



Faculty of Agriculture, University of Poonch Rawalakot



# Jammu Kashmir Journal of Agriculture

ISSN: 2312-9344 (Online), 2313-1241 (Print)

<https://jkjagri.com/index.php/journal>

## EVALUATING THE PURIFICATION POTENTIAL OF *MORINGA OLEIFERA* SEED IN DRINKING WATER

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### ABSTRACT

Water pollution is one of the major threats to public health throughout the world. In Pakistan, the drinking water quality is poorly managed and monitored. Both surface and groundwater sources are contaminated with municipal wastes, industrial effluents and agrochemicals wastes. Therefore, water purification is necessary to reduce the contamination effect. For water purification, available inorganic chemicals (alum) are costly, unfriendly to environment and result in serious health problems like cancer. As an alternative natural method is required, that may safe, effective in water treatment and eco-friendly. In this study the seeds of *Moringa oleifera* seed powder with different concentration (50, 75, 100, 125, 150 mg) with time duration (4, 8 and 12 hrs) was applied for purification of water collected from Rawalpindi and Islamabad. *Moringa oleifera* seed powder showed the best purification results upto 80%. Water-soluble proteins in seed that performed as a coagulant reduced the contamination of hardness 40%, turbidity 60%, chlorides to 61%, contained anti-microbial properties and removed the *Total coliforms* to 80%. As a result, it provided inclusive results on the proficient use of *Moringa Oleifera* seed in purification of drinking water and that purification technique is economical.

**Keywords:** Coagulant protein; Drinking water; *Moringa oleifera*; Purification

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### Article history

Received: June 25<sup>th</sup>, 2023

Revised: July 29<sup>th</sup>, 2023

Accepted: August 04<sup>th</sup>, 2023

### INTRODUCTION

For human beings drinking water is the basic need and is vital requirement for chemical and biochemical occurring in life as it constitutes two third of total body weight and life cannot occur in absence of water. Safe water is of supreme importance to the health of humans and the safe water is a major concern of humans living in underdeveloped countries (Fatombi et al., 2019). Almost 2 billion peoples have no access to safe water (Marobhe et al., 2021). Water pollution is mainly caused by human activities through physical such as; leakage of water distribution supply lines, over utilization of water resources and domestic sewage, chemical; agriculture and industrial wastes while the key risk is biological

contamination includes different types of bacteria, viruses and other microbes etc. Chemical contamination beyond its limit that causes numerous health problems in humans like; high amount of chloride and fluorides in water can cause methemaglobinaemia, amoebiasis and cryptosporidiosis. Excess amount of heavy metal causes many disorders like; toxicity, disorder in nervous, reproduction system and kidney of human beings. Purification of drinking water is vital for the removal of contaminants including colloidal organic particles, microorganism and other substances that are toxic to human health. This involves two important procedures to purify the water such as conventional method using aluminum sulphate (alum) as clarification, coagulation, sedimentation and

filtration. However, these also have several drawbacks as costly and not eco-friendly, their residuals in treated water (e.g. aluminum) are linked with neurodegenerative such as Alzheimer’s diseases as well as carcinogenic effects, elevated level of chloride and fluoride in drinking water cause methemaglobinaemia and amoebiasis, excess amount of lead induces toxic effect to digestive, reproductive system of human body (PCRWR 2020). As the physical parameters like chlorides cause change in taste of water e.g. saltiness in drinking water. Hardness if exceed the recommended limit may cause several problems in human. The prolong ingestion of these chemicals may cause severe health issues. Heavy metals like cadmium and lead create problem in several body organs like in kidney, liver, skin irritation and nervous system if they exceed from safe limit recommended for drinking water. Excess amount of lead may cause various diseases las; cardiovascular and bone diseases, while zinc cause abnormal growth. Natural coagulants (e.g. *Moringa oleifera*) are beneficial and has advantages to chemical as biodegradable and easily available. The analytical study of plants like chickpea, cactus and *Moringa oleifera* (*MO*) shows that that they remove the turbidity to 78, 75 and 89 percent respectively. Among all these plant-based natural coagulants, *Moringa oleifera* proves the best coagulants for drinking water treatments commonly in underdeveloped areas of the world. *Moringa oleifera* is a small, rapidly growing deciduous plant belongs to family Moringaceae. It contains the positively charged protein in nature particles named as *Moringa oleifera* cationic protein, that are readily dissolved in water, attract and bind with the suspended impurities present in water and move down by gravity (Arora et al. 2013).

*Moringa oleifera* seed cationic protein also has antimicrobial activity in drinking water, the protein attracts the bacteria, hold them along with other suspended impurities and move down by the action of gravity.

*Moringa oleifera* protein to purify and coagulation mechanism has been reported by several researches in different set of ways, either on the basis of adsorption phenomenon and charge neutralization or inter-particle bridging. *Moringa oleifera* seed contain 1 percent active agent named as polyelectrolyte that removes turbidity by neutralizing the negative charge of collides in the water (Chhikara et al., 2020). This polyelectrolyte is dimeric, stable and completely soluble in water; act as adsorption and charge neutralization. The better purification efficacy showed by *MO* seed led to increase the demand of *MO* seed day by day as compared to synthetic and other organic sources of water purification (Bancesi et al., 2020). This study was designed to achieve the following core objectives as; to investigate the effect of *Moringa oleifera* seed powder on physicochemical characteristics and its effect as an antimicrobial agent in drinking water.

**Methodology**

This research study was conducted at the Department of Food Technology, Pir Mehr Ali Shah Arid Agriculture University Rawalpindi. *Moringa oleifera* seed were collected from local market shelled grounded in an electric grinder, sieved in a mesh of 0.8 mm size to obtain a fine powder form. Raw water sample collected from Rawalpindi and Islamabad regions are also shown in Figure 1.

