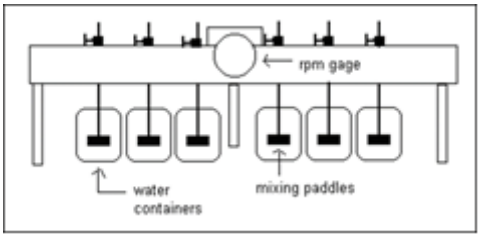

Fig 1: Jar Test Apparatus

The efficiency of a large-scale treatment process was evaluated by adding coagulant in several variations and testing it at various speeds in the lab. The following time constraints are supported by the findings of coagulation and sedimentation: Quick mixing or combining for 2 minutes at 100 rpm, Slow mixing for 20 minutes at 40 rpm, and Sedimentation for 45 minutes. Fig 1 above shows the Jar Test Apparatus

III. RESULTS AND DISSCUSSION

TABLE I. SAMPLE WATER QUALITY PARAMETER

The Table 1 below shows the various water quality parameters analyzed in diary waste water and house waste water.

Sl No	PARAMETERS	DAIRY WASTE WATER	HOUSE WASTE WATER
1	Color	>1 hue	>1 hue
2	Odor	Disagreeable	Disagreeable
3	Turbidity	500NTU	383NTU
4	Total Solids	3047 mg/l	2147mg/l
5	Total Suspended Solids	1045mg/l	950mg/l
6	Total Dissolved Solids	1802mg/l	1500mg/l
7	pH	8.02	7.14
8	Temperature	36	30
9	Dissolved Oxygen	2.5mg/l	0.7mg/l
10	Biochemical Oxygen Demand	418mg/l	275mg/l
11	Chemical Oxygen Demand	212mg/l	76mg/l
12	Electrical Conductivity	1.29ds/m	1.58ds/m
13	Carbonate	NIL	NIL
14	Bi Carbonate	380mg/l	392mg/l

15	Chloride	230mg/l	246mg/l
16	Sulphate	94mg/l	122mg/l
17	Phosphate	0.04mg/l	0.05mg/l
18	Silicate	2.63mg/l	1.97mg/l
19	Nitrate	0.6mg/l	0.7mg/l
20	Nitrite	0.22mg/l	0.26mg/l
21	Fluoride	3.16mg/l	3.68mg/l
22	Aluminium	0.07mg/l	1.67mg/l
23	Calcium	198mg/l	229mg/l
24	Magnesium	110mg/l	150mg/l
25	Sodium	215mg/l	126mg/l
26	Potassium	0.12mg/l	1.24mg/l
27	Zinc	0.19mg/l	1.44mg/l
28	Copper	0.11mg/l	0.3mg/l
29	Iron	1.12mg/l	4.12mg/l
30	Manganese	0.13mg/l	2.34mg/l
31	Oil And Greases	0.25mg/l	1.3mg/l

EFFECT OF ORANGE PEEL POWDER AND CORN POWDER AS COAGULANT ON DIARY WASTE WATER

TABLE II. EFFECTS OF TWO COAGULANTS AT DIFFERENT DOSAGE AND PH OF A DAIRY WASTE WATER SAMPLE

Dosage (in mg/l)	Orange Peel Powder	Corn Powder
0.2	7.82	7.1
0.4	7.52	7
0.6	7	6.5
0.8	6.67	7.12
1	6.65	7.52

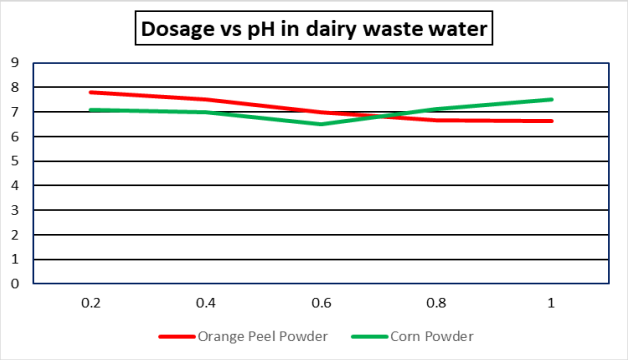

Fig 2: Graph showing Dosage vs pH in diary waste water

The above graph (Fig 2) shows the variation in pH in diary waste water by adding orange peel and corn powder as coagulant at varying dosages. When orange peel was added as the coagulant pH initially increases and then began to decrease. But when corn powder was added pH initially increased and then began to decrease with a further rise in pH at 1mg/l dosage of coagulant.

TABLE III. EFFECTS OF TWO COAGULANTS AT DIFFERENT DOSAGE AND TURBIDITY OF A DAIRY WASTE WATER SAMPLE.

