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Purification of Turbid Water Using Orange Peel Extract and Luffa Mucilage

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Abstract: The increase in aluminum ion concentration resulting from chemical coagulants in water treatment causes human health problems, including damage to brain cells and Alzheimer's disease. Therefore, numerous countries sought to find alternative coagulants extracted from natural, environmentally friendly organic sources for use in water treatment. The research included preparing an aqueous extract from orange peel, extracting luffa mucilage, as well as, calculating the yield, estimating the size of mucilage particles, and using them as plant coagulants to purify turbid water. Moreover, the optimum conditions were set for it, represented by the concentration of coagulants and the pH to give the highest efficiency in purifying turbid water. As well as using them as coagulation aids with alum to reduce the concentration of alum used in water purification. The results indicated that the optimum concentrations of natural coagulants ranged 40-50 ppm, where the orange peel coagulant exceeded the luffa coagulant with a significant difference in the turbidity removal, as it was 87 and 71% respectively, at pH values of 5 and 10. Likewise, there were significant differences in the reduction of heavy elements by using coagulants in water treatment. The results showed that there was a significant difference in the percentages of turbidity removal between the mixing ratio 1:0.5 and 1:0.25 (coagulant aid: Alum). Conversely, the use of the optimum concentration of orange peel coagulant with half the alum concentration gave turbidity removal percentages close to the use of alum alone in purifying water. It can be concluded from the study the possibility of using the extracted plant coagulants to reduce the concentration of alum used in purifying turbid water. The results reveled the highest significant decrease in the concentration of all heavy elements using luffa fruit coagulant and orange peel coagulant, compared to their concentration in turbid water before purification, which was 0.4 ppm.

Keywords: Alum, Heavy metals, Natural coagulant aids, Turbidity removal

Introduction

The global water demand is increasing due to rapid population growth, and water is material of great economic value and an increasingly important value. According to (Mohd-Salleh *et al.*, 2019), the world population will increase and it is expected to exceed 19 billion by 2050. The growing population will lead to greater water consumption, which resulted in greater quantities of wastewater. Non-polluted and clean water is one of the basic requirements for human life. Water is used in various fields, whether economic or agricultural for the continuity of human life. Consistent with the World Health Organization (WHO) and UNICEF reports, 780 million people do not have access to drinking water, of whom 185 million people use surface water to meet their daily needs (Cuerda-Correa *et al.,* 2020).

The turbidity removal of raw water and its contaminants is the most important goal of water purification plants that determine the quality of drinking water for human consumption (WHO, 2017). However, small suspended particles in the water are unacceptable because they contain microorganisms and pollutants harmful to human health. The suspended particles surround these microorganisms, providing them with protection and preventing sterilizers from reaching them. Turbidity also impedes the penetration of sterilization rays into the water, so the degree of turbidity should be less than 5 Nephelometric units (NTU) during the sterilization process (WHO, 2017).

Colloids and plankton represent most turbidity components. They include hydrophobic and hydrophilic compounds of various sizes containing electrical charges in their outer shells that make them diffuse and stable in water due to their repulsive forces. There are several methods for water turbidity removal, such as sedimentation, membrane filtration, gravel filtration, sand filter use, slow biological filter, and ion exchange technology. Nevertheless, the most common and simplest application method is the sedimentation method by using chemical coagulants that are used during the initial stage of treatment to reduce time, increase purification efficiency and reduce problems caused by a high concentration of plankton during the final stages of drinking water purification (Pichler *et al.,* 2012).

Small particles are converted into larger aggregates (flocs) during the coagulation process, and dissolved organic molecules are absorbed by flocs, making it easier to remove larger particles via filtration and sedimentation. Besides, this process reduces dissolved organic materials and reduces turbidity in liquids. In general, the coagulation process includes the following stages: Coagulant formation, particles stability disturbance, and particles aggregation (Khader *et al.,* 2018).

The most common coagulants used for wastewater treatment are alum, polyaluminum chloride (PAC), and iron (III). Although, the increase in the concentration of dissolved ions of chemical coagulants in the water, including aluminum ion, it causes several health problems for humans, and in a cumulative way. These problems are brain cell damage, Alzheimer's disease, memory loss, constipation, abdominal cramps, convulsions, learning difficulties, and energy loss (Khader *et al.,* 2018).