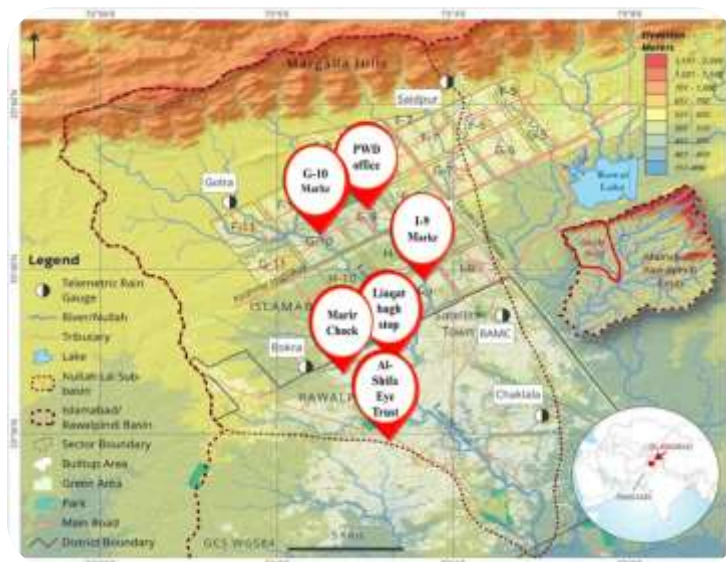


Figure 1. Water sampling points from Rawalpindi and Islamabad region.

An equal number of the samples were taken from Rawalpindi and Islamabad. The samples taken from Islamabad were labelled as I<sub>1</sub>, I<sub>2</sub>, I<sub>3</sub>, and sampling from Rawalpindi was labelled as R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>. Six glass beakers were filled with 1 liter sampled water. Five different weighing like; 50, 75, 100, 125 and 150 mg of *Moringa oleifera* seed used for treatments were made General flow chart for preparation of *Moringa oleifera* seed for treatment is shown in Figure 2.

**Physio-chemical and microbial parameters**

The physio-chemical parameters studied in current research

were turbidity with turbidity method No. 180.1 of AOAC (2000), alkalinity with the titrimetric method of AOAC (2000) method No. 973.43, sulphate with gravimetric method of AOAC (2000) method No. 925.54, nitrate, hardness with titrimetric method No. 973.50 (AOAC, 2000) and chloride by method No. 973.51 (AOAC, 2000) while *Total coliforms* that are mostly found bacteria in water was analyzed by agar disc diffusion method (Jonasson et al., 2020).

**Data analysis**

For statistical analysis of data SPSS (8.1) software was applied on all parameters.

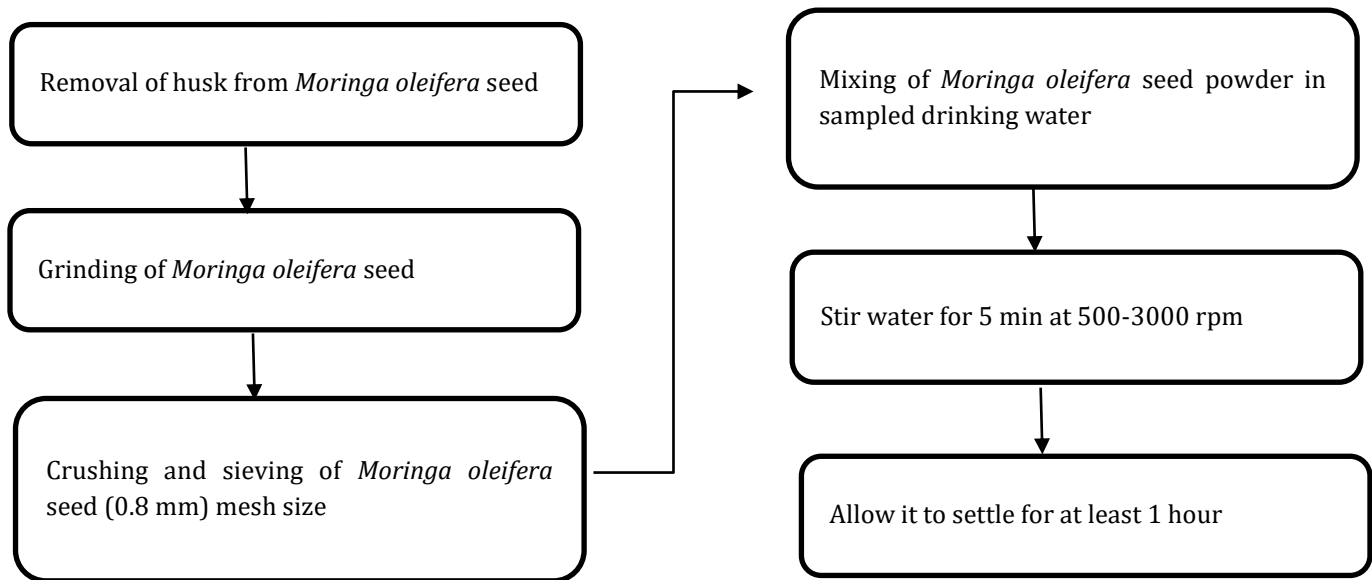


Figure 2. General flow chart for preparation of *Moringa oleifera* seed for application in water treatment.

The application of *Moringa oleifera* seed treatment on drinking water are described in the below table 1. Each treatment was replicated for three times. The time factor was also be noted (after 4, 8 and 12 hrs.).

Table 1. Treatment plan of drinking water with *Moringa oleifera* seed.

