Journal of Engineering Research and Reports

18(2): 1-11, 2020; Article no.JERR.62143
ISSN: 2582-2926

Influence of Powdered *Moringa oleifera* Lam. Almonds Dried at Different Temperatures on the Physico-chemical Quality of the Pond Water

Yerima Bako Djibo Aboubacar[1*] and Guero Yadji[1]

[1]Department of Science Soil, University of Niamey, Niger.

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JERR/2020/v18i217202
Editor(s):
(1) Dr. Heba Abdallah Mohamed Abdallah, National Research Centre, Egypt.
Reviewers:
(1) Tabe Franklin Nyenty, University of Yaounde 1, Cameroon.
(2) P. Rama Bhat, Moodbidri (Affiliated to Mangalore University), India.
Complete Peer review History: http://www.sdiarticle4.com/review-history/62143

Review Article

Received 10 August 2020
Accepted 15 October 2020
Published 03 November 2020

ABSTRACT

The study focused on the physico-chemical characterization of raw water samples from the Kongou Gorou pond treated with almond powder from Moringa oleifera seeds. The powder which was used for the present study was dried in the oven for one month at the respective temperatures of 25, 40 and 50 ° C and then applied at a dose of 100 mg /L. The parameters studied are pH, iron, copper, electrical conductivity, rate of dissolved substances (TDS), hardness, organic matter; calcium, HCO3-, magnesium, the Complete Alkalimetric Title (TAC).

The physico-chemical analysis showed that the waters studied have concentrations below the standards recommended by WHO in 2009. For the dose of 100 mg/L and stored at the respective temperatures of 50, 40 and 25 ° C, it was recorded: a pH close to neutrality, a reduction in iron content of 93.46% at 50 ° C, 90.76% and 90.76%, a decrease in magnesium of 27.21; 27.89 and 39.96%, a decrease in hardness of 37.98; 39.94 and 36.03%; a decrease in the TAC from 1.3 to 1.18; 1.29 and 1.23 ° F and finally a reduction of 9.26; 0.81 and 5.42% bicarbonate. At these respective temperatures of 50, 40 and 25 ° C, the electrical conductivity has increased by 33.63, 33.05 and 32.8µs.cm / L at 2 hours of settling and from 34, 64, 34, 28 and 36, 23 µs. cm / L at 24 hours of settling; an increase in the rate of Dissolved Substances from 15.21 to 16.32; 16.33 and 16.72 mg / L; an increase in the order of 34.48, 26.72 and 13.79% in calcium levels; an increase

**Corresponding author: Email: bakoyeri@yahoo.fr;*

on the one hand of copper from 0.114 mg/L to 0.903 and 2.39 mg/L respectively at 50 and 40 ° C and on the other hand a total removal of the latter at 25 ° C.
The results showed that the use of Moringa oleifera seeds effectively improves the physicochemical quality of the treated water, which not only meets the WHO drinkability standards but also the characteristics of water suitable for drip irrigation.

Keywords: Water treatment; drip irrigation; Moringa oleifera; physico-chemical quality of the water; Kongou Gorou Zarmagandey.

1. INTRODUCTION

Water is a renewable, limited and fragile resource. Thus, its management requires reconciling complex economic, social and environmental issues[1]. For most uses, the water should be treated to remove impurities. In arid and semi-arid areas, especially in the Sahel, access to water for agricultural production is becoming increasingly difficult given the irregularities of rainfall in space and time.