Dosage (in mg/l)	Orange Peel Powder	Corn Powder
0.2	300	230
0.4	240	182
0.6	98	208
0.8	170	250
1	200	220

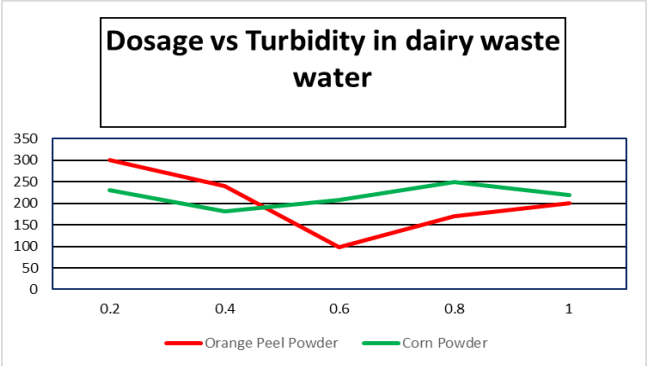

Fig 3: Graph showing Dosage vs Turbidity in diary waste water

The turbidity value in diary waste water was decreased to 98 NTU when orange peel powder was used as the coagulant at a dosage of 0.6mg/l, whereas maize powder achieved the lowest turbidity value of 182 NTU at a dose of 0.4mg/l as shown in Fig 3.

TABLE IV. EFFECTS OF TWO COAGULANTS AT DIFFERENT DOSAGE AND TOTAL DISSOLVED SOLIDS IN A DAIRY WASTE WATER SAMPLE.

Dosage (in mg/l)	Orange Peel Powder	Corn Powder
0.2	2042	1085
0.4	1152	1068
0.6	1030	1217
0.8	1132	1532
1	1455	1690

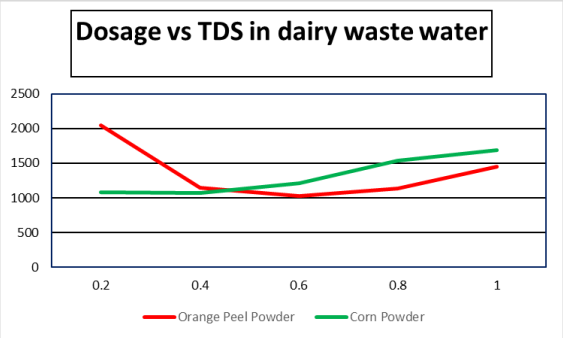

Fig 4: Graph showing Dosage vs TDS in diary waste water

When orange peel powder was employed as the coagulant at a dosage of 0.6 mg/l, the TDS value in diary waste water was reduced to 1030 mg/l, while maize powder achieved the lowest TDS value of 1068 mg/l at a dose of 0.4 mg/l, as shown in Fig 4.

EFFECT OF ORANGE PEEL POWDER AND CORN POWDER AS COAGULANT ON HOUSE WASTE WATER

TABLE V. EFFECTS OF TWO COAGULANTS AT DIFFERENT DOSAGE AND PH OF A HOUSE WASTE WATER SAMPLE.

Dosage (in mg/l)	Orange Peel Powder	Corn Powder
0.2	7.42	7.82
0.4	7.21	7.62
0.6	6.9	7.7
0.8	6.76	7.26
1	6.69	7.32

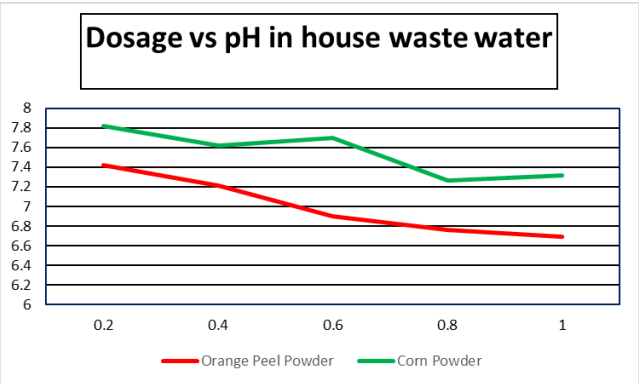

Fig 5: Graph showing Dosage vs pH in house waste water

The pH value initially rises when orange peel powder is used as the coagulant and subsequently falls, just as it did when maize powder was used as the coagulant, as shown in Fig. 5.

TABLE VI. EFFECTS OF TWO COAGULANTS AT DIFFERENT DOSAGE AND TURBIDITY OF A HOUSE WASTE WATER SAMPLE.