Treatment sequence	Concentration mgL <sup>-1</sup>
T <sub>0</sub>	Control sample
T <sub>1</sub>	50mgL <sup>-1</sup>
T <sub>2</sub>	75mgL <sup>-1</sup>
T <sub>3</sub>	100mgL <sup>-1</sup>
T <sub>4</sub>	125mgL <sup>-1</sup>
T <sub>5</sub>	150mgL <sup>-1</sup>

**Results and Discussion**

**Physio-chemical Parameters**

All collected samples were analyzed and their statistical results shown in Figure 3-8. The mean value of all parameters with respect to time (4-12 hrs), treatment

(increasing concentration), also the time and treatment interaction showed in the figures. The parameters are as follows:

**Hardness**

The mean values of hardness with respect to time factor

depicted in Figure 3(a). At the initial four hours' interval, the hardness value was 340 mg/L, at the second four hours' interval the hardness value was reduced to 330 mg/L and on the third interval of time (12 hours) hardness influenced was 290 mg/L. A significant variation with decreasing trend of hardness was observed with the passage of time.

The treatment influenced the hardness significantly depicted in Figure 3(b). Hardness in the control samples T<sub>0</sub> was 410 mg/L, but at T<sub>1</sub> treatment hardness was reduced to 390 mg/L, at T<sub>2</sub> it influenced the to 330 mg/L, at T<sub>3</sub> *Moringa oleifera* seed influenced the hardness to 280 mg/L, at T<sub>4</sub> it reduced the hardness to 275 mg/L, while at T<sub>5</sub> *Moringa oleifera* seed effected the hardness to 240 mg/L. In treatments difference the hardness decreased from 410-240 mg/L. A significant decreasing trend was observed with increasing concentration of *Moringa oleifera* seed level.

The interaction of hardness of water sampled collected from Rawalpindi and Islamabad is depicted in graphical form in Figure 3(c). Hardness of water sampled ranged from 225-440 mg/L. Hardness 440 mg/L was the highest of all the treatments that was observed in control sample T<sub>0</sub> at the 12 hours' time interval and lowest 225 mg/L was observed in the T<sub>5</sub> treatment at 8 hours' time interval. That mean the hardness showed better purification effect at 8 hours' interval. In all treatment the value of hardness observed were significantly decreasing with the increasing dose of *Moringa oleifera* seed, it indicated that for removing the hardness *Moringa oleifera* dose is good at all concentrations and with increasing dose the hardness

decreased. Mostly results were ranged in between 250-300 mg/L value that is good for consumption, that proved *Moringa oleifera* the best in hardness removal. The maximum permissible level of hardness in drinking water by PSQCA and WHO is 500 mg/L. The similar results were also discussed by Varkey (2020). He applied *Moringa oleifera* dose to purify common household water and found 60% of hardness removed.

Yuliastri et al. (2016) identified that *Moringa oleifera* seed recombinant protein express good flocculation effect on hardness removal of drinking water. Delelegn et al. (2018) and Chhikara, (2020) also explained that the *Moringa oleifera* seed with coagulation mechanism, occur when positive charge particles coagulate with negative charge of particles in water, this leads to the removal of their charges. It was observed that with respect to increasing time duration the 20% decreased in hardness in contamination of drinking water. The treatment factor also indicates the 40% removal of hardness in water. While 40% decreased with the interaction of time and treatment was observed for hardness contamination. The trend of graph shown in Fig 4 indicates that the increasing concentration of *Moringa oleifera* seed is more effective for hardness removal as compared to time factor. Ng and Elshikh (2021) also discussed the similar results in his study. They applied *Moringa oleifera* seed as natural coagulant for hardness removal and explained that *Moringa oleifera* seed produce carboxylate ions and protons in the contaminated water to attract the other metal and mineral ions to form charge free water.

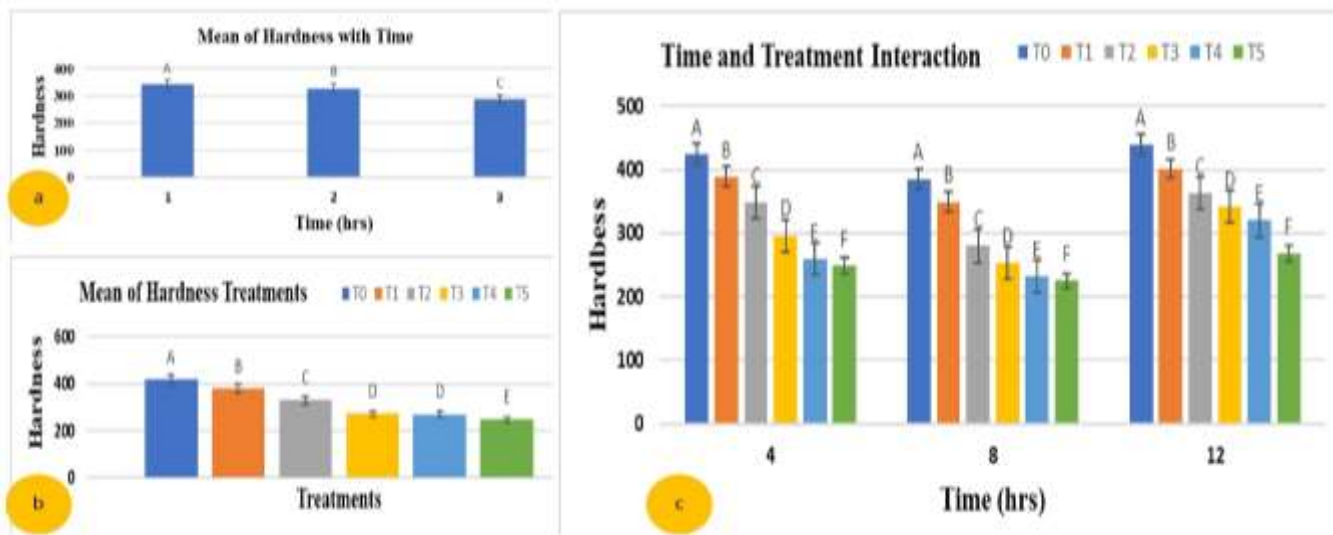


Figure 3. Effectiveness of time duration, effect of different treatments, time and treatment interaction of hardness (mg/L) obtained after application of *Moringa oleifera* seed.

