# THE USE OF PEANUT AND SESAME SEEDS AS NATURAL COAGULANT IN THE WATER TREATMENT

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## ABSTRACT

Natural coagulants are now proving to be good substitutes for chemical coagulants due to their availability, cost effectiveness, nontoxic and biodegradable natures. In this research work, the treatment of highly turbid surface water by coagulation method with sesame and peanut seeds as a natural coagulant has been investigated. This study investigates the potential, suitability, effectiveness and efficiency of sesame and peanut seeds as an environmental friendly and natural coagulant for the treatment of high turbid water, and the effect of each one of the coagulant on the pH of the water, as well as a comparison between the two natural coagulant as which one is more effective in removing the turbidity from water. The sesame and peanut seeds have been used after extraction of the active coagulation component by distilled water and salt solution. The results obtained from the jar test showed that peanut seeds extracted with KCL could effectively remove 88.3% of the 340 NTU turbidity using only dosage of 20 mg/l, while sesame seeds extracted could remove only 79.7% of the 344 NTU turbidity using dosage of 60 mg/l . Moreover, the results showed that the peanut seed is more effective in removing the turbidity from water more than the sesame seeds as it is not that effective in removing turbidity from water. So, it has been demonstrated, in this work, that peanut seed is one of the promising natural coagulants for water treatment.

**Keywords:**
*Coagulants, Environmental, Efficiency, Sesame, Peanut, Turbidity.*

## INTRODUCTION

In many developing countries, access to clean and safe water is a major problem. According to the UN, 1.1 billion people still do not have access to an adequate supply of drinking water and these people are among the world's poorest. Poor water quality is a key cause of poor livelihood and poor health with 80% of all diseases in developing countries being water related (OECD, 2006). The Millennium Development Goal number 7 and target 10 addresses the need to find better solutions/alternatives to halve by 2015 the proportion of people without sustainable access to safe drinking water and basic sanitation. Due to limited alternatives, surface water either from rivers or rain fed ponds has become one of the main sources of water supply. This water is vulnerable to various forms of pollution generated from different sources mainly households, agriculture and industries.

The most widely applied conventional water treatment technology consists basically of aeration, coagulation, flocculation, sedimentation, filtration and disinfection. When particles are slow to settle or are non-settling, the process is speeded up by coagulation and flocculation through the addition of certain chemicals known as coagulants. These processes are effective at removing fine suspended particles that attract and hold bacteria and viruses to their surface. They can remove up to 99.9% of the bacteria and 99% of the viruses from water supplies (CRC, 2003).

However there are constraints encountered in the use of chemical coagulants, such as scarcity of foreign currency for importation and inadequate supply of chemicals. Although aluminium is the most commonly used coagulant in the developing countries, studies have linked it to the development of neurological diseases (e.g. pre-senile dementia or Alzheimer's disease)

due to the presence of aluminium ions in the drinking water (Jekel, 1991). More so, large non-bio-degradable sludge volumes are produced containing residual aluminium sulphate needing treatment facilities to prevent further contamination into the environment.

As a consequence of the above mentioned drawbacks, there was a need to develop alternative, cost effective and environmentally friendly coagulants. A number of effective coagulants from plant origin have been identified: Peanut seeds (Birima et al., 2013), Sesame seeds (Abubakar et al., 2015), Nirmali seeds (Tripathi et al., 1976); Okra (Al-Samawi and Shokralla, 1996); red bean, sugar and red maize (Gunaratna et al., 2007), Moringga Oleifera (Jahn, 1988) and a natural coagulant from animal origin; chitosan. Natural mineral coagulants have also been used including fluvial clays and earth from termite hills.

This study investigates the potential of peanut and sesame seeds as environmental friendly and natural coagulants for the treatment of high turbid water. The peanut and sesame seeds have been used after the active coagulation component was extracted. Researches on peanut and sesame seeds for turbidity of water is very limited, however the seeds have been promoted locally for many purposes.

## LITERATURE REVIEW

Water is a precious natural resource vital for sustaining life. It is in a continuous circulation movement (i.e., hydrological cycle), and is not uniformly distributed in time and space. Due to its multiple benefits and the problems created by its excesses, shortages and quality deterioration, water, as finite resource requires special attention (Pinderhughes, 2004).