Aluminum ions also interact with the water, causing its pH to decrease, which reduces the coagulation efficiency in cold water and increases the salts ions after treatment. Therefore, developed countries have sought in recent years to find coagulants extracted from environmentally friendly natural organic sources obtained from agricultural and animal sources, characterized by that their residual sediments after treatment are biodegradable. As well as, they do not change the pH of the treated water and do not need to provide special conditions for treatment (Renault *et al.,* 2009). These coagulants contain polysaccharides or proteins that contain effective ionic groups represented by the amino groups $R\text{-}NH^+$ and the carboxylate CH_3COO^- that works by the mechanism of neutralizing charges and forming bonding bridges between them and the suspended particles called natural polymers (Arguello *et al.*, 2015).

Several studies have indicated the possibility of using coagulants from microbial, animal, and plant sources. Microbial polysaccharides, starches, gelatin, chitosan, tannins, cellulose and its derivatives, alginate, gums, mucilages, and glues are examples of natural coagulants utilized in wastewater treatment. Natural or industrial coagulants aim to remove pollutants, whether physical (solids and turbidity) or chemical (BOD and COD). Furthermore, Natural coagulants are combined with commercial coagulants as a coagulation aid, and their efficacy as initial coagulants is still being studied (Kumar *et al.*, 2017).

The coagulants are widely distributed in nature and are derived from plant sources and agricultural residues. Among the natural coagulants used in wastewater treatment are *Moringa oleifera* seeds, basil seeds (*Ocimum basilicum*), *Corchorus olitorius* L., *Opuntia ficus-indica*, *Jatropha curcas* seed, rice starch, Tapioca starch (TS), Jackfruit seed starch (JSS), pectin of orange peel pith, Nirmali seed and banana pith (Mohd-Salleh *et al.*, 2019).

Luffa (*Luffa cylindrica*) belonged to the Cucurbitaceae family, also known as Sponge gourd, a subtropical plant with green fruits and black edges, cylindrical in shape, and they grow in a climbing shape on solid materials. Their fruits contain chemical compounds such as triterpenoid saponins: lucyosides, ginsenosides, and alpha-spinasterol, in addition to containing gum and flavonoids. Thus, research has shown that fruits contain antioxidant and hydrophilic compounds. The young fruits can be eaten uncooked like cucumbers or cooked as in squash. Dried fruit fibers are used as sponges for skincare, removing dead skin and stimulating blood circulation (Partap *et al.*, 2012). The fruits are characterized by health and medical benefits because they have an anthelmintic antimicrobial effect, laxative, antiseptic, expectorant, tonic, and moisturizing effect. They are also used in the treatment of fever, syphilis, tumours, chronic bronchitis, sinusitis, leprosy, intestinal worms, asthma, abscesses, heat rashes of children in the summer, and treatment of intestinal inflammation or bladder bleeding, splenomegaly, jaundice, and menorrhagia (Al-Snafi, 2019).

Citrus fruits and by-products have a significant economic and therapeutic value because of their numerous use in the food, cosmetics, and folk medicine industries (Yerou *et al.*, 2017). Orange (*Citrus sinensis*) is one of the most important citrus fruits and belongs to the family Rutaceae, and is consumed in abundance all over the world. These fruits are peeled during the various manufacturing processes and during the manufacturing process of orange juice, the orange peel accumulates in large quantities and causes great environmental problems. Thousands of tons are produced annually in various parts of the world from byproducts of orange peeling represented by the peel, which is characterized by their rich content of nutrients and is a good source of bioactive chemical compounds and therefore can be used in many nutritional, industrial, medical and pharmaceutical applications (Gotmare & Gade, 2018).

Because of the negative health effects of using chemical coagulants in water purification and the lack of adequate local studies on the use of extracted plant sources in the purification of turbid water, being non-toxic, bio-regeneration, and in addition to the low costs of its extraction. The research aims to use the aqueous extract of orange peel and the organic extract of Luffa fruits to purify turbid water and determine the optimal conditions represented by the coagulant concentration and the pH to give the highest efficiency in water purification. In addition to coagulation aids with alum to reduce the concentration of alum used for water purification.