**Turbidity**

The mean values of turbidity with respect to time factor depicted in Figure 4(a). By application of *Moringa oleifera* seed the turbidity in water significantly reduced. At the initial four hours’ interval, the turbidity value was 3.2 NTU, at the second four hours’ interval the turbidity value was observed 3.1 NTU and in third interval of time (12 hours) the turbidity was reduced to 2.8 NTU. It indicated that with passage of time more turbidity can be removed from water. Overall, the turbidity difference reduced from 3.2 NTU to 2.8 NTU was observed and with the passage of time a significant decreasing trend of turbidity in drinking water was observed.

The treatment influenced the turbidity significantly depicted in Figure 4(b). The control samples T<sub>0</sub> has the turbidity value 5 NTU, but at T<sub>1</sub> treatment *Moringa oleifera* seed reduced turbidity to 3.9 NTU, at T<sub>2</sub> it was reduced to 3.17 NTU, in T<sub>3</sub> turbidity was observed 2.3 NTU, at T<sub>4</sub> *Moringa oleifera* seed removed the turbidity to 1.8 NTU, while at T<sub>5</sub> the turbidity was observed 1.7 NTU. In treatments the turbidity decreased from 3.9-1.7 NTU. A significant decreasing trend was observed with increasing concentration of treatment level.

The turbidity of water samples collected from Rawalpindi and Islamabad shown in Figure 4(c). The turbidity was in range between 1.3 to 2 NTU but some goes to higher 5.6 NTU. The highest turbidity was observed in T<sub>0</sub> untreated or control sample at initial stage of 4 hour’s containing value 5.6 NTU, while the lowest turbidity was 1.3 NTU was observed in T<sub>5</sub> at 8 hours’ time interval. The lower values

observed in high dosage of *Moringa oleifera*, that indicated that with the increasing doses of *Moringa oleifera* seed the turbidity value was decreased. All these results indicated that *Moringa oleifera* seed is best in drinking water purification and in a permissible range of turbidity in drinking water by PSQCA is less than 0.5 NTU while according to WHO it must be less than 25 NTU.

*Moringa oleifera* seed with the coagulation mechanism has been reported by several researches in different set of ways, either on the basis of adsorption phenomenon and charge neutralization or inter-particle bridging. *Moringa oleifera* seed contain 1 percent active agent named as polyelectrolyte that removes turbidity by neutralizing the negative charge of collides in the water. This polyelectrolyte is dimeric, stable and completely soluble in water; act as adsorption and charge neutralization. The turbidity removal depends upon the nature of coagulant used and the initial turbidity of water. While 70% decreased with the interaction of time and treatment was observed for turbidity contamination. The trend of graph shown in Fig 5 indicates that the increasing concentration of *Moringa oleifera* seed is more effective for turbidity removal as compared to time factor. Fatombi et al. (2019) also discussed the similar results in his study. He applied *Moringa oleifera* seed to purify the polluted drinking water and obtained 70% turbidity removed. Jeje et al (2021) also tested purification the purification effect of *Moringa oleifera* seed with banana peel powder and concluded that *Moringa oleifera* seed removed better than banana peel. They also *Moringa oleifera* seed powder form inter-particle bridging in water that binds with turbid material.

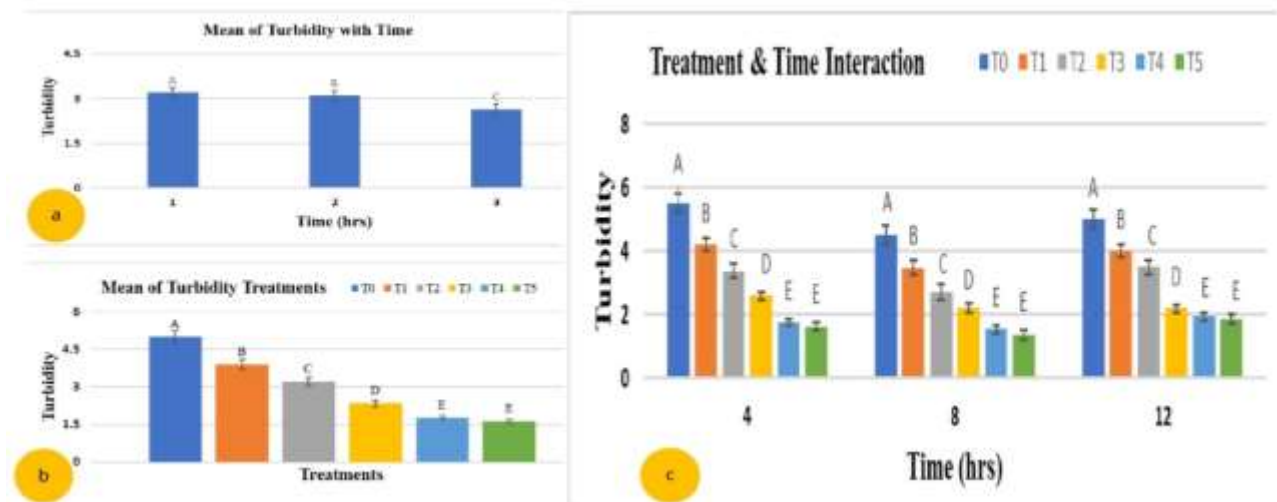


Figure 4. Effectiveness of time duration, effect of different treatments, time and treatment interaction of turbidity (NTU) obtained after application of *Moringa oleifera* seed.