Dosage (in mg/l)	Orange Peel Powder	Corn Powder
0.2	62	180
0.4	35	152
0.6	106	105
0.8	130	58
1	160	76

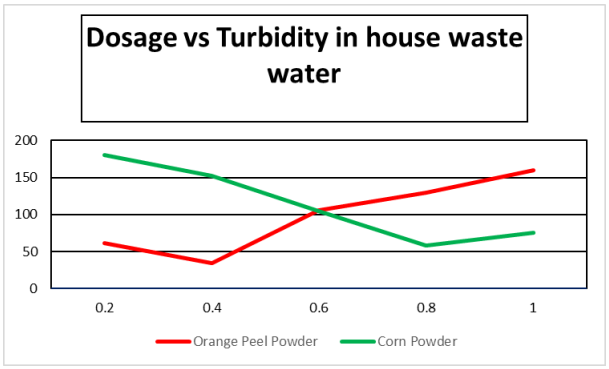

Fig 6: Graph showing Dosage vs Turbidity in house waste water

As shown in Fig. 6, maize powder obtained the lowest turbidity value of 58 NTU at a dose of 0.8 mg/l, while orange peel powder, used as the coagulant, lowered the turbidity value in household waste water to 35 mg/l.

TABLE VII. EFFECT OF TWO COAGULANTS AT DIFFERENT DOSAGE AND TOTAL DISSOLVED SOLIDS IN A HOUSE WASTE WATER SAMPLE.

Dosage (in mg/l)	Orange Peel Powder	Corn Powder
0.2	621	1012
0.4	928	1320
0.6	1127	1218
0.8	1176	1120
1	1182	1348

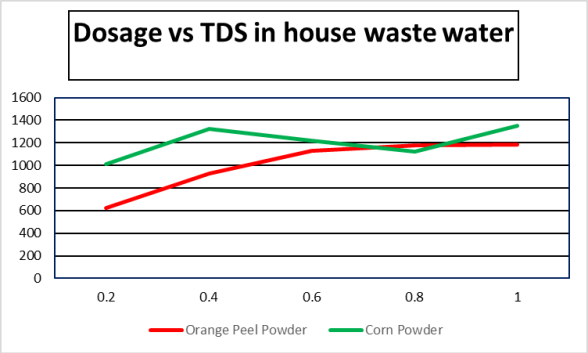

Fig 7: Graph showing Dosage vs TDS in house waste water

The TDS value in house waste water was reduced to 621 mg/l when orange peel powder was employed as the coagulant at a dosage of 0.2 mg/l, while maize powder produced the lowest TDS value of 1012 mg/l at a dosage of 0.2 mg/l, as shown in Fig 7.

IV. CONCLUSION

The current investigation on the use of natural coagulant in waste water treatment led to the following conclusions. This is a summary of the batch experimental data that were acquired using various coagulant dosages.

Dairy waste water:

When the orange peel was added to dairy wastewater as a coagulant at a concentration of 0.6 mg/l and a pH of 7, the water's initial turbidity was reduced from 500 NTU to 98 NTU. About 80.4% of the turbidity was eliminated. However, the greatest turbidity lowered with adding corn powder as a coagulant was 182 NTU at a dosage of 0.4 mg/l at a pH of 7, and the percentage reduction in turbidity was almost 63.6%. Similarly, the initial TDS concentration in dairy wastewater was 1802 mg/l. TDS was decreased to 1030mg/l at a dosage of 0.6mg/l by adding orange peel as a coagulant, and the percentage reduction was approximately 42.8%; however, when corn powder was used as a coagulant, the maximum TDS lowered was approximately 1068mg/l at a dosage of 0.4mg/l, and the percentage reduction of TDS was 40.7%. Hence, at a dosage of 0.6 mg/l, orange peel works better as a coagulant than corn powder in reducing TDS and turbidity from dairy wastewater.

House waste water:

Initial household water turbidity was 383 NTU, which was decreased to 35 NTU at a dosage of 0.4 mg/l of orange peel powder at a pH of 7.21, decreasing turbidity to 90.8%. When corn powder was added as a coagulant, turbidity was reduced to 58 NTU at a dosage of 0.8 mg/l at a pH of 7.26, lowering turbidity to 84.8%. When orange peel powder (0.2 mg/l) was added, the original TDS of 1500 mg/l was reduced to 621 mg/l at a pH of 7.42, eliminating TDS to 58.6% of the total, while the addition of maize powder (0.2 mg/l) decreased the initial TDS to 1012 mg/l at a pH of 7.82, lowering the TDS value to 32.53%. As a result, with dosages of 0.2mg/l and 0.4mg/l, orange peel powder outperforms corn powder in reducing TDS and turbidity from domestic water.

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