Thus, in these areas, farmers have to use different water sources to irrigate crops and ensure agricultural production, especially during the dry season. In Niger, there are significant unexploited groundwater reserves and surfaces (river, ponds, shallow water tables, etc.) that can be used for agricultural purposes, but less than 1% of this surface water is used for crops [2] . All this water potential deserves to be exploited to the maximum and in an optimal way in order to alleviate the food insecurity which has been raging for several decades. While gravity irrigation is the most developed in the world, according to Driss [3], this technique has the following drawbacks: labor time for distribution and significant monitoring, significant costs in the event of 'art, significant water losses in the canals depending on the nature of the soil, low efficiency, difficult estimation of the volume actually consumed, requires flat ground or leveling, possible pollution of water and soil (by percolation or by dumping) of to waste water. Urgent solutions deserve to be proposed, calling for technological solutions respectful of the environment making rational use of water which is increasingly scarce. The drip irrigation system appears to be the most efficient and meets these requirements. Thus, the drip irrigation system is more and more developed to save water mobilization. However, pond water is generally too loaded with suspended matter which often clogs the drippers. Thus, it is imperative to improve the quality of water intended for irrigation, especially in drip irrigation systems.

The objective of this study is to improve the physico-chemical quality of the pond water by using *Moringa oleifera* almond powder in order to use it in drip irrigation.

2. MATERIALS AND METHODS

2.1 Study Site

The study site is the Kongou Gorou Zarmagandey pond (KGZ) located 7 km northeast of the city of Niamey and covers an area of 9,596 ha (96.0 km²).

2.2 Plant Material

In the present study, *Moringa oleifera* seeds of the variety PKM1 is the plant material used.

Ripe and dry on the stalk, the *Moringa oleifera* pods used for the study were first harvested and then peeled by hand. The almonds from these pods are dried for 30 days at the respective temperatures of 40 ° C, 50 ° C in two ovens and then at room temperature in the laboratory at 25 ° C.

2.3 Preparation of *Moringa oleifera* Powder

The preparation of *Moringa oleifera* powder was made according to the method described by Lea., (2010):

• Leave the shelled *Moringa oleifera* seeds to dry for 2 to 3 days in sunlight;
• Grind using a porcelain mortar and pestle to obtain a fine powder;
• Sift the powder through a sieve of 0.5 mm mesh;
• Mix the powder with distilled water (0.4 grams in 5 ml of distilled water; to promote water extraction of coagulant proteins;
• Pour into the water to be treated according to the turbidity of the water;
• Mix for 30 seconds with a spatula;

• Stir vigorously for 2 to 3 minutes (150 revolutions / min) then stir slowly for 20 minutes at a speed of 60 revolutions / min;
• Allow the treated water to settle for 2 to 24 hours.

- .4 Pond water sampling plan and Preparation of *Moringa oleifera* powder
- The water samples are collected in 5l cans rinsed three times before filling with pond water, then sealed. They are collected in sterile 1l glass vials with caps. To properly preserve these collected samples, they were placed in a cooler and quickly transported to the laboratory where they are stored at around 4 ° C for physico-chemical analyzes.
- 2.5 Physico-chemical analyzes
- The analysis focused on electrical conductivity, pH, iron, calcium, magnesium, hardness, TDS, Full Alkalimetric Titer, and bicarbonate and organic matter.
- The pH measurement was carried out using a WTW 315i brand pH meter;
- The conductivity was carried out with a specific device; The determination of iron was made using the Spectrophotometer;
- The determination of copper was carried out using a Dr 6000 spectrophotometer which is the device for measuring this metal;
- The measurement of calcium or rather the level of calcium ions was made by multiplying the calcium titer by a coefficient equal to 0.4 (Ca = TCa x 0.4 mg/L;
- The following procedure was adopted to determine the total hardness by assaying the Hardness1 reagents at a pH of 10.1; of Hardness Reagent 2 and Tetrasodium EDTA drop by drop, stirring until a slightly dark blue color is achieved. Finally, reading the amount of EDTA added corresponds to the hardness value;
- The magnesium content was determined by the ratio: Magnesium content (TMg) = Total hardness (TH) -Calcium titration (TCa). Then the Mg^{++} is deduced from the TMg according to the ratio: Mg^{++} = TMg x 0.243
- The bicarbonate was deduced from the TAC according to the report:
- HCO_3^- = TAC x 12.2 mg / l and the TAC was determined using a specific device called TITRALINE 7000.