Materials & Methods

Orange peel extraction

Fresh orange fruits were obtained from the local markets of Baghdad, in December 2020. These fruits were washed with tap water and peeled, where the peel was cut into small pieces, then the peel was dried in an electric oven at a temperature of 60 ± 2 °C. Besides, they were milled with an electric grinder, after which they were kept in dry sealed bottles until use in the extraction. Moreover, an aqueous extraction was performed according to (Gotmare & Gade, 2018) procedure by soaking 20 g of orange peel powder in 250 ml of distilled water for 24 hours at room temperature with stirring by an electric stirrer. Finally, the extract was filtered with Whatman No.1 filter paper, dried at 50 °C in an electric oven, and stored in dry, sealed bottles until use in subsequent experiments.

Extraction of luffa mucilage

Fresh luffa was obtained from the local markets of Baghdad, in September 2020, it was cleaned by removing impurities from it, and the process of extracting the mucilage was carried out according to Bustillos *et al.* (2013) with some modifications by cutting 25g of the fresh plant fruit into small pieces. Then, 250 ml of distilled water was added to it and boiled for 10 minutes, while the pieces of the plant were separated from the mucilage using a sieve with large holes, chilled ethyl alcohol 96% was added to it at a ratio of 1:1 (v/v) to precipitate the mucilage. The mucilage was separated with a cotton sieve and dried in a heated oven at a temperature of 50 °C for 24 hours, then grinded, dried and the powder kept in sealed containers.

Estimation of the yield of orange peel extract and luffa mucilage (Y)

The yield of aqueous extract of orange peel and luffa mucilage was calculated based on the dry weight from dividing the weight of the dried aqueous extract or the dry mucilage by the initial weight of the dried orange peel or the initial weight of the luffa plant multiplied by 100.

Estimation of the mucilage particle size

The particle size of the orange peel extract and dried luffa mucilage was estimated using an optical microscope with a magnification of 400 times. Also, the average volume of 100 particles was calculated for the powder of each type of extract (Jangdey *et al.,* 2016).

Preparation of industrial coagulant

Aluminum sulfate (alum) solution was prepared according to Sulaymon *et al.* (2013) method, by dissolving 10 g of aluminum sulfate in 1 litre of distilled water to obtain a concentration of 10,000 ppm of industrial inorganic coagulant, and kept in a glass bottle until use.

Preparation of natural coagulants

Natural coagulants were prepared which involved dissolving 1 g of powder from each type of plant source in distilled water individually. The solution was then completed to 1 litre with distilled water using a magnetic stirrer at 30 °C to obtain a 1000 ppm solution as natural coagulants in water purification.

Preparation of turbid water and the tests conducted on it

Turbid water was prepared by adding 50 g of pure clay material after grinding and sifting it by 0.2 mm sieve to 1 litre of distilled water. The mixture was homogenized for an hour using a shaker at 100 rpm before 24 hours to allow the clay material to hydrate fully. Using a Turbidity meter at pH 7.5-8, the turbid filtrate was added to the tap water sample to adjust the turbidity to the desired turbidity of 100 NTU (Binayke & Jadhav, 2013).

Physical and chemical examinations were conducted in the Environment and Water Department/Ministry of Science and Technology laboratories according to the methods mentioned in Standard Methods for the Examination of Water and Wastewater (2017).

The electrical conductivity was measured using a conductivity meter, and a total suspended solids (TSS) was measured by filtering 100 ml of the water sample, it was placed on aluminum foil and dried in an air oven at 104 °C for an hour, then TSS was calculated by finding the weight difference before and after drying. Some heavy metals were examined for the water filtrate after adding solutions prepared with known concentrations of heavy metals, including Cu^{++}, Pb^{++}, Cd^{++}, Cr^{++}, and Fe^{++} by an atomic absorption device at 30 °C.

