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The use of onion seeds extract as a natural coagulant in water treatment

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الملخص العربى :

يسبب التعكر مشكلة كبيرة في معالجة المياه. تم استخدام بذور البصل كمخثر طبيعي متاح محليًا في هذه الدراسة لتقليل تعكر المياه الاصطناعية. تم إجراء الاختبارات باستخدام الماء العكر الاصطناعي مع جهاز اختبار الجرة التقليدي. تم تحديد كثافة ومدة الخلط الأمثل و الجرعات ، تم استخدام مستخلصات بذور البصل القابلة للذوبان في الماء مع عكارة تتراوح من 14 إلى 198 (NTU) وقيم مختلفة من معامل الحموضة 3 - 10 . تعمل مواد التخثر الطبيعية بشكل أفضل مع المياه عالية التعكر مقارنة بالمياه ذات التعكر المتوسط أو المنخفض. تمت إزالة العكارة المحققة في حدود 97-99٪ ، حيث تم تحقيق أعلى كفاءة في الإزالة عند درجة الحموضة 9 ، ووقت الترسيب 60 دقيقة وجرعة الاستخلاص 4 مل / لتر. ثبت أن مواد التخثر الطبيعية المتوفرة محليًا المستخلصة من بذور البصل هي خيار مناسب وسهل وصديق للبيئة لمعالجة المياه.

Abstract:

Turbidity conveys a great problem in water treatment. In this study, onion seeds were utilized as a locally available natural coagulant to reduce a turbidity present in synthetic water. The experiments were made using artificial turbid water using the conventional jar test apparatus. Mixing intensity and duration were proven to be optimal. After preparing, water-soluble extracts of onion seed have been used with turbidities ranging from 14 to 198 (NTU) and different values of PH 3–10. Natural coagulants worked better with high turbidity water compared to medium or low turbidity water. The achieved turbidity removal was in the range of 97-99%, where the highest removal efficiency was achieved at PH equal to 9, sedimentation time of 60 min and extract dose of 4 ml/L. Natural coagulants extracted from onions were shown to be acceptable, simple, and environmentally friendly options for water treatment.

Keywords: Onion; turbidity; natural coagulant; alum; water treatment

1. Introduction

Water is, without a doubt, the most important of all the natural resources on the planet. Access to clean and safe drinking water is a major issue in several developing countries, particularly in Africa. More than six million people die each year as a result of diarrhoea caused by contaminated water. In order to import chemicals for water treatment, developing countries must pay a hefty premium.(Ghebremichael 2004).

Water from all sources must be treated in some way before it can be used for human consumption. A variety of techniques were employed to ensure that water is safe to consumers. The methods that have been used were determined by the characteristics of the raw water. It is one of the challenges associated with surface water treatment that the turbidity varies so widely from one season to another. (McConnachie et al. 1999). In the treatment of water, some traditional chemicals are used at various stages of the process, particularly during the treatment of surface water. Artificial organic and inorganic substances are among the most commonly encountered chemicals in a variety of treatment units. These are typically expensive because they are required in higher doses and do not demonstrate cost effectiveness in the majority of cases. Many of the chemicals have also been linked to adverse effects on human health and the environment.(Kaggwa et al. 2001). As a result, they raised their voices in support of the development of a water clarification process that is more cost-effective, simpler, and environmentally friendly.

The use of natural materials for water clarification has increased as a result, particularly in the treatment of high-turbidity waters (>100 NTU). Natural coagulants of mineral and vegetable origin have been used in water treatment since before the invention of chemical salts, and natural coagulants have been used for traditional water treatment in tropical rural areas since the invention of chemical salts.(Šćiban et al. 2009) however, due to a lack of scientific understanding of their efficacy and mechanism of action, they have been unable to compete effectively in the marketplace. The use of natural coagulants has traditionally been discouraged due to a paucity of scientific evidence supporting their efficacy..(Muthuraman and Sasikala 2014) .

Recent years have seen a significant increase in the interest in natural coagulants, which can be synthesised or isolated from microbes, animal, and plant tissues. This group of coagulants must be non-toxic to humans and environmentally friendly, as well as biodegradable.(Pearse 2003). Furthermore, natural coagulant ingredients result in a sludge that is significantly more biodegradable and less voluminous than its alum-treated counterpart, with a volume that is only 20–30 percent that of the alum-treated equivalent(Rondeau et al. 2000). Numerous papers provide a comprehensive summary on bio-products renowned by their coagulation–flocculation properties(Hussain and Haydar 2019).

Polymer bridging, double layer compression, sweep coagulation, and charge neutralisation are the most common coagulation mechanisms. Charge neutralisation and polymer bridging are the only accepted coagulation processes for a plant-based natural coagulant(Amran et al. 2018). Polymer adsorption is the first step in polymer bridging, and it occurs when long chain polymers bind to the surface of a colloidal particle as a result of their affinity for the colloidal particle. It is only a small portion of the polymers that are bound to the particle, with the remainder forming loop and tail structures(Bolto and Gregory 2007). The basic structure of polymer bridging is loops and tails, which allow attachments to other colloidal particles and therefore the formation of bigger flocs. The presence of sufficient vacant particle surface, as well as a bridging length sufficient to overcome interparticle repulsion, are both required for effective polymer bridging to occur. These criteria are addressed by using a natural coagulant to provide a sufficient amount of polymer, which provides adequate bridging linkages and bare particle surface for strong polymer bridging(Miranda, Latour, and Blanco 2020). It has been demonstrated by others that, regardless of their protein content or coagulation/flocculation performance, the most important pollutant uptake mechanisms in these plants can all generally be classified as adsorption and charge neutralisation mechanisms(Othmani, Rasteiro, and Khadhraoui 2020). Realistically, different plants have been studied for their coagulating/flocculating performance in the removal of suspended matter (SM), chemical oxygen demand (COD), and turbidity (TN) from various types of freshwaters, whether through the use of seeds or other forms of plant material (husk, pith, kernels, and leaves)(Gaikwad and Munavalli 2019) and wastewaters(Gökçek and Özdemir n.d.). Because the chemical composition of extracts obtained from solid coagulants does not fully explain the coagulation activity of natural coagulants, it is necessary to look elsewhere. (Bodlund 2013). Because of this, the coagulation activity of natural coagulants can only be demonstrated through experimental testing.

Following on from previous studies, some researchers have used natural coagulant extracts directly after preparation, without any modification to the extracts. (Sanghi, Bhatttacharya, and Singh 2002). Since, only an optimum concentration of protein in natural coagulant extract can remove turbidity from water effectively(Hussain, Ghouri, and Ahmad 2019), It is necessary that the density of natural coagulant extract be concentrated to the highest possible levels. Apart from coagulant density, other variables such as initial water turbidity, coagulation dose, pH, rapid mixing time, and slow mixing time have an impact on the coagulation process and performance. The coagulation efficiency of a natural coagulant is highly dependent on the coagulant itself; in another world, the amount of crude extract that mixes with turbid water and forms better agglomeration flocks .