Water treatment usually comprises water clarification and disinfection processes (Suarez et al. 2003). In conventional water treatment a series of processes including coagulation, flocculation, sedimentation, filtration and disinfection are often used (AWWA, 1990). A combination of several processes is usually needed to improve the quality of raw water depending on the type of water quality problems present, the desired quality of the treated water, the costs of different treatments and the size of the water system (Kalibbala, 2007).

Methods of water treatment from biological materials will indeed be effective in providing water at a very cheap and affordable price and at all times in every household. One method that has been practiced by people in some parts of the developing world is the use of locally available natural coagulants to improve turbidity and reduce bacteria in surface water (Ghebremichael et al., 2005).

## ALUMINIUM SALTS

Common aluminium coagulants include aluminium sulphate (alum), sodium aluminates and polyaluminium chloride. Dry alum is available in several grades, with a minimum aluminium content expressed as 17% of A12O3. Liquid alum is about 49 % solution, or approximately 8.3 % by weight aluminium as A12O3. Alum coagulation works best for a pH range of 5.5 to 8.0. However, actual removal efficiency depends on competing ions and chelating agent concentrations. Sodium aluminate is an alternative to alum and is available in either dry or liquid forms, containing an excess of base. Sodium aluminate provides a strong alkaline source of water-soluble aluminium, which is useful when adding sulphate ions is undesirable. It is sometimes used in conjunction with alum for controlling pH. Polyaluminum chloride (PAC), another aluminium derivative, is a partially hydrolyzed aluminium chloride solution. Although still not widely used, it has been reported to provide stronger, faster settling flocs than alum in some applications (Hahn and Kunte, 1990).

## PEANUT SEEDS AS A COAGULANT FOR TURBIDITY OF WATER

Attracting attention in recent decades is the use of the dried, crushed seeds as a coagulant. Even very muddy water can be cleared when crushed seeds are added. Solid matter and some bacteria will coagulate and then sink to the bottom of a container. The cleaned water can then be poured off and boiled (Birima et al., 2013).

Current studies have shown that peanut seeds can effectively remove 92% of the 200 NTU turbidity using peanut extracted with NaCl, KCL and other different salt solutions, while peanut seeds extracted with distilled water could remove only 31.5% of the same turbidity (Birima et al., 2013).

## SESAME SEEDS AS A COAGULANT FOR TURBIDITY OF WATER

It is proposed that there is the possibility of using coagulant produced from sesame seed for water treatment. Just like other natural coagulant sources such as Moringa Oleifera seed, peanut seed is rich in minerals and vitamins. The seed is used for both nutritional and medicinal purposes. As such, using the seed in water treatment may neither result into any health problem nor can the sludge resulting from the treatment lead to secondary pollution, as natural coagulants have been described to be highly biodegradable (Abubakar et al., 2015).

Recently, researchers have shown that the use of natural coagulant is a promising solution to chemical coagulant problem and that sesame coagulant could effectively remove 92% of the 200 NTU turbidity of the synthetic water used in their work (Abubakar et al., 2015).

## METHODOLOGY

The Methodology of this research is a complete frame work of components which consist of the following:

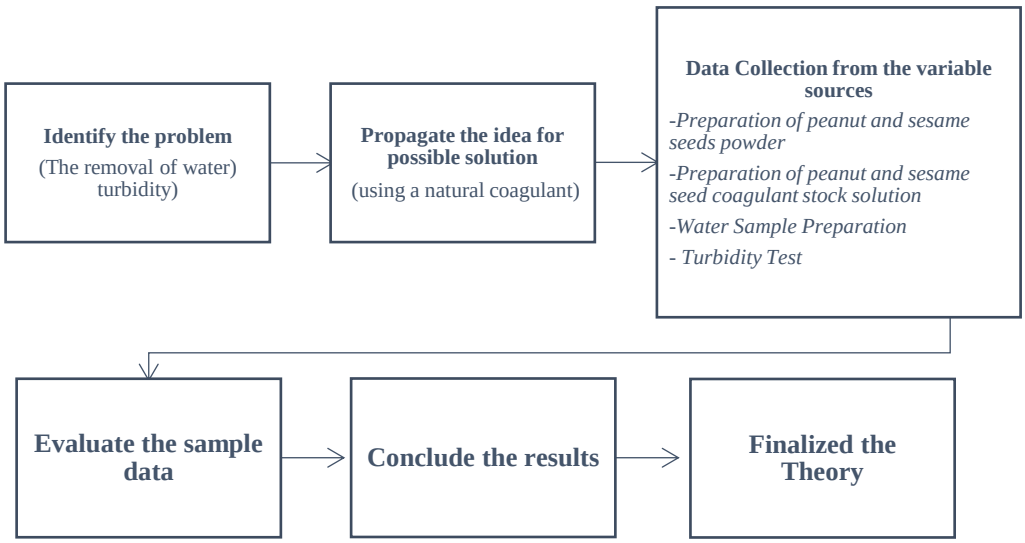


Figure 1: Research framework

**Preparation of peanut and sesame seeds powder**

In this study, the peanut and sesame seeds were obtained from local market at Kuala Lumpur, Malaysia. Good quality of peanut and sesame seeds were selected. The peanut seed cover was shelled by hand just before extraction. The extraction of the active ingredients was carried out by removing the shell to collect the kernel inside the shell. In order to ensure the efficiency of peanut seeds extraction, the kernels have been crushed and grinded to medium fine powder by using the domestic blender (Assparo, Model 900) every time when the preparation of peanut seeds extraction was needed. Then, for the sesame seeds, the seeds were cleaned and crushed into small particles using mortar and pestle. The ground sesame seed obtained was spread in a tray and left at room temperature for about 2 hours. The dried sesame seed powder was used as the coagulant for the treatment of the turbid water.

Figure 2: Peanut seeds grounded to powder form

Figure 3: Sesame seeds grounded to powder form

**Preparation of peanut and sesame seed coagulant stock solution**

Stock solution of peanut seeds extracted by distilled water at 20 000 mg/L was prepared by dissolving 20 g of the dry powder peanut seeds in 1000 ml of distilled water. Peanut powder (Figure 2) in 20 g suspension mixed with distilled water conducted inside a volumetric flask with working volume of one liter (1L). A magnetic stirrer bar was place inside the same volumetric flask and put it on the magnetic stirrer; creating stirring condition for active coagulant extracting process. The extraction process ended after 10 minutes and another 10 minutes left for settling process of passive coagulant. The resulting suspension was then filtered using a vacuum pump filter with filter paper of 70 µm pore size (Whatman). This filtrate is referred as stock solution of coagulant for coagulation process. The stock solution is prepared fresh for use when needed, since deterioration sets in if stored for more than two days at room temperature. The same procedure applied for sesame seeds (Figure 3) coagulant stock solution.

**Water Sample Preparation**

The sample for the turbid water was collected from Mines Resort Lake in Serdang, Selangor, Malaysia. About ten litres (10L) of turbid water sample was collected within 6 weeks period for the use of sample characterization and jar test. In each week, chose one day for sampling day. Storage of the turbid water sample was conducted using HDPE sampling bottle before transported to the Environmental Laboratory at Infrastructure University Kuala Lumpur within 30 minutes. The collected turbid water sample was distributed into six beakers with working volume of 500 ml. The initial turbidity concentration and pH for all six (6) water samples were recorded. The initial turbidity and pH of the turbid water were measured to be 344 NTU and 8, respectively.

**Experimental Run**

The turbid water sample was treated systematically by coagulation and flocculation process using a jar test apparatus. The coagulant dosages used in this study were ranging from 10 to 60 mg/l. During the coagulation, a rapid mixing at a rate of 110 rpm was performed for 3 minutes, and the remaining 7 minutes was used for slow mixing at 30 rpm to allow formation of flocs. After the treatment, the resulting mixture was left for 40 minutes to allow the formed flocs to settle at the bottom of the beakers. The treated water was then separated from the flocs by filtration using #40 grade Whatman filter paper. After the filtration, the treated surface water was sampled for residual turbidity measurement.

**Turbidity Test**

Turbidity is the measurement of relative clarity of a liquid. It is an optical characteristic of water and is an expression of amount of light that is scattered by some materials in the water when a light is projected through the water sample. The higher the intensity of scattered light, the higher the turbidity. The turbidity values of the water sample were measured by using a Turbidimeter 2100N, the Instrument in Nephelometric Turbidity Units (±0.01 NTU).