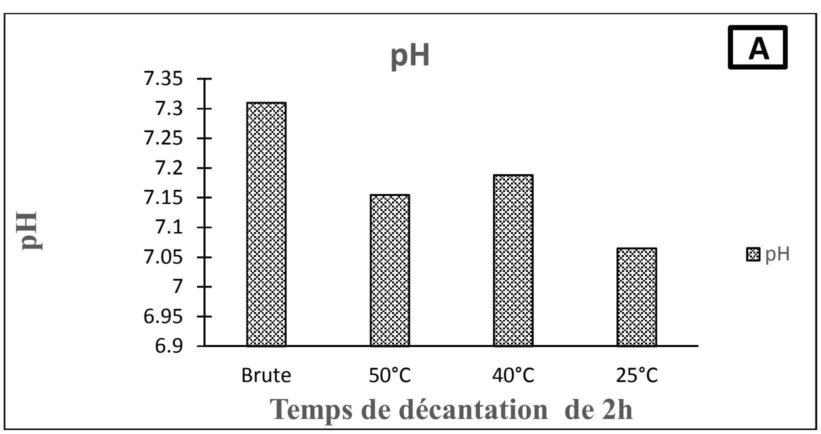
3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Variations of the physical parameters

3.1.1.1 pH and Electrical Conductivity (CE)

The initial raw water pH is 7.31, thus joining the pH values of most natural waters (between 6 and 8.5). After treatments with almond powder, the pH decreases regardless of the settling time and the drying temperature (Fig. 1). After 2 hours of decantation, the pH drops from 7.31 to 7.065, 7.188 and 7.155 (Fig. 1A) at drying temperatures of 25 ° C, 40 ° C and 50 ° C respectively for the dose of 100 mg / l of the powder almonds. After the application of the dose of 100 mg / l and for a settling time of 24 hours, a decrease in the pH is observed at the respective temperatures of 25 ° C, 40 ° C and 50 ° C. These decreases are respectively 6.895, 6.923 and 7.033 (Fig. 1B)



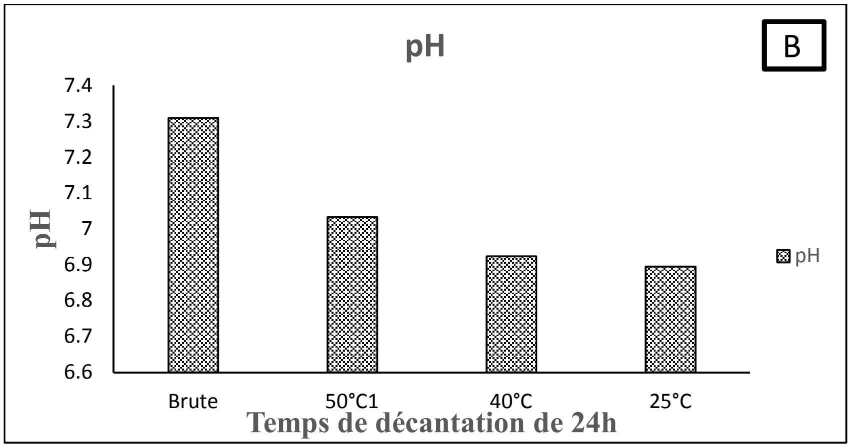


Fig. 1. Evolution of the pH of the water as a function of the drying temperature of 100 mg/L of *Moringa oleifera* powder after settling for 2 hours (1A) and 24 hours (1B)