Materials and methods

1.1.Preparation of onion extract

Onion were brought locally from the city of Mansura-Egypt, selected carefully for the best quality. First, using a mortar and pestle, grind the ingredients to a fine powder, and then use a laboratory mill..

Five grams of the prepared powder was suspended in 100 mL of NaCl solution containing 1 molar concentration, and the suspension was stirred at a speed of 500 rpm with a magnetic stirrer for 1 hour at room temperature (25°C) to obtain the best dissolving and extraction of the coagulation active components. Using a piece of gauze, the suspension was gravity filtered through a rugged filter paper, and then through a 45-micron filter to remove any remaining particles. The filtered solutions, which were referred to as crude extracts, were stored at 4°C in a refrigerator.

1.2.Coagulant Characterization

Many tests are required to establish a thorough understanding of the feasibility of using onions as natural coagulants in the treatment of turbid water and regarding their surface morphologies and crystallinity. A scanning electron microscope (SEM) which is the JEOL JSM 6510 LV was used to examine the surface of samples and produce a high-quality and clear stereoscopic image for the purpose of studying the morphology. The magnification capacity reaches 300,000 times. It works under high vacuum and can work under low vacuum. Also, energy dispersive X-ray ETDX (SPI Module-Sputter Carbon/Gold Coater) by covering the sample with a thin layer of carbon or gold, or a mixture of gold and palladium with a thickness of 10-30 nanometers after the drying operations of the samples to be examined with the aim of making them conductive to the electric current because the samples are examined using electrons inside the scanning electron microscope. The Malvern Zeta potential analyzer (Malvern Zeta size Nano-zs90) is used in stress analysis measurements, in addition to measuring the size of particles present in the solvents from 0.3 nm to 5 micrometers, as well as the molecular size, molecular weight, and rheological properties. Biodiesel blending analysis, gemstone analysis, polymers and plastics, quality assurance/quality control (QA/QC), pharmaceuticals, and forensics are all applications for the NicoletTM iSTM 10 FTIR Spectrometer.Spectral range of 7800-350 cm-1 optimized, mid-infrared KBr beam splitter, 11000-375 cm-1 XT KBr extended range mid-infrared optics. Moreover, the total organic carbon of the treated sample was measured using aj-Analyzer multi N/C 3100; multi Win 4.07; serial no: N3-191/I. The following devices were used (T80 Series UV/Vis Spectrophotometer by PG Instruments Ltd, Thermo Scientific iCAP 7000 Series ICP-OES: ICP-OES Optical Design, behr distillation units of the S series, and Chamber Furnaces

Standard Series Product Models (MT Series 1100°C-1300°C) for testing the composition and characteristics of onions and their extracts.

1.3. Turbid water preparation:

Preparation of turbid water for coagulation tests is done by adding stock kaolin suspension into tab water. The stock kaolin suspension contained 15 g of kaolin in 1 L of distilled water and was mixed at 120 rpm stirring for 2 h to achieve a uniform dispersion of kaolin particles, and then it was allowed to remain for 24 h to complete the hydration of the particles(Okuda et al. 2001). A series of (14-198) NTU solutions were prepared before the coagulation tests by adding sequential dilutions before the start of the test just before the coagulation test. The pH of the synthetic water was adjusted to the desired range of 3–10 using 1 mol/L NaOH or HCl to achieve the desired results. A pH metre was used to measure the pH of solution. (Model 341350A, EXTECH Instruments, PH/Conductivity, TDS/Salinity/ORP Meter).

1.4. Coagulation experiments

To evaluate the coagulation activity of the natural coagulant, jar test experiments were conducted. Turbidity concentration of solutions was prepared in six beakers of 1 L volume each, which were then placed in a conventional jar tester to measure turbidity concentration. Onion extract of various dosages was added to each beaker and stirred for 5 min at 140 rpm for rapid mixing. Then, the mixing speed was reduced to 40 rpm for 30 min as slow mixing. The stirrer was then stopped and After that, all suspensions were allowed to settle for 1hr. After that, the samples for the residual measurement were collected carefully from the top of each beaker. By using a turbidity metre (TB300 IR Turbidity meter, P/N TB300IR-10, S/N 12/1727), the turbidity of each sample was measured. All of the experiments were carried out at a constant room temperature of 25 degrees Celsius. While the pH of the solution was controlled using either NaCL or NaOH to investigate the effect of the pH parameter on turbidity removal. The values of pH were varied from 3–10, while the dosages of natural coagulant were changed from 1 to 5 ml/L. The initial turbidity of the solution was investigated from 14 to 198 NTU. The same coagulation test was conducted with no coagulant as a blank. The efficiency and activity of coagulants were calculated based on Eqs. (1) and (2):(Choy et al. 2016)

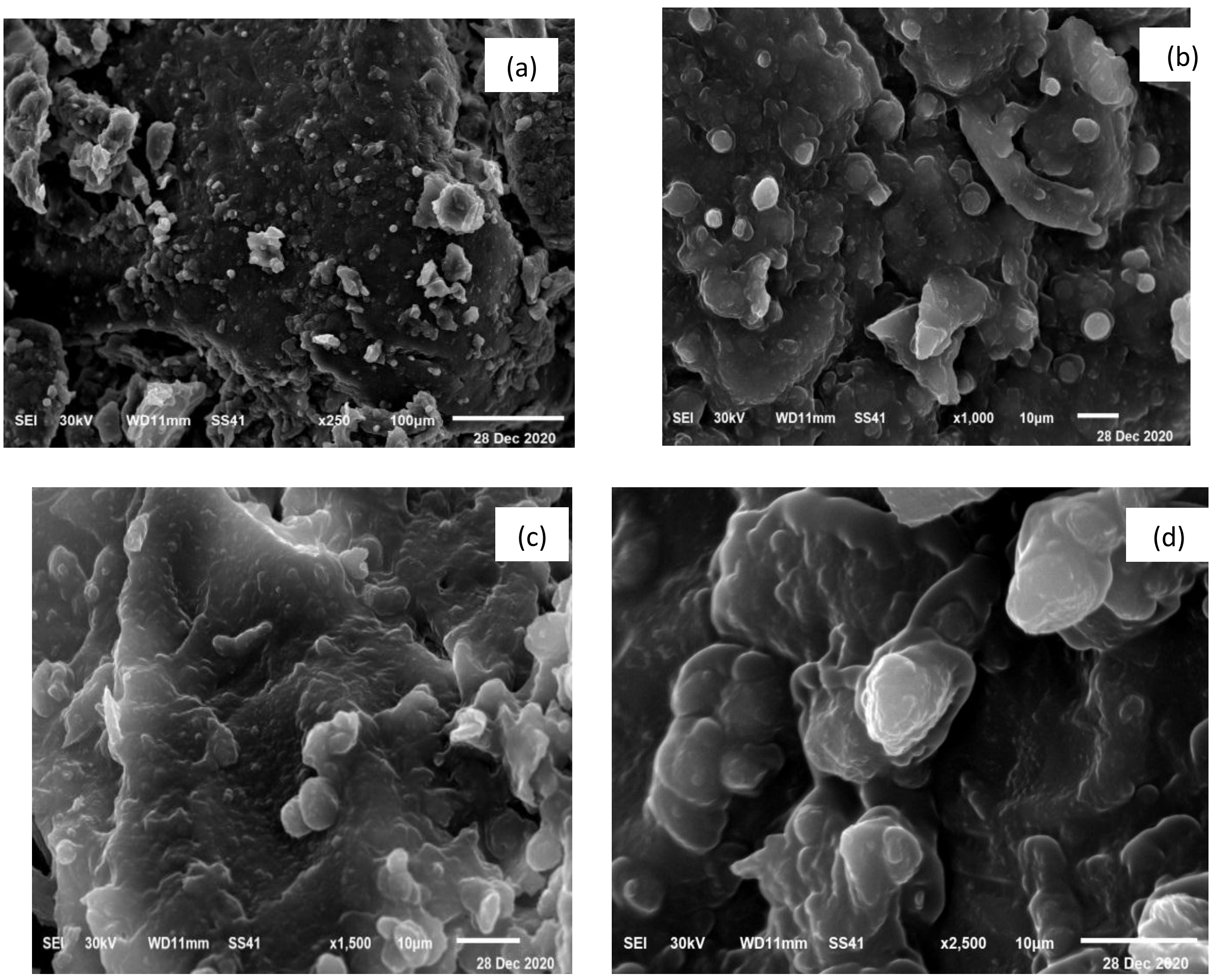
$$\text{Turbidity Reductions (\%)} = \frac{Initial\ Turbidity\ Sample - Final\ Turbidity\ Sample}{Initial\ Turbidity\ Sample} * 100\% \quad (1)$$