**Conductance**

The mean values of conductance with respect to time factor shown in Figure 5(a). *Moringa oleifera* seed in water showed a significant decreasing trend of conductance with the passage of time. At the initial four hours' interval, the conductance value was 330 ppm, in the second four hours' interval the conductance value was 325 ppm and in the third interval of time (12 hours) *Moringa oleifera* seed reduced the conductance was 290 ppm. It indicated that at 12 hours 'time interval the conductance showed decreasing effect in water. Overall, the conductance removed from a value of 330 ppm to 290 ppm.

The treatment of *Moringa oleifera* seed affected the conductance significantly shown in Figure 5(b). A significant decreasing trend was observed with increasing concentration of *Moringa oleifera* seed. The control samples T<sub>0</sub> has the conductance value 405 ppm, but at T<sub>1</sub> treatment it was reduced to 385 ppm, in T<sub>2</sub> *Moringa oleifera* seed reduced the conductance to 330 ppm at T<sub>3</sub> it influenced 280 mg/L, at T<sub>4</sub> it removed the conductance to 278 ppm, while at T<sub>5</sub> *Moringa oleifera* seed reduced the conductance to 250 ppm. In treatment difference the conductance decreased from 405-250 ppm. All these results showed that the *Moringa oleifera* seed effectively removed the conductance from drinking water, with increasing concentration of seed.

The time and treatment interaction of conductance is shown in Figure 5(c). In all treatments there is a significant decreasing trend of conductance was observed with the increasing dose of *Moringa oleifera* seed. conductance of

water samples ranged from 430-224 ppm. Maximum conductance 430 ppm was observed in control samples (T<sub>0</sub>) of time interval 4 and 12 hrs, while minimum 224 ppm conductance was observed in T<sub>5</sub> treatments at 8 hours' interval. This indicates that for removing the conductance, *Moringa oleifera* dose are good to reduce the conductance. Mostly results were ranged in between 224-300 ppm value that is good for consumption, that proved *Moringa oleifera* seed is the best in conductance removal and beneficial for purification. The permissible standard of conductivity is not clearly explained by PSQCA and WHO but generally follows the standard of less 500 ppm is safe and 300 ppm is good for human health. So, all values of the conductivity results were in range permissible by PSQCA and WHO.

Gomes et al. (2019) worked on the water quality assessment with *Moringa oleifera* seed and it was observed that with respect to increasing dose of *Moringa oleifera* seed the conductance in water was 50% decreased. In the time duration the 20% decreased in conductance of drinking water was observed. The treatment factor also indicates the 40% removal of conductance in water. The trends of graph shown in Fig 6 indicated that the increasing concentration of *Moringa oleifera* seed is more effective for conductance removal. Alam et al. (2020) also discussed that *Moringa oleifera* seed is more effective in conductance removal the seed reacted as natural polymer and positively charged coagulant that reduced the conductivity of water. They also obtained 50% decreased in conductance value in the drinking water.

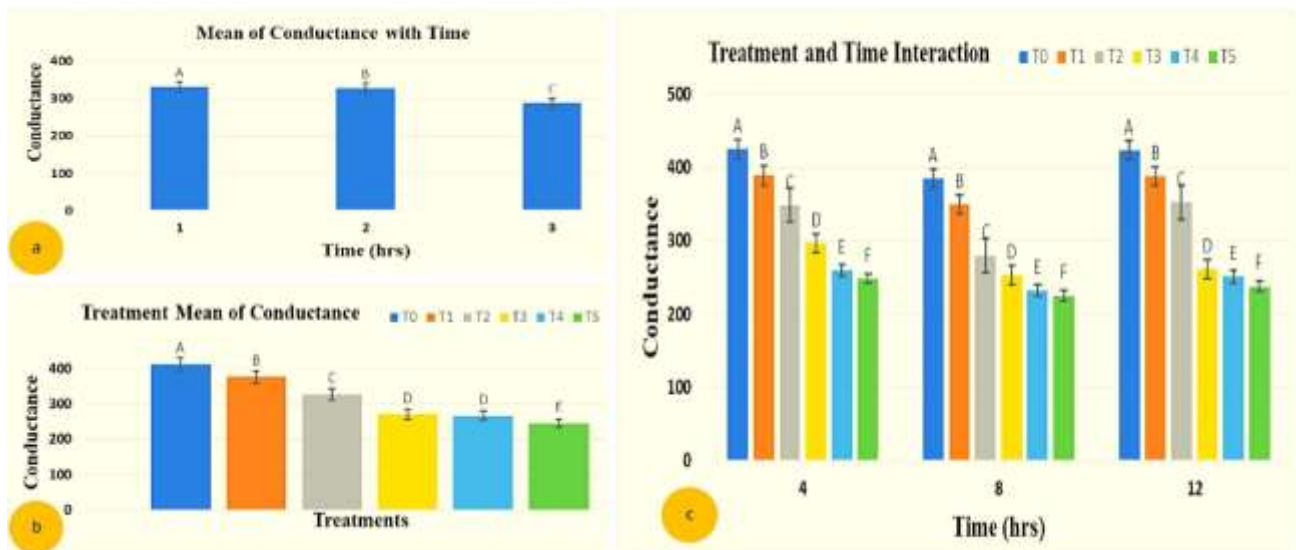


Figure 5. Effectiveness of time duration, effect of different treatments, time and treatment interaction of conductance (ppm) obtained after application of *Moringa oleifera* seed

**Chlorides**

The mean values of chlorides with respect to time factor shown in Figure 6(a). Chlorides with respect to time factor influenced significantly. After applying *Moringa oleifera* seed a decreasing trend of chlorides was observed with the duration (4, 8 and 12 hours) of time. Overall, the chlorides reduced from 88 mg/L to 60 mg/L. At the initial four hours' interval, the chlorides value was 88 mg/L, at the second four hours' interval the chlorides value was obtained was 68 mg/L and in the third interval of time (12 hours) chlorides was reduced to 60 mg/L. It indicated that with duration of time more chlorides can be removed from water.