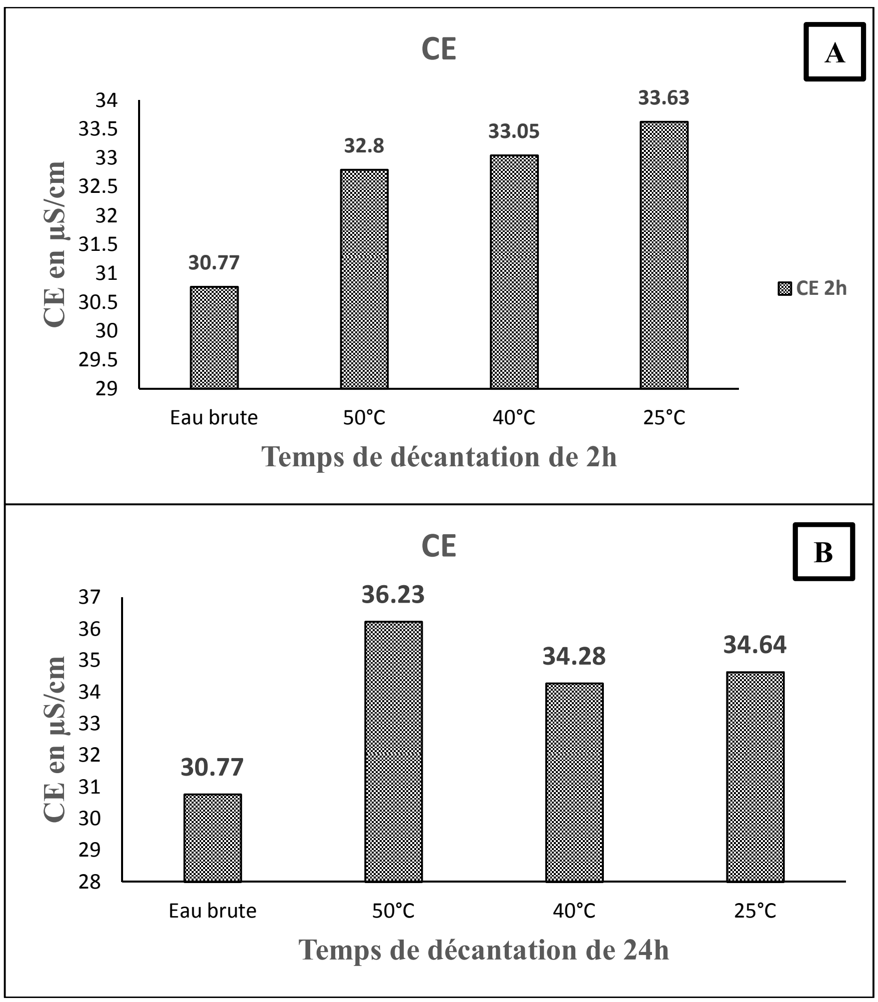


Fig. 2. Evolution of the electrical conductivity of water as a function of the drying temperature of 100 mg / l of *Moringa oleifera* powder after 2 h (2A) and 24 h (2B) of decantation

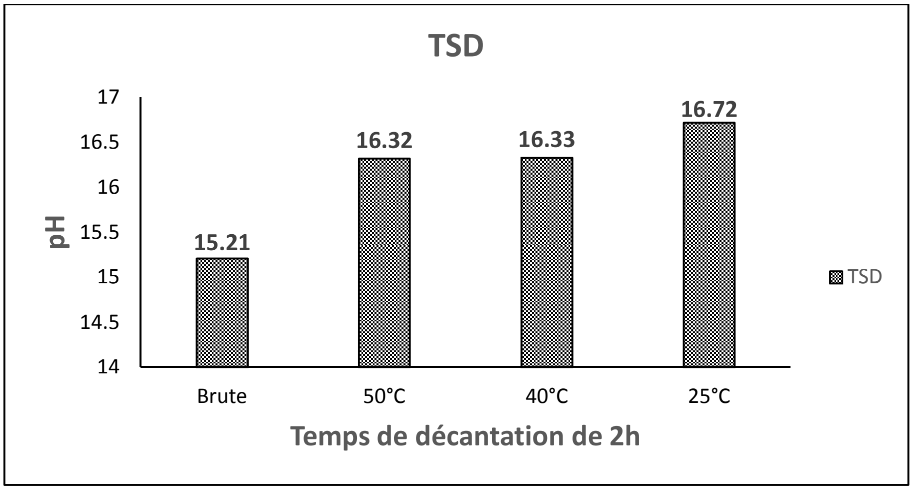


Fig. 3. Evolution of the TDS of water as a function of the drying temperature for 100 mg/L of *Moringa oleifera* powder