$$\text{Coagulation Activity (\%)} = \frac{Final\ Turbidity\ blank - Final\ Turbidity\ Sample}{Final\ Turbidity\ \ blank} * 100\% \quad (2)$$

2. Results and discussion

2.1.Coagulant Characterization

Fig. 1 (a, b, c, d, and e) depicts a scanning electron micrograph of an onion seed. The presence of numerous pores of varying sizes on the surface of the seed is indicative of the seed's ability to coagulate water from the surrounding environment.Fig.1 (e) shows (EDX) of the onion seed powder confirmed the presence of C, N, O, Na, Mg, P, S, K, Ca, Br, Fe and Cu compounds. Other than that, the presence of O and C in onion seeds is associated with the presence of a high protein content, which contributes to the excellent performance of this natural material during the coagulation process. According to previous findings, minerals in onion seed composition suggest that anions and cations can attach to free active sites in the seed composition, which is consistent with the presence of free active sites in onion seed composition.(Shak and Wu 2015).



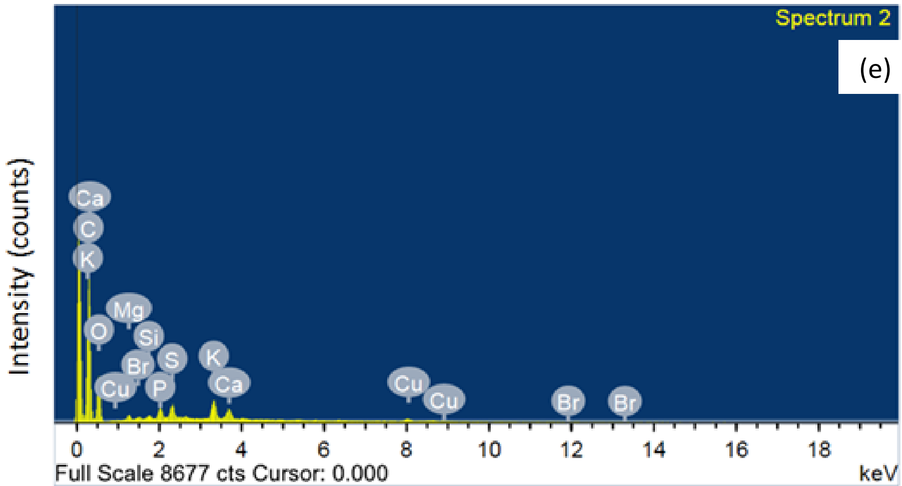


Fig. 1 SEM micrograph of onion powder (a) x500 (b) x1000 (c) x1500 (d) x5000 and (e) EDX pattern.

FTIR analysis

The functional groups present in onion powder were studied by the FTIR technique, as shown in Fig. 2. O-H qualified the wide band at 3714 cm^{-1} and bands from 3752 to 3906 cm-1, stretching that can be found in lignin, carbohydrates, protein, and fatty acids(Younes, Mahanna, and El-Etriby 2019);(Younes, H., El-Etriby, H. K., & Mahanna 2021). Regarding C–H group the peaks from 1849 to 3449 cm^{-1} were at 1849, 2121 and 3008 cm^{-1}(N. El-Bendary, El-Etriby, and Mahanna 2021). The characteristic peaks from 1546 to 1743 cm^{-1} were ascribed to the C-N elongation vibration due to amide group (Mateus et al. 2018). While peaks from 1243 to 1460 cm^{-1} were linked to C-O stretching vibration(Wan et al. 2019);(Nohier El-Bendary, El-Etriby, and Mahanna 2021). There have been some observations of the distinct vibrations of the elongation of the C-OH hydroxyl bond at the wavelengths 1027 and 1164 cm^{-1} (Mateus et al. 2018). Whereas, the peaks placed at 722 and 875 cm^{-1} proposed the presence of CH2 distortion(Choy et al. 2016). Another peaks at 422 and 613 cm^{-1} could be associated with metal hydroxyl and metal oxygen(Mahanna and Samy 2020). As a result, one of the most important factors in the successful coagulation activity of onion natural coagulant is the presence of diverse functional groups with varying wave numbers.