## RESULTS AND DISCUSSION

The parameters including pH, temperature and turbidity have been obtained for the raw samples as initial readings in order to be compared with the treated samples are summarized in Table 1. The average for each parameter was 8.00 in pH, 30°C in temperature and 344 NTU in turbidity. Based on the value obtained for turbidity, shows that the Mines Lakes is under Class IV for National Water Quality Standard (NWQS)

Table 1: Characteristics of lake water taken from Mines resort city, Serdang

| Parameter | Value Obtained (Optimum Value Chosen) |
|---|---|
| pH | 8.00 |
| Turbidity | 344 NTU |
| Temperature | 30°C |

**PEANUT SEEDS AS A NATURAL COAGULANT**

Based on Figure 4 shown below, the pH level reduced for each of the jars after the peanut seeds coagulant stock solution was added compared to the initial reading. The reading was getting lower consistently until it reached the forth reading which pH 7.31 which is also the lowest reading recorded. The pH level later increased to pH 7.42 and 7.39. The optimum pH is usually between pH 6.5.9.5 (World Health Organization, 2007). The reading after the experiment decreased but it is still in the acceptable range.

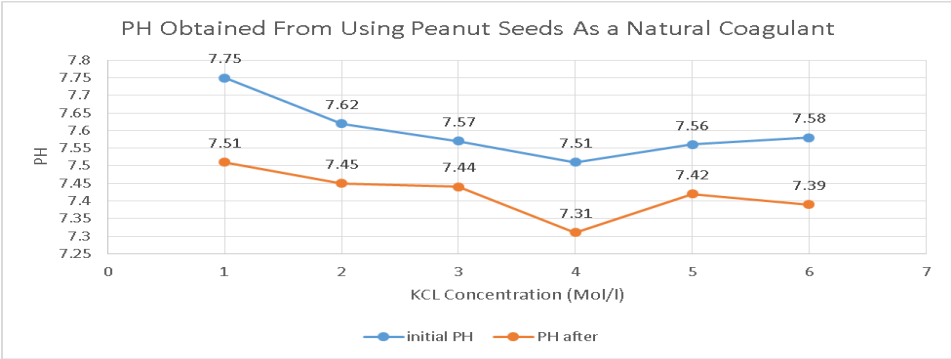


Figure 4: pH value obtained for using peanut seeds as a coagulant

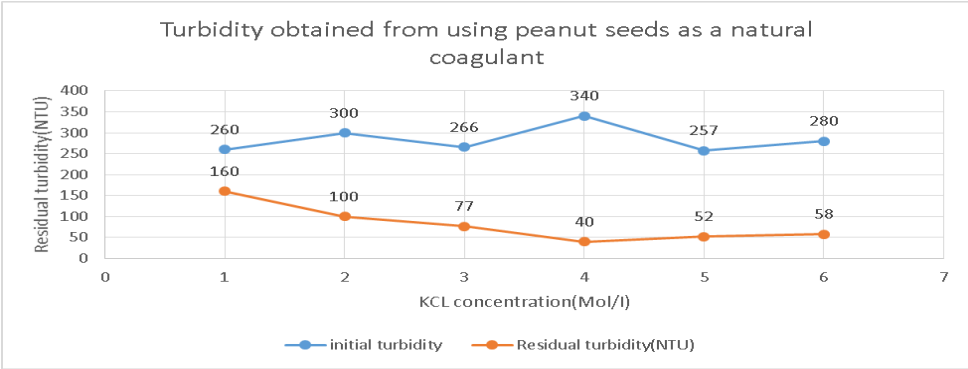


Figure 5: Turbidity obtained for using sesame seeds as a natural coagulant

Figure 5 shows a graph of turbidity against dosages, results were represented by residual turbidity the optimum value was obtained is 40 NTU at a concentration of 4 mol/l, the results after that became consistent as there was no big increasing or decreasing in the value as we increasing the KCL concentration.

It can be observed that the residual turbidity decreased with increasing the concentration of KCL, the decrease in coagulation activity at 6 mol/l could be due to saturation stage where by the KCL solution reached saturation stage at 6 mol/l.