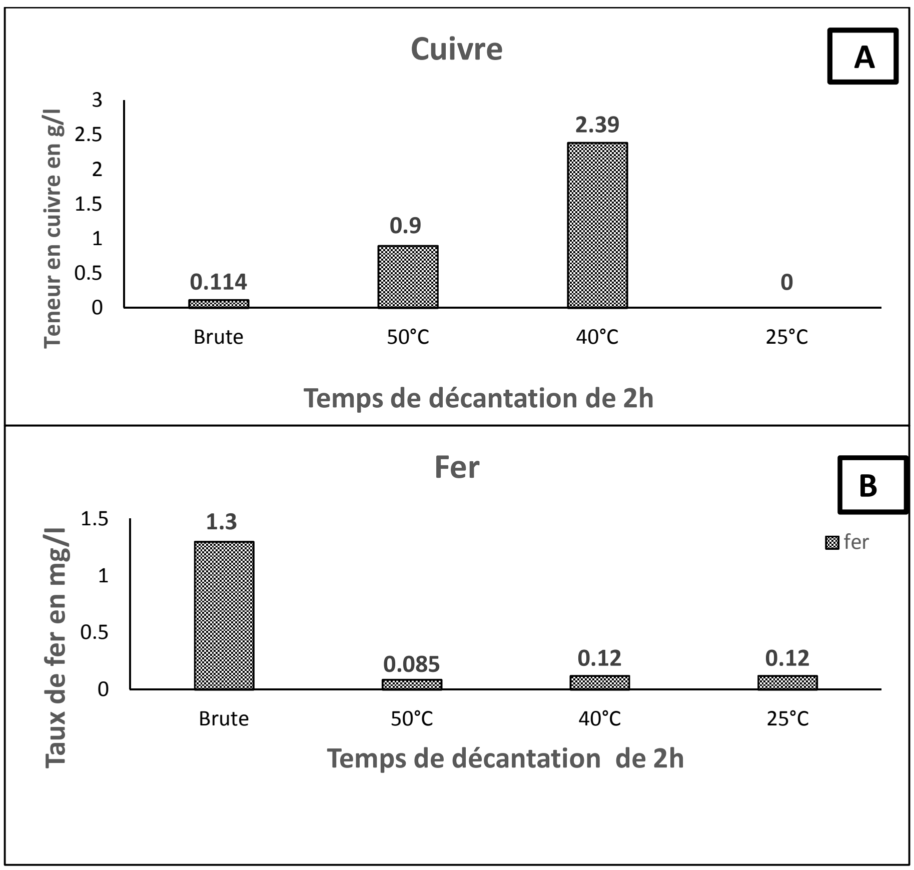


Fig. 4. Variation of the iron (4A) and copper (4B) content in water as a function of the drying temperature of *Moringa oleifera* powder

The electrical conductivity (EC) of raw water at the initial state is 30.77 µs / cm. After treatment with *Moringa oleifera* almond powder at a dose of 100 mg / l and after 2 hours and 24 hours of decantation, the EC increases slightly whatever the temperature (Fig. 2A and 2B). This increase varies from 30.77 µs / cm for the control to 33.63, 33.05 and 32.8 µs / cm at the respective drying temperatures of 25 ° C, 40 ° C and 50 ° C at 2 hours of decantation. At 24 hours of settling, it increased from 30.77 µs / cm for the control to 34.64, 34, 28 and 36.23 µs / cm.

3.1.1.2 Rate of Dissolved Substances (TDS)

The initial rate of dissolved substances TDS (15, 21 mg/L) increased slightly during treatment with almond powder of *Moringa oleifera* seeds, in particular with the drying temperature of 25 ° C (16.72 mg/L) (Fig. 3).