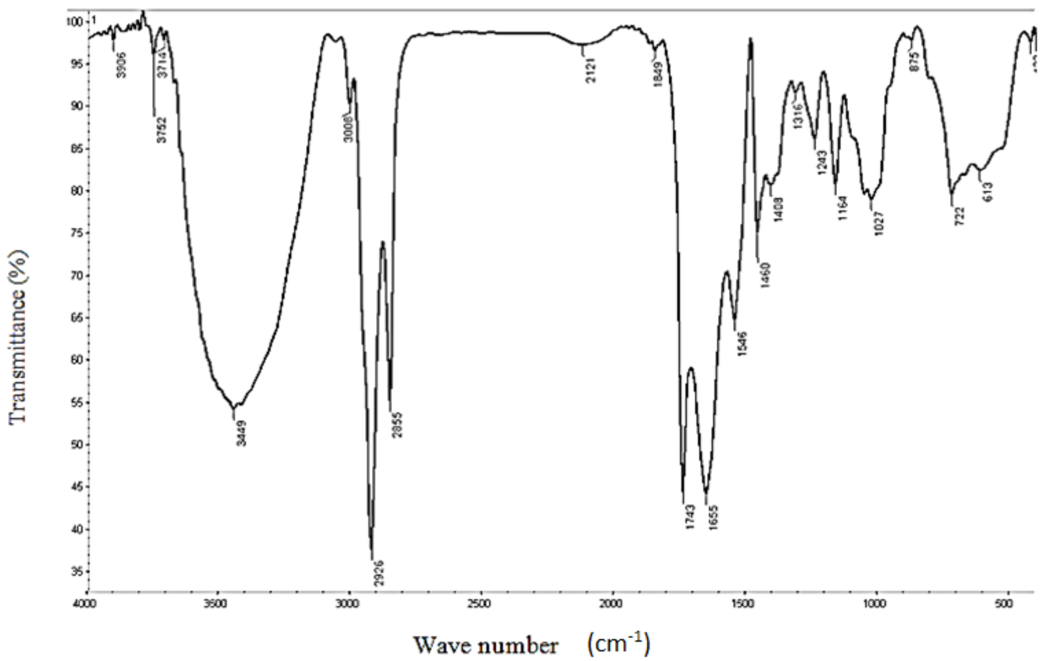


Fig. 2 FTIR spectra of onion powder.

Zeta potential

The factor zeta potential affects the clotting process. According to the fig. 3, the onion extract had a positive charge of +2.5 millivolts when the pH was 2 and the amount of charge was directed towards zero when the pH reached 4 and with the increase of the pH values up to 8 in terms of the value of the charge to peak level of onion extract to -5.48 mV. The presence of hydroxyl groups and carboxyl groups of proteins on the coagulation surface (as shown in the previous FTIR analysis), which differ according to the percentage of protein content, is related to the ability of the negative charge(Choy et al. 2016). After continuing to increase the pH value to 10, the value of the charge began to decrease to the level of-4.21 The higher difference in condensed charge of onion extract indicates the presence of a greater number of separable groups due to pH change(Mateus et al. 2018). The potentially high value of zeta indicated the higher performance in coagulation activity(Baptista et al. 2017).

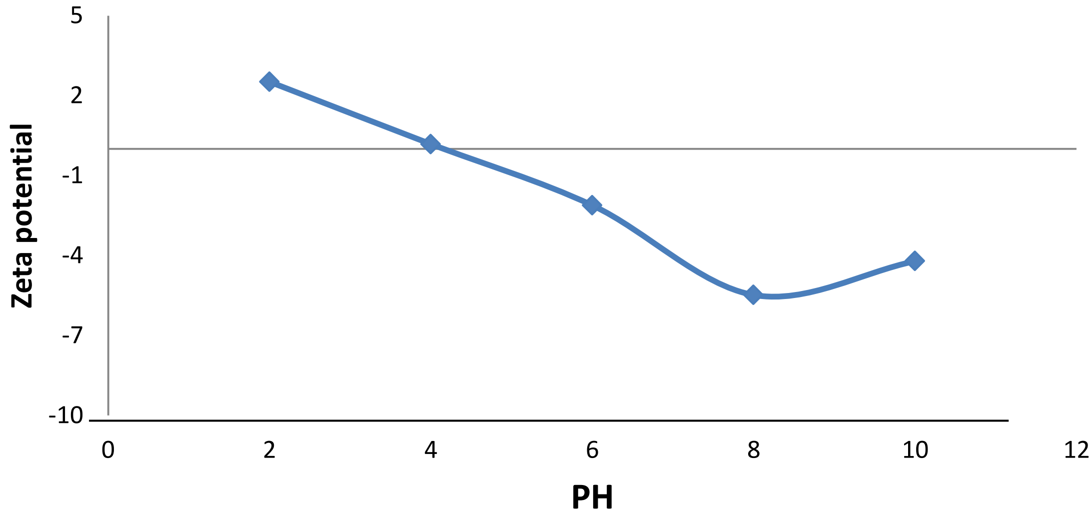


Fig.3 Zeta potential as a function of pH.

2.2.Effect of natural coagulant dose

aqueous solutions with turbidities of 14, 54, and 198 NTU were treated with coagulant doses of 1 mL/L onion extract and a settling time of 60 min in order to investigate the effect of initial turbidity and coagulant dose on the effectiveness of coagulation. The best dose was 4ml/L, which produced removal efficiencies of 85.5%, 96%, and 98.9% respectively, as shown in fig.4 a, and the coagulation activities at the same condition were 74.5%, 92%, and 97.5% respectively. Figure 4b.

With low doses of the extract such as 2, 3 ml/L or less, the coagulation process was reduced with increased primary turbidity due to decreased protein concentration, which is the main reason for decreased coagulation activity because the coagulating dose is not enough.

The highest effective dose of coagulant was noticed, which was 4ml/L, while increasing the coagulation dose more than 4ml/L led to an increase in turbidity because of the elevated concentration of organic material.

When it comes to turbidity removal, it was discovered that the efficiency of coagulants extracted from onions was comparable to the efficiency of some natural coagulants that had previously been investigated.(Bodlund 2013) or less efficient than others (Ghebremichael et al. 2005). Anyway, the findings of this study, which showed a low organic load in water treated by onion extract, indicated promising prospects for further research into the extraction, purification, and application conditions of onion extract.