Determination of the optimum conditions for sedimentation of plant coagulants

The prepared water sample was used to determine the optimum concentration and pH of sedimentation of plant gum extracted as natural coagulants for comparison with the industrial coagulant represented by aluminum sulfate (alum) $Al_2(SO_4)_3.16H_2O$ (Arguello *et al.*, 2015), using the Jar apparatus. The coagulant was added to 1 litre of the sample, where eight levels of concentrations were studied for each type of plant source (10, 20, 30, 40, 50, 60, 70, and 80) ppm, and seven levels of pH were used (4, 5, 6, 7, 8, 9 and 10) at the optimum concentration of each plant coagulant used to remove turbidity at a temperature of 30 ° C. The process was carried out with rapid mixing of 200 rpm for 1 minute, then a slow mixing process at 40 rpm for 30 minutes, after which a sedimentation process was for 60 minutes. Further, the filtrate was withdrawn from the top layer of water to conduct tests that included turbidity, pH, and heavy elements Cu^{++}, Pb^{++}, Cd^{++}, Cr^{++}, and Fe^{++}. Three replicates calculated the percentage of turbidity removal for each treatment according to the equation mentioned by (Arguello *et al.*, 2015):

$$\textbf{Turbidity removal}\ (\%) = \frac{Turbidity\ (in)\ -\ turbidity\ (re)}{Turbidity\ (in)}$$

Where: (in), initial turbidity; and (re), residual turbidity of sample.

Use of plant coagulants as coagulant aids with alum solution

Plant coagulants were used as coagulant aids (at their optimum concentrations) with alum for water treatment at a turbidity level of 100 NTU. In this study, the concentrations of alum 20 ppm at a pH ranged of 7.5-8 with a sedimentation period of 60 minutes were used to purify the water. These conditions were suitable for alum coagulants in several studies (Baghvand *et al.*, 2010; Binayke & Jadhav, 2013; Sulaymon *et al.*, 2013). Water purification experiments were carried out according to (Binayke & Jadhav, 2013) method, with mixing ratios 1: 0.5 and 1:0.25 (coagulant aid: alum), according to the jar apparatus method.

Statistical analysis

Statistical analysis was performed using the Genstat program represented by examining the T-test at a significant level (0.05) to find the significant differences in the average turbidity removal ratios between the mixing ratios 1: 0.5 and 1: 0.25 (coagulant aid: alum). The statistical analysis of the results was carried out by the Genstat program according to the completely randomized design CRD to find the significant differences between the mean of the treatments by testing the least significant difference LSD at a significance level of 0.05.

Results & Discussions

The yield of orange peel extract and luffa mucilage

Table (1) showed the yield of orange peel extract and luffa mucilage, which was 3.0 and 7.1%, respectively. The yield of orange peel extract is consistent with what Gotmare & Gade (2018) found, as the yield of aqueous extraction of orange peel was 3.2%. The researchers pointed out that the yield of aqueous extraction of orange peel differs from the yield of extraction by using the solvents represented by hexane, methanol, and acetone, which were (1.8, 55.6 and 2.2)%, respectively, as the results showed that the yield of methanol extraction was higher compared with hexane and acetone, which gave the lowest yield.

The yield of extracted mucilage is affected by several factors, including the temperature and the duration of extraction, the ratio of explant to the percentage of added water, and the extraction time also affects the efficiency of the extraction process (Jouki *et al.*, 2014).

The size of orange peel particles and luffa mucilage

The results showed that the average size of orange peel particles was higher than the size of the luffa mucilage, as it was 80.0 and 72.1 µm, respectively as shown in table (2).

The difference in their sizes may be attributed to their chemical composition, fiber content, extraction methods and chemical and physical treatments carried out when preparing these plant sources. Pais (2011) indicated that the size of the small gum particles had caused an increase in the efficiency of water purification, as the cactus gum particles that did not exceed 7 µm in size gave a high efficiency of water purification compared to the larger particles.

Table (1): The yield of orange peel extract and luffa mucilage.

Sample	Yield (%)
Orange peel extract	3.0
luffa mucilage	7.1

Table (2): The particle size of orange peel extract and luffa mucilage.