3.1.2 Variations in chemical parameters

3.1.2.1 Iron and copper

The water used for this study has 1.3 mg/L of iron. This iron level was reduced after treatment with *Moringa oleifera* powder. The variations recorded are 0.085, 0.12 and 0.12 at the respective temperatures of 50, 40 and 25 ° C with the dose of 100 mg/L each (Fig. 4). This corresponds to a reduction in the iron level of 93.46% for the dose at 50 ° C, 90.76% for those at 40 and 25 ° C. This variation in the iron level is statistically significant. Thus, the treated water is homogeneous with one another but different from the control. Despite everything, storage at 50 ° C seems to give better than the others, but we cannot draw any conclusions that discriminate one temperature from another.

The initial copper content of the raw water (0.114 mg/L) increased significantly after the treatment at 100 mg/L of *Moringa oleifera* almond powder for all temperatures except 25 ° C where the copper content is became almost zero after treatment (Fig. 4A). These increases are 0.903 and 2.39 mg/L respectively at drying temperatures of 50 and 40 ° C. Regarding the drying temperature of 25 ° C, we note a total removal of copper. Treatments with copper augmentation are statistically different from each other and from the Control.

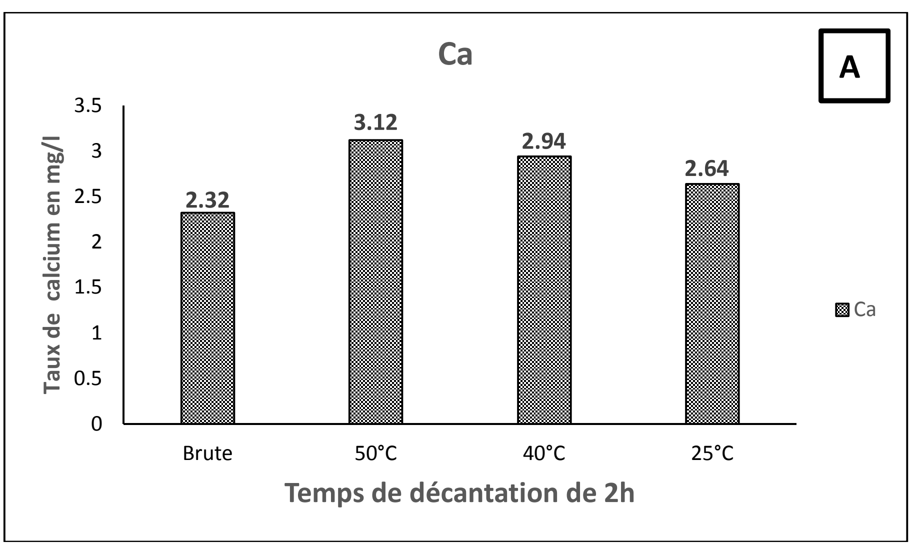
3.1.2.2 Calcium and magnesium

The initial calcium content of raw water (2.32 mg/L) increases significantly after treatment with *Moringa oleifera* almond powder at a dose of 100 mg/L for all storage temperatures (Fig. 5A) This calcium content increases by 34.48, 26.72 and 13.79% respectively at storage temperatures of 50, 40 and 25 ° C.

For magnesium, its initial content in raw water (2, 94 mg/L) significantly decreased by 27.21, 27.89 and 39.96% after treatment with the dose of 100 mg / l of the powder of *Moringa oleifera* almond stored at 50, 40 and 25 ° C respectively (Fig. 5B).

3.1.2.3 Hardness

The initial hardness of the raw water (17.9 mg/L) significantly decreased by 37.98, 39.94 and 36.03% after treatment with the dose of 100 mg/L of almond powder from *Moringa oleifera* dried at 50, 40 and 25 ° C respectively (Fig. 6).