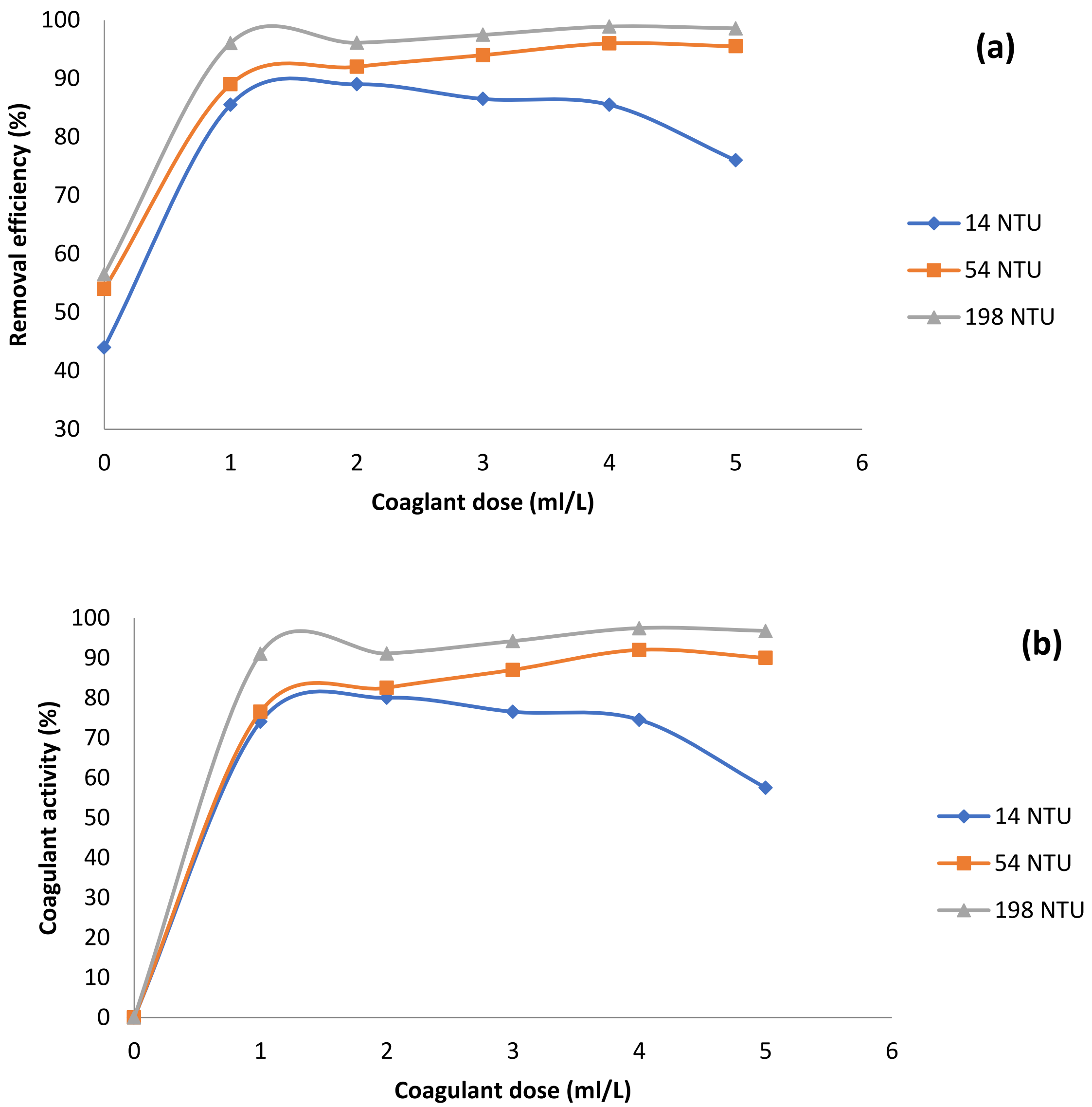


Fig. 4 effect of natural coagulant dose on (a) turbidity removal efficiency and (b) coagulation activity at pH = 8 for different turbidities.

2.3.Effect of pH

In order to study the effect of pH on the coagulant material, three different levels of turbidity were used: low 14 NTU, medium 61 NTU, and high 169 NTU. Considering the optimal fixed dose of onion extract at 4 ml/L with different values of pH 3, 5, 7, 9, and 10 respectively, it is clear that the removal efficiency is greatly affected by the change of pH, where the lowest value for removal efficiency for three levels of turbidity was at 3. It also achieved the highest levels of removal efficiency at pH 7 and 9, turbidity of 14 NTU was 87%, 87%, turbidity 61 was 96.3%, 97.8%, and turbidity 169 was 97.5%,97.8 respectively.

Observed by Fig.5 when pH is increased more than 9, the removal efficiency begins to gradually decrease, and we attribute the reason for this decrease to a decrease in the value of zeta potential according to the fig. 3

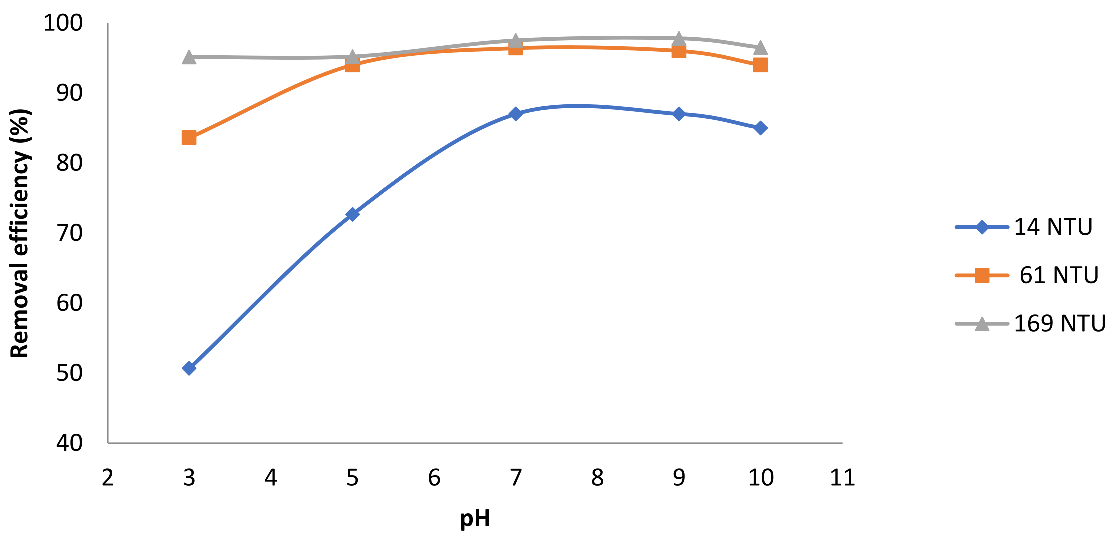


Fig.5. Effect of pH on turbidity removal efficiency.

2.4. Effect of slow mix time

Through the tests that have been conducted on the extract, and as shown in fig. 6, slow mixing time is very important and has an active influence where increasing slow mixing time increases the opportunity of the extract to coagulate and form flogs of a good size, which leads to faster sedimentation. With the use of fixed turbidity of 70 NTU in 6 beakers with slow mixing times of different periods of 10, 15, 20, 25, 30 and 35 min., after a settling time of 30 min., the percentage of turbidity removal was 88.5%, 90.2%, 93%, 94.97%, 95.3% and 94.1%, respectively. When the settling time was increased for 60 min., the percentage of turbidity removal was 93.3%, 94.2%, 95.2%, 96%, 97% and 97% respectively. The percentage of turbidity removed increased with increasing the period of slow mixing(Ernest et al. 2017). According to that 30 min was chosen as the best time for slow mixing time for these tests.