The treatment influenced the chlorides significantly shown in Figure 6(b). The chlorides value affected in a decreasing trend by increasing concentration of *Moringa oleifera* seed. The maximum chloride value was 130 mg/L in the control sample T<sub>0</sub>, but at T<sub>1</sub> treatment chlorides was reduced to 107 mg/L level, at T<sub>2</sub> chlorides decreased to 80 mg/L, at T<sub>3</sub> it influenced 54 mg/L, at T<sub>4</sub> *Moringa oleifera* seed reduced the chlorides to 35 mg/L while at T<sub>5</sub> it influenced the chlorides to 30 mg/L. In all treatments the chlorides decreased from 130-30 mg/L. All these results showed that the *Moringa oleifera* seed effectively reduced the chlorides in drinking water with increasing dose.

The interaction of time and treatment of chloride in water samples collected from Rawalpindi and Islamabad is shown in Figure 6(c) ranged from 21-157 mg/L. The maximum

chloride was 157 mg/L in T<sub>0</sub> in 12 hours' time interval of water and minimum was 21 mg/L was also observed in treatment T<sub>5</sub> sample of drinking water at time interval 8 hours. All the samples were in safe limit for consumption and a significant decreasing trend was obtained with increasing *Moringa oleifera* seed concentration. According to PSQCA and WHO the chlorides permissible range is 250 mg/L in drinking water. Higher level of chloride in the drinking water may cause cancerous diseases in humans.

Ng and Elshikh (2021) also discussed the similar results in their study. They applied *Moringa oleifera* seed as natural coagulant for chloride removal and explained that *Moringa oleifera* seed produce carboxylate ions and protons in the contaminated water to attract the chloride ions that eventually form a floc in water. Overall, by application the *Moringa oleifera* seed treatment the 60% removal of chloride in water was observed. The trend of graph shown in the Figure 7 indicated that the increasing concentration of *Moringa oleifera* seed is more effective for chloride removal. Jonasson (2020) explained that *Moringa oleifera* seed is good for chloride or other contamination removal as compared to other organic and inorganic methods and the results in this study was also similar to the Jonasson's study results. It was observed that by increasing the level of *Moringa oleifera* seed dose the chlorides concentration decreased in all time intervals (4-12 hrs) treatments of water sample.

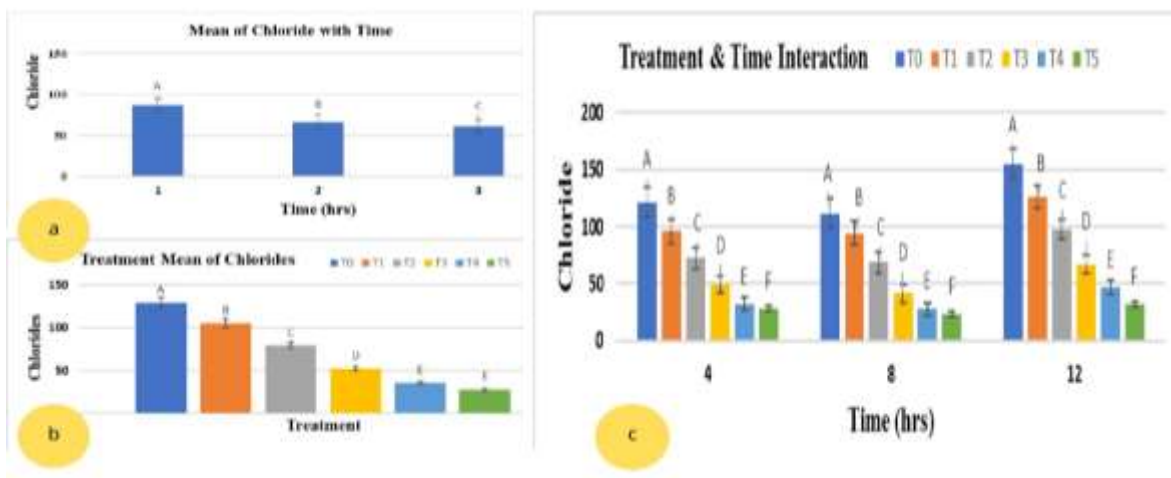


Figure 6. Effectiveness of time duration, effect of different treatments, time and treatment interaction of chlorides (mg/L) obtained after application of *Moringa oleifera* seed.

**Nitrate**

The mean values of nitrate with respect to time factor shown in Figure 7(a). After applying *Moringa oleifera* seed a

significantly decreasing trend of nitrate was observed with the duration (4, 8 and 12 hours) of time. Overall, the nitrate reduced from 88 mg/L to 60 mg/L. At the initial four hours'

interval, the nitrate value was 16.8 mg/L, at the second eight hours' interval the nitrate value was 16.7 mg/L and on the third interval of time (12 hours) nitrate influenced was 16.3 mg/L. It indicates that with duration of time nitrates reduced non-significantly from water.