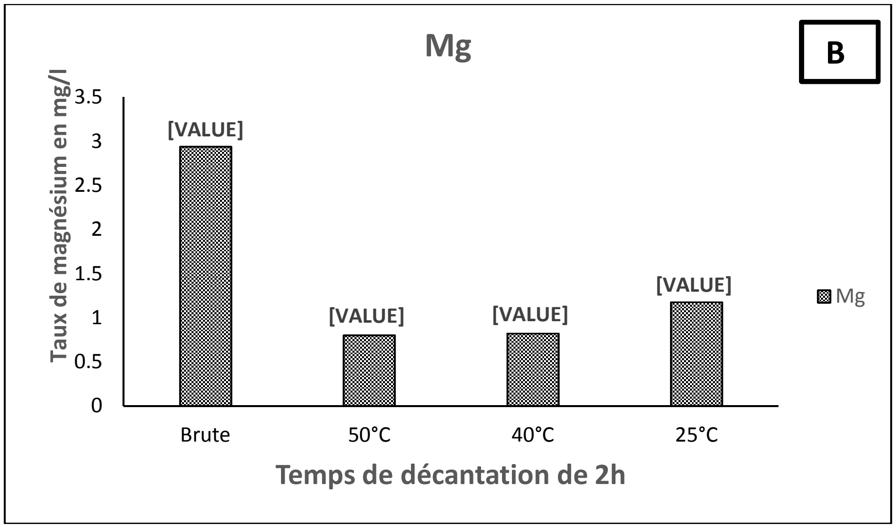


Fig. 5. Variations in the calcium (5A) and magnesium (5B) content of water as a function of the drying temperature of the *Moringa oleifera* powder

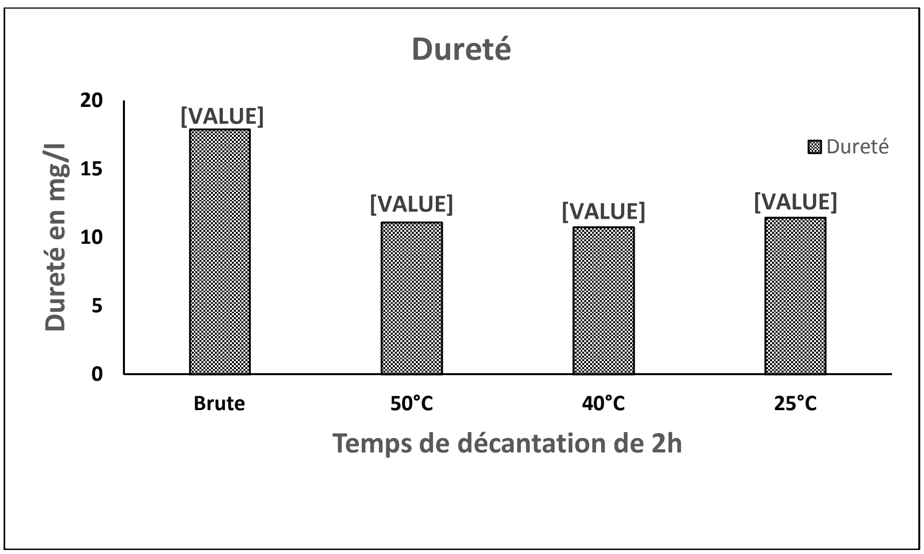


Fig. 6. Variation of water hardness as a function of the drying temperature of 100 mg/L of *Moringa oleifera* powder

3.1.2.4 Complete Alkalimetric Title (TAC) and bicarbonate

The Complete Alkalimetric Title or TAC expressed in ° F allows to know the concentrations of bicarbonates, carbonates and possibly hydroxides (strong bases) contained in the water [4]. The raw water TAC is 1.3 ° F which is much lower than the WHO standard value (50 ° F). After the treatment with *Moringa oleifera*, the TAC slightly decreased and its value thus decreased from 1.3 to 1.08; 1.29 and 1.23 ° F respectively for temperatures of 50, 40 and 25 ° C. This corresponds to slight reductions of the respective order of 9, 23; 0.76 and 5.38% (Fig. 7A) for a settling time of 2 h. The TAC values of treated water and raw water are statistically homogeneous.