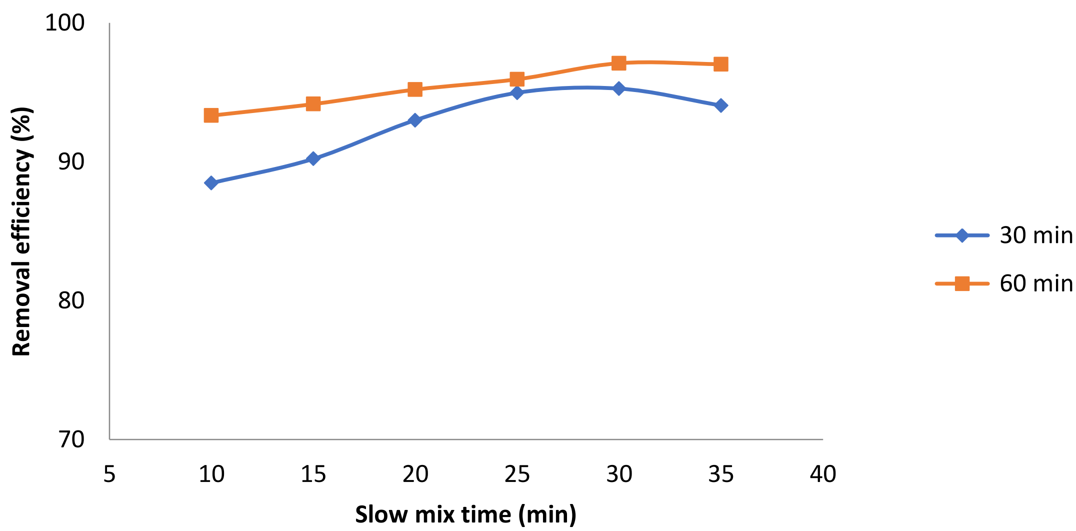


Fig. 6 effect of slow mix time on turbidity removal efficiency.

2.5. Effect of settling time

One of the most important factors affecting the efficiency of coagulation is the amount of time it takes for the solution to settle. Suspensions and other substances in water vary according to their volumes, weight, and charges after coagulation. According to the fig.7, tests were carried out for three levels of different turbidity, low 14, medium 70 and high 194, onion extract was used with the optimal dose of 4ml/L with pH 8 and the sedimentation time periods of 15, 30, 45, 60, 75 and 90 minutes. The percentage of turbidity removal for 14 NTUs were 82%, 85%, 87.88%, 88.5%, 92.5% and 93.6%, respectively. For 70 NTU turbidity the percentage of turbidity removal were 92.5%, 95%, 95.7%, 97.5%, 98% and 99%, respectively. And with turbidity of 194 NTU the percentage of turbidity removal were 96.5%, 97.8%, 98%, 99%, 99.5% and 99.5%, respectively. The highest percentage of removal occurred within the first hour. The removal efficiency started to decline with time gradually, this may be due to that the amount of active protein present in the extract dose have high reaction rates and was active within 30 to 60 min of sedimentation(Shak and Wu 2014).

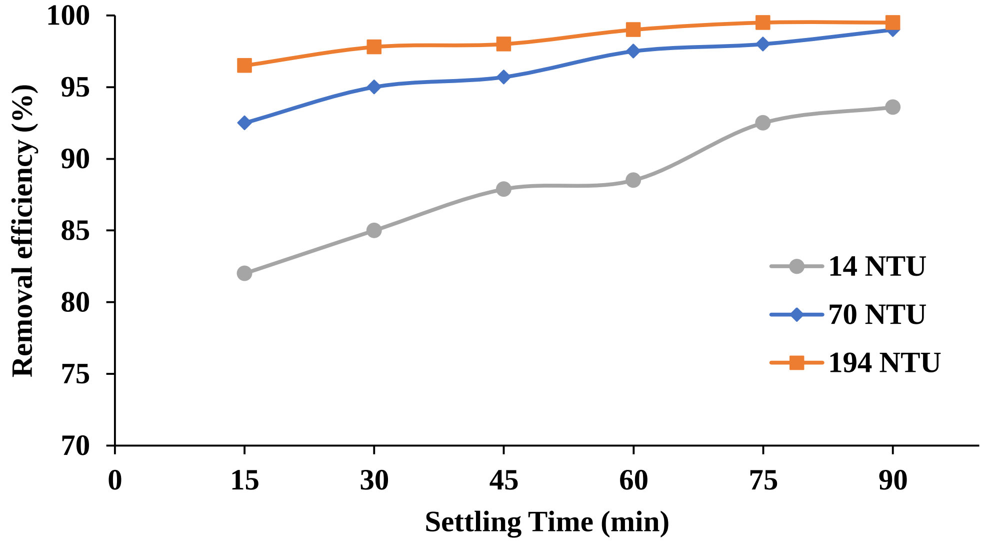
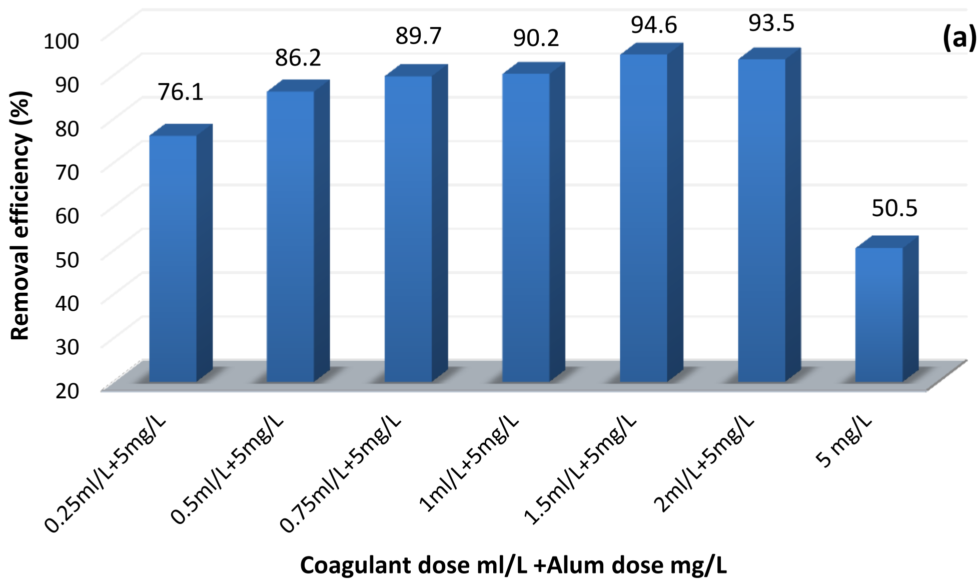


Fig.7 effect of settling time on turbidity removal efficiency.

2.6.Effect of combination with alum

For the purpose of improving the removal efficiency of the onion extract, a small dose of alum was added with small doses of onion extract, and as shown in Fig.8(a) an average turbidity of 52 NTU was used with a pH equal to 8 where the sedimentation time was 30 min adding a dose of alum by 5 mg/L with different low doses of onion extract less than the optimum dose (0.25, 0.5, 0.75, 1, 1.5 and 2) ml/L where the removal efficiencies were (79.1%, 86.2%, 89.7%, 90,2%, 94.6% and 93.5%) respectively. Under the same condition, a unit dose of alum 5 mg/L was tasted alone with the same turbidity and pH and gave coagulation activity of 50.5%.