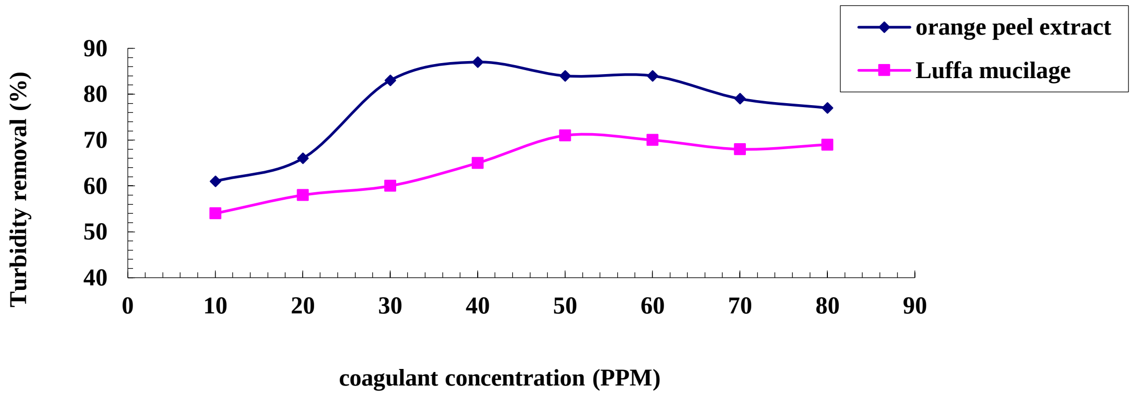
Sample	Particle size (micrometre)
Orange peel extract	80.0
luffa mucilage	72.1

Determine the optimum conditions for water treatment with plant coagulants

The turbid water tests before filtration showed that the electrical conductivity, degree of turbidity, and total suspended solids were 933 µS. cm^{-1}, 100 NTU, and 59.3 ppm, respectively.

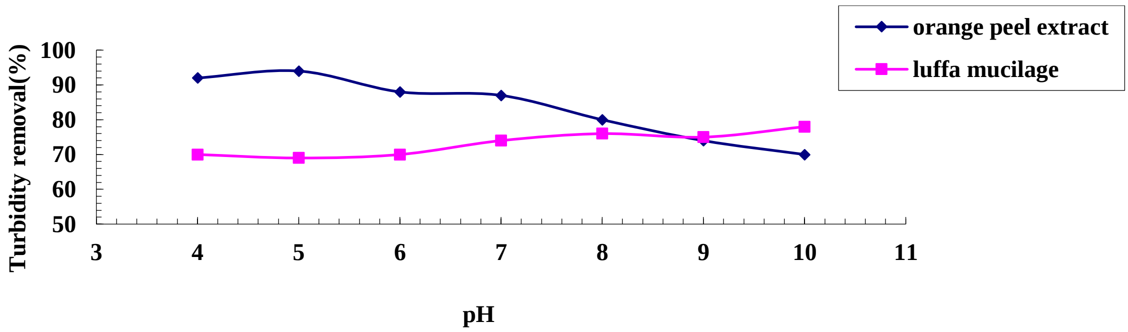
Determination of the optimal concentration for coagulant

Fig. (1) showed the effect of plant coagulants concentration used in water purification on the percentage of turbidity removal, as the concentrations of coagulants, which ranged between 40-50 ppm, gave the highest significant difference in the percentage of turbidity removal, as they were 87 and 71% for coagulant of orange peel and luffa, respectively. The difference in the percentage of turbidity removal among coagulants is due to the difference in the amount of ionic neutralization between the opposite charges of the polymer and the impurities.



LSD: 2.22

Fig. (1): The effect of coagulant concentrations of orange peel extract and luffa mucilage on the percentage of turbidity removal.



LSD: 1.89

Fig. (2): The effect of pH values at the optimal concentration of the coagulant for orange peel extract and luffa mucilage on the percentage of turbidity removal.

Determination of the optimal pH

Fig. (2) showed the effect of pH values, which are 4, 5, 6, 7, 8, 9, and 10 at the optimal coagulant concentration on the percentage of turbidity removal. Thus, the optimal pH values were 5 and 10 for each coagulant of the orange peel and luffa, which achieved the highest significant difference in the percentage of turbidity removal, as it reached 94 and 78%, respectively. This may be due to the difference in the content of the orange peel extract of active groups and the type of charges they carry, and the nature of suspended materials and their content of electrical charges.

The pH plays an important role in changing the electrical charges of the active groups of coagulants, including the galacturonic acid present in the composition of plant gum, which affects the degree of connecting of the gum to suspended substances and reduces turbidity (Jadhav & Mahajan, 2013). When the pH value is high above the isoelectric point, negative charges increase.