The treatment difference in the nitrate is shown in Figure 7(b). The nitrate effected significantly in a decreasing trend after applying the increasing concentration of *Moringa oleifera* seed. The maximum nitrate value 27 mg/L was observed in the control sample T<sub>0</sub> but at T<sub>1</sub> treatment it was reduced to 22 mg/L level, at T<sub>2</sub> it was obtained 18 mg/L at T<sub>3</sub> *Moringa oleifera* seed removed it to 13 mg/L, at T<sub>4</sub> it influenced nitrate to 12 mg/L while at T<sub>5</sub> *Moringa oleifera* seed influenced the nitrate to 10 mg/L. In all treatments the nitrate decreased from 27-10 mg/L. All these results showed that the *Moringa oleifera* seed effectively reduced the nitrate in drinking water with increasing dose.

The time and treatment interaction of nitrate in water samples collected from Rawalpindi and Islamabad is shown in Figure 7(c). Nitrate of water samples ranged from 8-28 mg/L. The maximum nitrate was 28 and minimum was 8

mg/L. The highest value 28 mg/L was observed in 8 hours' time interval and the minimum 8 mg/L was observed in same time interval. The overall highest nitrate removal was also observed in 8 hours' time interval. It was observed that by increasing the level of *Moringa oleifera* seed dose the nitrate concentration decreased gradually in all time intervals. All the observed results of nitrate with treatment were in safe range and meet permissible value by PSQCA and WHO is 10-45 mg/L for drinking water that cause no toxic effect to human's health.

The polyelectrolyte particles in the *Moringa oleifera* seed found active against the nitrate contents in drinking water that bind with nitrate ions and form a floc. The similar study results were also discussed by Marobhe et al. (2021) they discussed that the polyelectrolytes present in *Moringa oleifera* seed has the ability to bind with the nitrate ion and 60% reduced its level. The trend of graph shown in Fig 8 indicated that the increasing concentration of *Moringa oleifera* seed is more effective for nitrate removal as compared to time factor. Vunain et al. (2019) also discussed that the polyelectrolytes are in *Moringa oleifera* seed responsible to bind with nitrate particles.

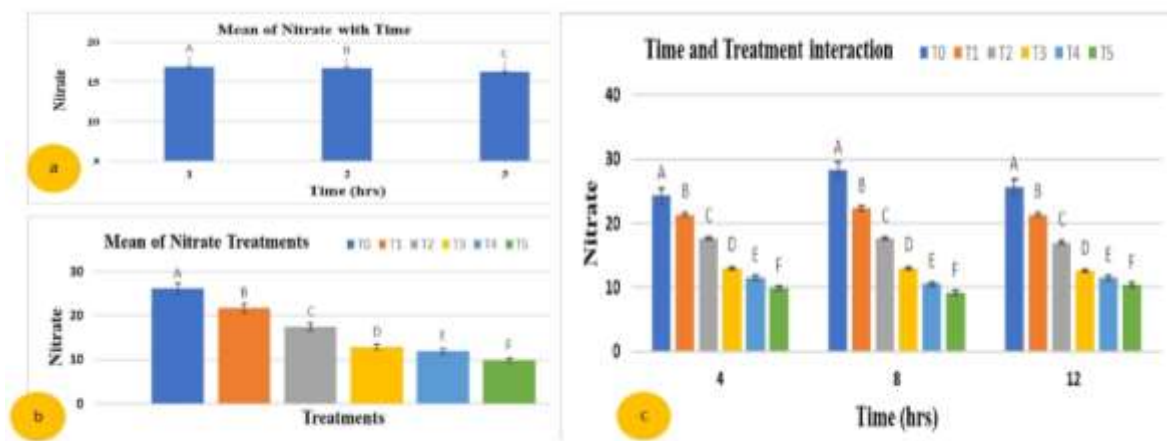


Figure 7. Effectiveness of time duration, effect of different treatments, time and treatment interaction of nitrate (mg/L) obtained after application of *Moringa oleifera* seed.

**Microbial Parameter**

The mean values of *Total coliform* with respect to time factor is shown in Figure 8(a). After applying *Moringa oleifera* seed a significant decreasing trend of *Total coliforms* was observed with the duration of time (4, 8 and 12 hours). Overall, the *Total coliforms* reduced from 4 to 2 cfu/L. At the initial four hours' interval, the *Total coliforms* value was 4 cfu/L, in the second four hours' interval the

*Total coliforms* value was 3 cfu/L and in the third interval of time (12 hours) *Total coliforms* influenced was 2 cfu/L. It indicated that with duration of time *Total coliforms* reduced significantly from water.

The treatment difference removed the *Total coliforms* shown in Figure 8(b). In the *Total coliforms* a significant decreasing trend was found by increasing concentration of *Moringa oleifera* seed. In all treatments the *Total coliforms*



decreased from 7-1 cfu/L. The maximum *Total coliforms* value 7 cfu/L was observed in the control sample T<sub>0</sub>, but at T<sub>1</sub> treatment it was reduced to 5 cfu/L level, at T<sub>2</sub> it influenced the *Total coliforms* to 4 cfu/L, at T<sub>3</sub> *Moringa oleifera* seed reduced to 3 cfu/L, at T<sub>4</sub> *Moringa oleifera* seed influenced *Total coliforms* to 2 cfu/L, while at T<sub>5</sub> the *Total coliforms* value was observed 1 cfu/L. All these results showed that the *Moringa oleifera* seed significantly reduced the *Total coliforms* in drinking water with increasing dose. The time and treatment interaction of *Total coliforms* is shown in Figure 8(c). The *Total coliforms* interaction showed the significantly decreasing trend with increasing

dose of *Moringa oleifera* in drinking water. They ranged from 2-9 cfu/L, maximum *Total coliforms* 9 cfu/L was observed in T<sub>0</sub> control sample at 12 hours' time interval and minimum value 2 cfu/L was observed in T<sub>4</sub>, T<sub>5</sub> of time interval 4 and T<sub>5</sub> at time interval 8 hours. In this study after applying different concentrations of *Moringa oleifera* at three interval of time, the numbers of *Total coliforms* reduced to recommend limit by PSQCA and WHO that is zero per 100 ml of drinking water. Moreover, it was also observed that increasing dose of *Moringa oleifera* seed decrease the *Total coliforms* in drinking water.