As shown in Fig.8 (b), a dose of alum was added at an amount of 10 mg/L instead of the dose of alum of 5 mg/L in a second test under the same conditions with the same previous doses of onion extract. The turbidity removal efficiency was (92.6%, 93.9%, 95.8%, 96%, 95% and 94.6%) respectively in a sedimentation time of 30 min. When the dose of onion extract was low, the coagulation activity was also low. With increasing dose, the coagulation activity also increased up to 1 mg/L. Any dose increase beyond this limit may result in reduced coagulation efficiency, as 1 mg/L of onion extract was considered the best dose. Under the same conditions, a 10 mg/L dose of alum was tasted alone with an initial turbidity of 52 NTU and pH = 8, yielding an 84% coagulation activity.



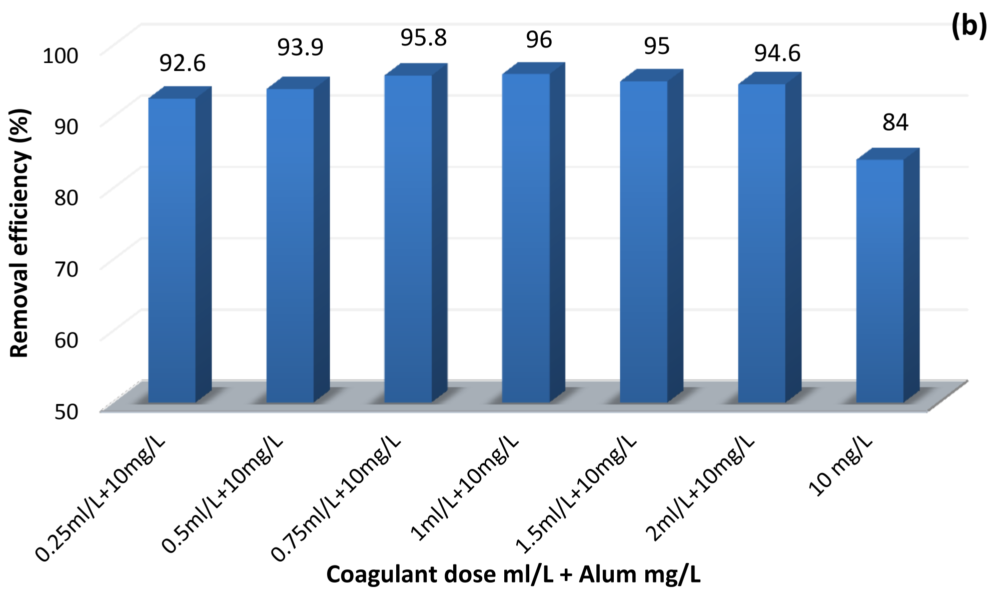


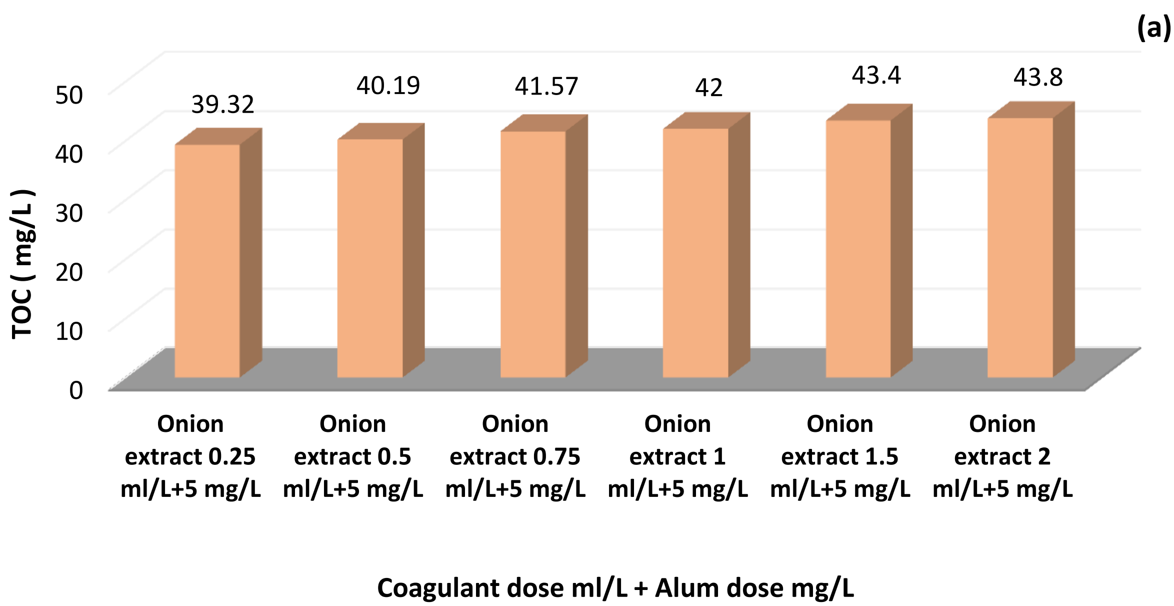
Fig. 8: Effect of combination of alum with natural coagulant (a) natural coagulant dose extract with 5ml/L alum (b) natural coagulant dose extract with 10ml/L alum and initial turbidity NTU=52 , pH =8, settling time 30 min