The improvement of turbidity removal implied improvement in coagulation activity. This could be losing-up of the protein associations leading to more soluble and coagulation active species in solution, which means that addition of salt solution enhanced the breaking of protein associations, leading to increased protein solubility.

## SESAME SEEDS AS A NATURAL COAGULANT

Figure 6 shows the pH level obtained before and after adding sesame seeds into the water sample. The optimum level obtained was when a dosage of 60 mg/l of sesame was added into the water sample which gave a reading of pH 5.65. This reading showed that the water was beginning to become more acidic as the dosages increases. The higher the dosage used, the more acidic the water sample would become which was not very suitable to be used or consumed.

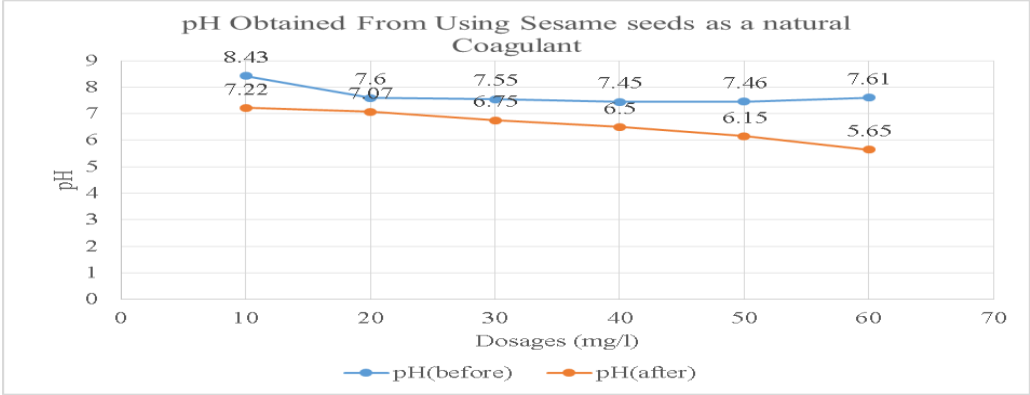


Figure 6: pH value obtained for using sesame seeds as a natural coagulant

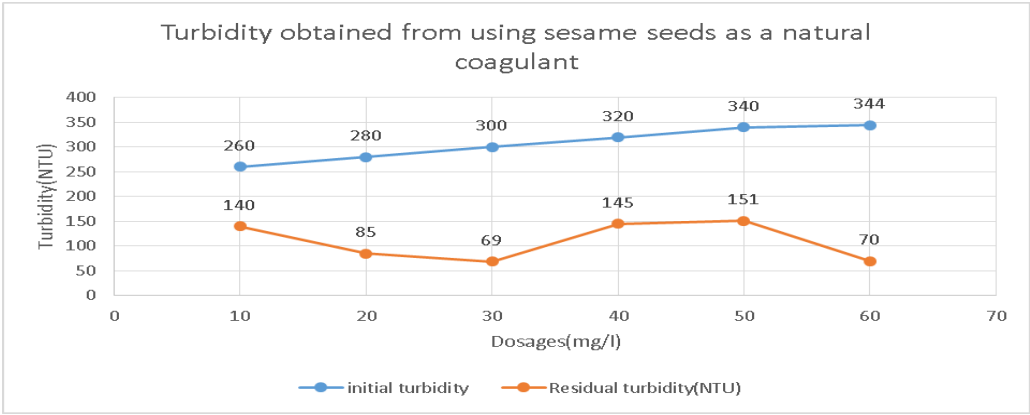


Figure 7: Turbidity obtained for using sesame seeds as a natural coagulant

Figure 7 shows a graph of turbidity against dosages. The optimum value was obtained at 69 NTU. The reading later increased before decreasing at a reading of 70 NTU. Once the optimum value had been achieved at a dosage of 30mg/l, the chances of the reading getting lower that value was slim. The reason the reading dropped could be due the highest amount of dosage of sesame used.

## COMPARING EFFECTIVENESS OF SESAME SEEDS WITH PEANUT SEEDS

The comparison between sesame seeds and peanut seeds stock solutions showed how effective each one of the natural coagulant in removing the turbidity in the water sample. This would also provide a good opportunity for the water treatment plants in deciding which one of the natural coagulant was more effective that should be used for treating the turbid water.