In contrast positive charges increase when it is lower, affecting the degree of contact, adsorption, and bond formation between the impurities and the coagulant. The charge yield nears zero when the coagulant and impurities reach an isoelectric point, and aggregation and sedimentation ensue (Díaz *et al.*, 2016).

Fig. (3) showed the concentrations of some heavy elements represented by iron, chromium, copper, cadmium, and lead in water before and after purification under optimal conditions. The results of the statistical analysis showed the highest significant decrease in the concentration of all heavy elements using luffa fruit coagulant and orange peel coagulant, which were 0.2, 0.25, 0.16, 0.24, 0.21 ppm and 0.27, 0.25, 0.31, 0.28, 0.3 ppm respectively, compared to their concentration in turbid water before purification, which was 0.4 ppm.

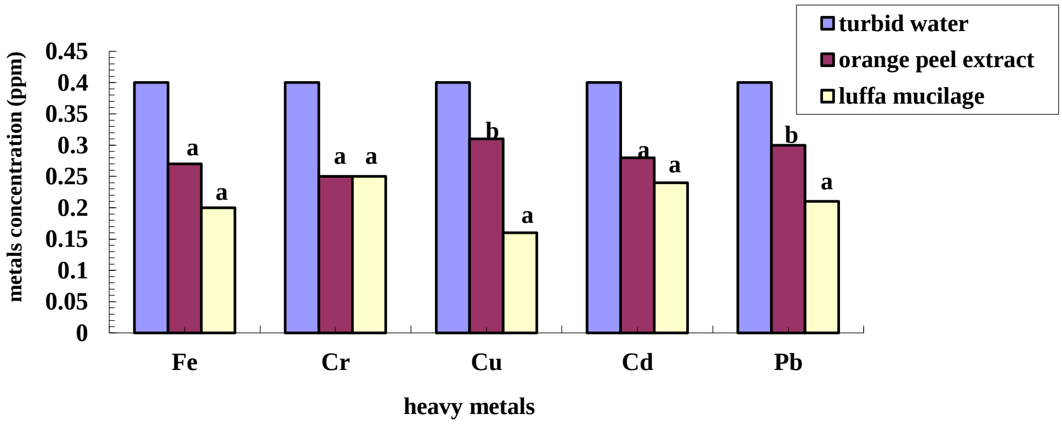


Fig. (3): Concentrations of some heavy elements in fresh water and after purification (orange peels extract and luffa mucilage), under optimal conditions.

The results of the current study consistent with what Rebah & Siddeeg (2017) findings, where they found that the gum of the cactus plant used in purifying contaminated water significantly reduced the concentration of heavy elements represented by cadmium, chromium, copper, lead, and zinc in the adsorption process. Nharingo *et al*. (2015) stated that the mechanism for removal of heavy elements using organic coagulants is carried out because they contain hydroxyl and carboxyl groups, as well as amine groups that are associated with lead, zinc, cadmium, and copper ions in rivers that contain high concentrations of these elements. The method of removal of heavy metals with coagulants is more efficient than other methods. The removal efficiency of heavy metals are affected by the increase in the bonding surface area, and the coagulant concentration and pH (Gupte *et al.*, 2012).

Use of plant coagulants as coagulant aids with alum in the treatment of turbid water

Fig. (4) showed the effect of using plant coagulants represented by orange peel extract and luffa mucilage as coagulant aids with alum in the percentage of turbidity removal. Besides, it became clear that using the optimal concentration of plant coagulants that ranged between 40-50 ppm with a quarter of the optimal concentration of alum 5 ppm in water purification achieved a percentage of turbidity removal ranged between 81-89%. However, using the optimal concentration of coagulants with half the concentration of alum 10 ppm gave a percentage of turbidity removal ranged between 87-93%. The results of the statistical analysis showed that there was a significant difference in the percentages of turbidity removal between the mixing ratio 1:0.5 and 1: 0.25 (coagulant aid: alum). Cactus gum coagulant was used at a concentration of 40 ppm as a coagulant aid with alum, the percentage of turbidity removal was 91% when purifying industrial wastewater (Rebah & Siddeeg, 2017).