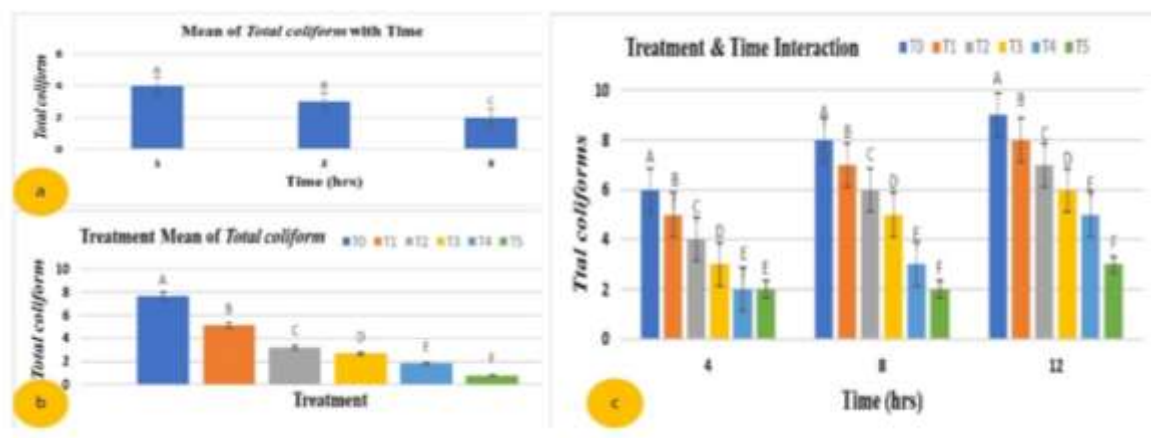


Figure 8. Effectiveness of time duration, effect of different treatments, time and treatment interaction of *Total coliforms* (cfu/L) obtained after application of *Moringa oleifera* seed.

Different studies have also identified antimicrobial activity in *Moringa oleifera* recombinant (heterologous) protein. It removes bacterial cells pointed that protein from *Moringa oleifera* seed is effective for disinfection in water treatments (Omokpariola et al., 2021). *MO* seed also contained a chemical compound 4 ( $\alpha$ -L-Rhamnosyloxy) benzyl isothiocyanate that perform an antimicrobial activity against microbes mostly present in drinking water like; *Total coliform* (e.g. *Escherichia coli* and *Faecal coliform*), *Enterobacter cloacae*, *Pseudomonas* and *Staphylococcus* etc. and removed microbial contamination up to 70-80%. The  $\alpha$ -L-Rhamnosyloxy particles bind with microbial entities present in water and reduced their level. The trend of graph shown in Fig. 9 indicated that the increasing concentration of *Moringa oleifera* seed decreased the *Total coliforms* value. Arora et al. (2013) also discussed the similar results in their study. They applied *Moringa oleifera* seed powder from 10-100 mg to purify the drinking water with time duration of time 5-180 mints and obtained 80%

*Total coliforms* removed from water. They also explained that *Moringa oleifera* seed has disinfection effect in water treatments that reduce the microbial load. Fatombi et al. (2019) study the *Moringa oleifera* seed powder to check its antibacterial efficacy with agar disc diffusion method and he also found 90% microbial removed in the drinking water. Jonasson (2020) also purify the water with *Moringa oleifera* seed and check its antibacterial against *Total coliforms* with disc diffusion method and removed 80% from water. All the numbers of *Total coliforms* reduced to the recommended limit by PSQCA and WHO that is zero per 100 ml of drinking water.

**CONCLUSION**

Water is a great blessing of God on the earth, as it assures the occurrence of life. Unfortunately, this blessing is getting largely contaminated with several physio-chemical and biological factors that include trace elements, pesticides and detergents etc. that causes several diseases and a great threat

to humans. For purification, several methods have developed for purification of drinking water. This study was conducted on the purification potential effect of *Moringa oleifera* seed in the drinking water. The aim of the study was to analyze the effect of *Moringa oleifera* seed against the physicochemical and microbial properties in accordance with PSQCA and WHO safe range of drinking water. The physio-chemical parameters analyze in this research were; turbidity, hardness, chlorides, nitrates and in microbiological parameter (*Total coliform*) were analyzed that are mainly occur in drinking water. It was found in this study that polyelectrolytes present in *Moringa oleifera* seed removed the hardness 40%, turbidity 40%, 50% conductance and chlorides 60% in drinking water with increasing passage of time (4-12 hrs) and concentration of *Moringa oleifera* seed. As *Moringa oleifera* seed contain 4-rhamnosyloxy –benzyl-isothiocynate which is essential antimicrobial agent. It has been also found that with increasing concentration of *Moringa oleifera* seed the *Total coliform* level also decreased to 80-90%. So, this technique should be preferred am compared to other inorganic techniques used in all over the world.

#### ACKNOWLEDGMENTS

All praises be to **ALLAH Ta'ala**, who endowed me with mental and physical health, patience, cognizance strength and power to complete my work, also the countless salutations be upon the great and last Messenger of **Allah Ta'ala Hazrat Muhammad S.A.W.W.** who is the city of knowledge. I am indebted to my Parents and encouragement and guidance given to me by **Prof. Dr. Asif Ahmad**.

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