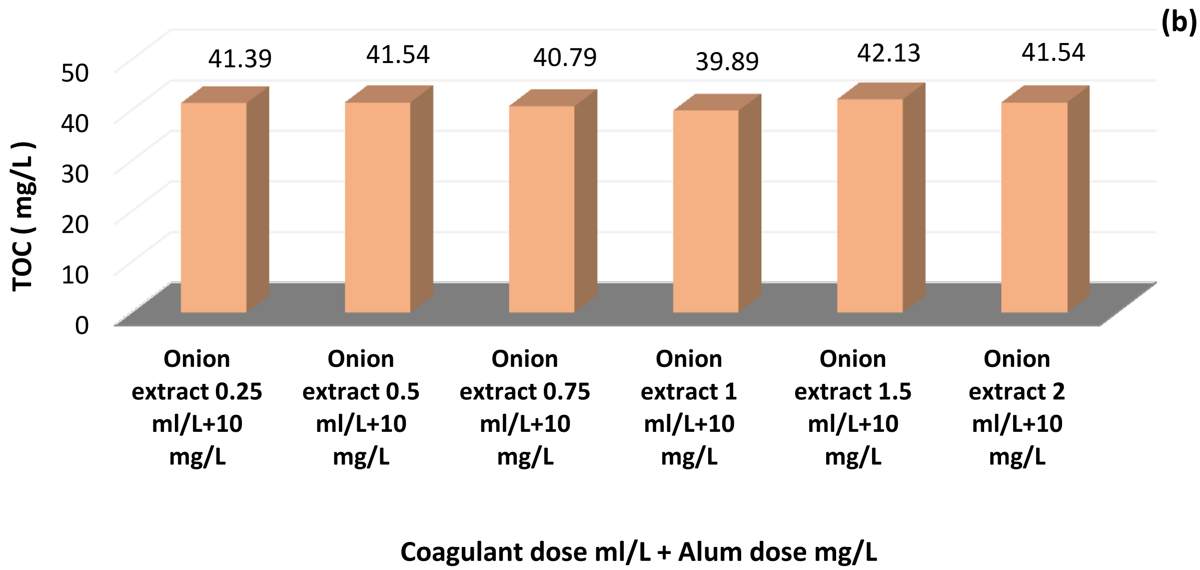
2.7. Organic load in coagulated water

Water quality is greatly influenced by the indicator of the concentration of organic matter in the water. For the purpose of monitoring the percentage of organic matter in the treated water, a number of tests were conducted. It is evident from the fig. 9(a) that six beakers of 1-liter with a fixed turbidity of 52 NTU were prepared with PH 8. Doses of 0.25, 0.5, 0.75, 1, 1.5 and 2 ml/L of onion extract with a fixed dose of alum 5mg/L were added to the beakers. After rapid and slow mixing, and leaving them to settle for 30 min, the TOC was 39.32, 40.19, 41.57, 42, 43.4 and 43.8 mg/L, respectively.

The fig.9 (b) shows the test of adding onion extract in doses with a fixed dose of alum 10mg/L with a fixed turbidity of 52 NTU in the same way as before with pH 8. After rapid and slow mixing, and leaving them to settle for 30 min, the TOC was 41.39, 41.54, 40.79, 39.89,42.13 and 41.54 mg/L, respectively.

Fig.9 (c) Conducting a comparison test between TOC at the same turbidity 52 NTU and pH 8. Only the optimal doses of alum 20 mg/L and the low dose 10ml/L were added, the values of TOC were (32 and 38.4) respectively. Only onion extract tests at optimum dose 4ml/L and low dose 1ml/L were the TOC value (36.75 and 39.89) respectively. TOC value 39.32 was achieved by combining the dose of alum (10 mg/L) with the dose of onion extract (1ml/L) in the same solution. From the previous test and after comparing the results that have been gained by treating the samples with onion alone, with alum alone and with both onion and alum, the organic matter of the treated samples were within the accepted limits(RS2 2012).





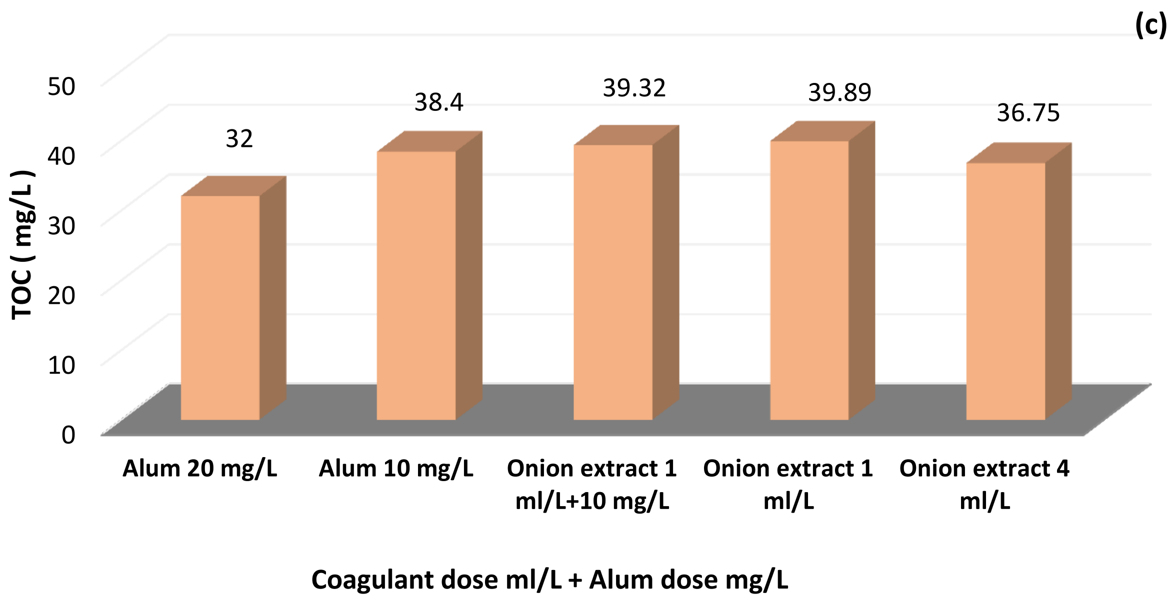


Fig.9 Total organic carbon as a function of (a) natural coagulant dose with alum dose 5ml/L (b) coagulant type with alum dose 10ml/L and (c) Optimum dose of coagulant and alum with initial turbidity of 52 NTU .

2.8. Environmental significance and comparison with different other natural coagulants

In this study, a natural coagulant was used which is onion. It has been found that it was effective in turbidity removal alone, by itself, or combined with alum. When comparing the use of an optimum dose of onion extract (4 ml/L as a natural coagulant), turbidity removal efficiency was 97-98%, and when the same dose of 1 ml/L of this extract was mixed with 10mg/L of alum, the turbidity removal efficiency became 96%. And the efficiency of onion extract as a natural coagulant was better than some other natural materials from previous studies, like pine cones, that gave a removal efficiency of 82%(Hussain, Sattar, and Ahmad 2019), bean seed of 50.6% (Antov, Šćiban, and Prodanović 2012) and chestnut and acorn with a removal efficiencies of 80% for both (Šćiban et al. 2009). Onion extract gave removal efficiency equals to moringa olievera (96.23%)(Ali et al. 2010) and moringa olievera with alum(97 – 99%) (Liew et al. 2006).

3. Conclusions

This present study, and the results that have been obtained from samples, proved that onion extract can be used as a natural coagulant for raw water turbidity removal with an efficiency of 97–99% without the addition of chemical material. The percentage of proteins and amino acids are active and high enough to cause coagulation. The optimum dose of the extract, 1ml/L, can be used with the addition of alum 10 mg/L to get a removal percentage of 96. From the TOC test to determine the total organic matter in the water treated by onion extract and comparing it with the total organic matter in the water treated by alum, it had found that it was within the limits of the World Health Organization's international standards for drinking water quality. According to the results, we found that onion is an active coagulant for turbidity removal from raw water. The use of onion extract can reduce the use of alum. Acidity and alkalinity have a role in stimulating proteins found in coagulant and increasing coagulant efficiency. For optimum removal of turbidity, optimum density of extract should be prepared. A small dose of onion extract alone or with a small dose of alum gave turbidity removal efficiency higher and better than the doses of other natural coagulants.

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