It is close to the percentages of turbidity removal resulting from the study when using plant coagulants as coagulant aids. The study results are also consistent with Hayder &

Rahim (2018) results they found that using lablab extract (*Dolichos lablab*) as a coagulant aid with alum, with a mixing ratio of 1:0.5 and 1:0.25 (coagulant aid: alum), the percentage of turbidity removal was 95.5 and 71.2% respectively, with precipitation time of 1 hour.

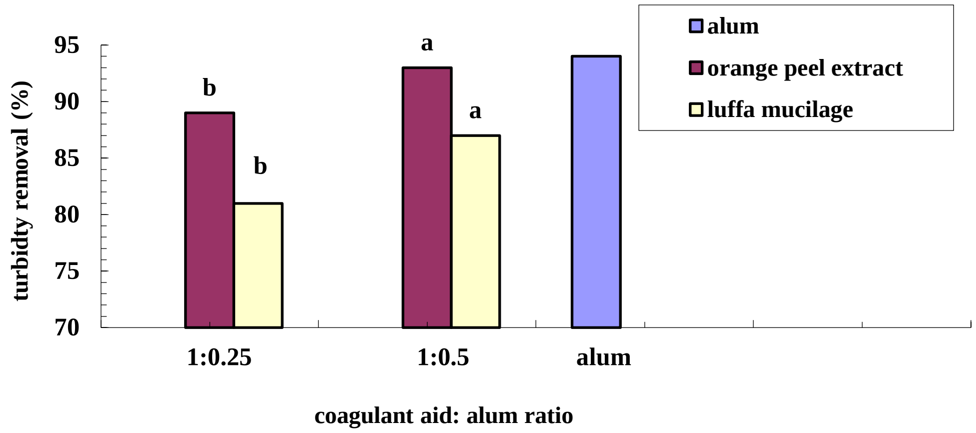


Fig. (4): The effect of using orange peel extract and luffa mucilage as coagulant aids with alum on the percentage of turbidity removal.

Also, this method reduced the concentration of alum required for purification by 40%. Additionally, the study of Sulaymon *et al.* (2013) showed that gum arabic as a coagulant aid in purifying water with 100-500 NTU, its turbidity decreased to more than 50%. Even though, Shamsnejatia *et al.* (2015) showed that using basil gum as a coagulant aid with alum was more efficient in removing the organic content of industrial wastewater at a percentage of 76% compared to using alum alone at a higher concentration.

The study indicated that using natural coagulants with alum in a ratio of 1:0.5 (coagulant aid: alum) is more efficient than using plant coagulants alone in purifying water during the initial stage of water treatment. Using, it gave the highest percentages of water turbidity removal. It is possible to increase its efficiency in turbidity removal and suspended substances by increasing the concentration of coagulant aids. Otherwise, by prolonging the sedimentation period to reach the alum efficiency when used as a main coagulant in water purification, reducing the concentration of water purification. Alum added to water being a substance harmful to human health.

Processing mechanism

There are forces of attraction between suspended materials called the Van der Waals force that tries to collect suspended materials together. However, the repulsive forces between these materials resulting from the similarity of charges on their external surfaces are stronger than them. Upon reaching the optimal concentration of the coagulant, neutralization of charges occurs and the zeta potential is reduced to close to zero. This behavior represents the value of the potential present between the double layer represented by the liquid medium and the layer surrounding the suspended materials, called the isoelectric point. The suspended materials are collected and deposited in the highest proportion. Despite the fact, when the polymer concentration increases above the required limit, there will be a reverse increase in the charges resulting from the coagulant, excessing the isoelectric point, and returning to the repulsion state as shown in fig. (1) (Sulaymon *et al.*, 2013).

Biological coagulants contain active groups represented by carboxylic, hydroxyl, and amine groups resulting from the organic content of mucilage. These groups are a source of positive and negative charges that neutralize the charges on the outer shells of suspended materials and reduce the repulsive forces between these particles or work to bind suspended materials together by polymeric bridges, aggregating and precipitating them. This process is called adsorption (Lee *et al.,* 2014).

Orange peels extract is a good source of bioactive compounds and phytochemicals like tannins, flavonoids, saponins, and terpenoids which, effectively bind to suspended matter and pollutants (Gotmar & Gade, 2018).