% Removal = (Before – After) / Before x 100%

Table 2: Percentage removal of turbidity using Sesame seeds

| Dosage (mg/L) | Initial (NTU) (Before) | Residual (NTU) (After) | Removal (%) |
|---|---|---|---|
| 10 | 260 | 140 | 46.2 |
| 20 | 280 | 85 | 69.7 |
| 30 | 300 | 69 | 77 |
| 40 | 320 | 145 | 54.7 |
| 50 | 340 | 151 | 55.6 |
| 60 | 344 | 70 | 79.7 |

Based on Table 2, the addition of sesame seeds as natural coagulant had been applied for treating the turbid water sample. The dosage of coagulant from 10 mg/l to 30 mg/l showed that percentage removal of turbidity were continuing increased with increment of sesame seeds natural coagulant. At 40 mg/l of sesame seeds coagulant added to the sample, the percentage removal started to decrease. This condition occurred possibly due to the optimum dosage had been determined at 30 mg/l for the sesame seeds dosage of coagulant.

Table 3: Percentage removal of turbidity using peanut seeds

| Dosage (mole/L) | Initial (NTU) (Before) | Residual (NTU) (After) | Removal (%) |
|---|---|---|---|
| 1 | 260 | 160 | 38.5 |
| 2 | 300 | 100 | 66.6 |
| 3 | 266 | 77 | 71 |
| 4 | 340 | 40 | 88.3 |
| 5 | 257 | 52 | 79.8 |
| 6 | 280 | 58 | 79.3 |

Based on Table 3, the addition of peanut seeds as natural coagulant had been applied for treating the turbid water sample. The dosage of coagulant from 1 mole/l to 4 mole/l showed that percentage removal of turbidity were continuing increased with increment of peanut seeds natural coagulant. At 5 mole/l of peanut seeds coagulant added to the sample, the percentage removal started to decrease. This condition occurred possibly due to the peanut seeds dosage was weak when binding between the colloid particles and it could not agglomerate to large aggregate and settled down to bottom.

The comparison between using sesame seeds and peanut seeds showed that peanut seeds had an advantage over sesame seeds as far as turbidity was concern because the peanut seeds had a higher percentage removal which is 88.3% compared to sesame seed which the higher percentage was 79.7% not very effective in removing the turbidity of the water sample.

## CONCLUSION

Using sesame seeds as a coagulant was not very effective in removing the turbidity as it showed an optimum residual turbidity only at 69 NTU at a dosage of 30 mg/l, even the residual turbidity was increasing with every time we increased the dosage. Besides, the results showed that the addition of the sesame seeds as a coagulant could affect the water pH as the more we added the coagulant the more the water became acidic. Consequently, it was not a suitable coagulant to be used and consumed. The results also showed that using sesame seeds as natural coagulant removed the turbidity up to 79.7%. However, it seemed to be a promising method due to its environmental friendliness and could be very effective for low turbid water treatment.

For peanut seeds, the results proved that using the peanut seeds as a natural coagulant for removing the turbidity of water was very effective. The optimum dosage for the residual turbidity was 40 NTU at a concentration of 4 mol/l and with each time increasing the concentration the residual turbidity showed a consistent result. Adding peanut seeds into the water showed that it did not really affect the PH of the water. The optimum dosage was 7.31 and the optimum pH was usually between pH 6.5-9.5 (WHO, 2007). Therefore, it was considered it was still in the acceptable range.

Peanut seeds had a high potential for coagulation of turbid water with an initial turbidity of 340NTU. Thus, turbidity removal reached up to 88.3 %. The improvement of turbidity removal implied improvement in coagulation activity. This could be losing-up of the protein associations leading to more soluble and coagulation active species in Solution. Consequently, it could be concluded that the peanut seeds have a high potential of coagulation of turbid water; and that the protein associations inside the peanut seeds are responsible for coagulation activity. On the other hand the results proved that the peanut better than the sesame seeds in terms of the PH of the water as the peanut seeds doesn't affect the water PH, but the sesames seeds makes the water more acidic each time the dosages increasing.

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