Furthermore, fig. (2) showed that the percentages of water turbidity removal change according to the pH values change. It was observed that coagulant of orange peel extract and luffa mucilage gave the largest proportion of turbidity removal at pH values of 5 and 10, respectively. The pH affects the type and density of the charges present on the coagulant surfaces, when the pH value is high above the isoelectric point, the negative charges increase, while the positive charges increase when it is lower from it, which affects the degree of interaction, adsorption and the formation of bonds between the impurities and the coagulant, and upon reaching the isoelectric point between coagulant and impurities, the charge yield near to zero, and aggregation and sedimentation occur (Lee *et al.,* 2014; Díaz *et al.,* 2016).

Conclusions

It can be concluded from the study that:

1-The highest significant difference in turbidity removal was obtained by using orange peel coagulant, which reached 94% at a pH of 5.

2-The possibility of using plant coagulants as coagulant aids at a ratio of 1:0.5 (coagulant aid: alum) to increase the efficiency of coagulation and to reduce the concentration of alum added to the water. Besides, they are environmentally friendly coagulants, as well as they do not affect the increase of organic and inorganic compounds in the water. It is possible to increase the percentage of turbidity removal and suspended matter by increasing the concentration of coagulant aids or by prolonging the sedimentation time to reach the alum efficiency when used as the main coagulant in water purification.

3-Plant coagulants achieved significant differences in reducing the concentration of heavy elements in the water.

Contributions of authors

I.M.A.: Mucilage extraction and write the manuscript.

L.Q.H.: Statistical analysis and assist in analysis of water samples.

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Conflict of interest

The authors have no possible conflict of interest.

Ethical approval

All ethical guidelines related to poultry breeding and care issued by national and international organizations were implemented in this report.

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تنقية المياه العكرة باستعمال مستخلص قشور البرتقال وهلام نبات الليف

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المستخلص: يسبب زيادة تركيز أيون الألمنيوم الناتج من استعمال المخثرات الكيميائية في معالجة المياه مشاكل صحية للإنسان منها تلف خلايا الدماغ والاصابة بالزهايمر، لذا سعت دول عدة لإيجاد مخثرات بديلة او مساعدة مستخلصة من مصادر عضوية طبيعية صديقة للبيئة لأستعمالها في معالجة المياه. شمل البحث تحضير مستخلص مائي من قشور البرتقال واستخلاص صمغ الليف وحساب الحصيلة وتقدير حجم الجسيمات الصمغية واستعمالها كمخثرات نباتية لتنقية المياه العكرة، وتم تعيين الظروف المثلى لها تمثلت بتركيز المخثر والأس الهيدروجيني لأعطاء أعلى كفاءة في تصفية المياه العكرة المصنعة، فضلا عن استعمالها مساعدات للتخثير مع الشب لتقليل تركيز الشب المستعمل في تصفية المياه. اشارت النتائج إن التراكيز المثالية للمخثرات الطبيعية تراوحت بين 40-50 جزء بالمليون ، فقد تفوق مخثر قشور البرتقال على مخثر الليف بفرق معنوي في إزالة العكورة اذ كانت 87 و 71% على الترتيب، عند قيم اس هيدروجيني بلغت 5، 10 . فضلاً عن وجود فروق معنوية في خفض العناصر الثقيلة باستعمال المخثرات في معالجة المياه. بينت نتائج التحليل الاحصائي وجود فرق معنوي بنسب ازالة العكورة بين نسبة الخلط 0.5:1 و 0.25:1 (مخثر مساعد: شب). اذ تبين ان استعمال التركيز المثالي لمخثر قشور البرتقال مع نصف تركيز الشب قد أعطى نسبة إزالة للعكورة مقاربة لاستعمال الشب بمفرده في تصفية المياه. نستنتج من الدراسة امكانية استعمال امكانية استعمال المخثرات النباتية المستخلصة للتقليل من تركيز الشب المستعمل في تنقية المياه العكرة . واظهرت النتائج اقصى انخفاض معنوي في تركيز كافة العناصر المعدنية باستعمال مخثر نبات الليف ومخثر قشور البرتقال مقارنة مع تركيزها في المياه العكرة قبل التنقية الذي كان 0.4 جزء بالمليون.

الكلمات المفتاحية: الشب، معادن ثقيلة، مساعدات تخثير طبيعية، ازالة العكارة.