Relative to bicarbonate, raw water contains 15.86 mg/L. This rate decreased slightly after treatment at the dose of 100 mg/L. After 2 hours of settling, it becomes 14.39; 15.73 and 15 mg/L respectively at drying temperatures of 50, 40

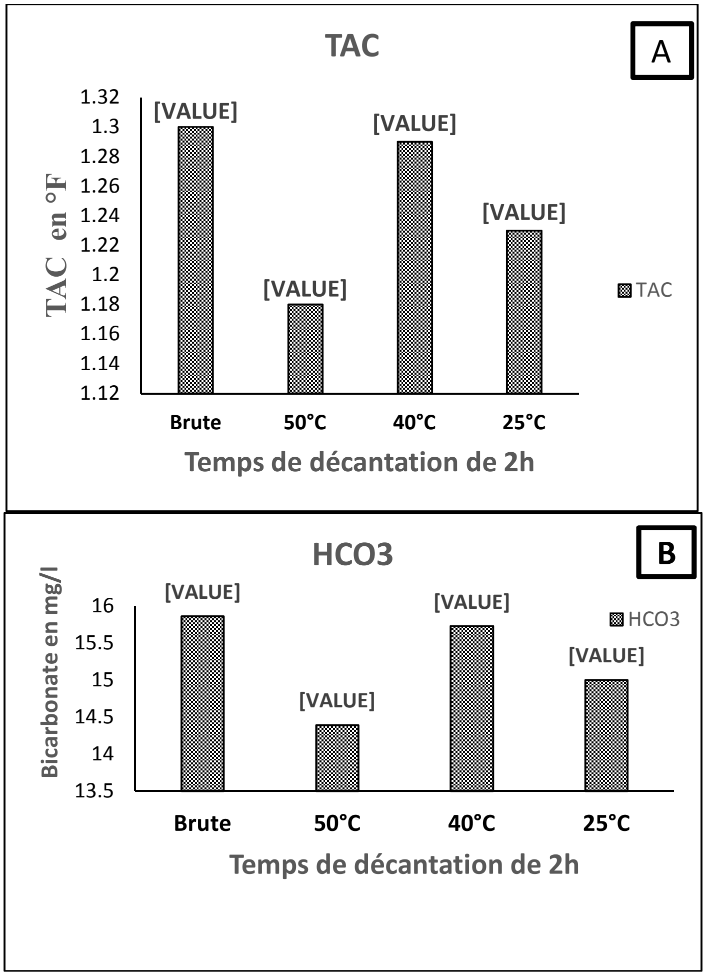


Fig. 7. Evolution of the Complete Alkalimetric Titer (7A) and of the bicarbonate (7B) of water as a function of the drying temperature of 100 mg /L of *Moringa oleifera* powder

3.2 Discussion

After treatments with almond powder, the pH decreases regardless of the settling time and the drying temperature. The smallest values at 2 hrs and at 24 hrs of settling are obtained with the drying temperature of 25 ° C., they are not statistically different from one another, but strongly different from that of the control. At 40 ° C and 50 ° C the pH is not different between them and the control. After settling for 24 hours, the pH changes little, from 7.31 to 6.895 for the dose of 100 mg / l at 25 ° C. They are all statistically different from the control and homogeneous between them.

For all the temperatures and at the different settling times, the pH changed little. And this does not allow any effect of the dose or the drying temperature to be deduced from the fact that all these values fall within the range of the FAO guideline values for irrigation water which is 6.5 to 8.4 .

These results confirm those of Eman [5] who pointed out that the treatment of water with *Moringa oleifera* has little influence on the pH. The slight drops in pH observed in this study using *Moringa oleifera* powder directly are contrary to the results achieved by Rakotoniriana[6] who found no change in pH when treating the water with active ingredient from *Moringa oleifera* and those from Ngbolua [7] for which the pH increased slightly by treating it with aliquots of a stock solution of *Moringa oleifera* seeds. In view of these results cited above, it can be deduced that the behavior of the pH of the water treated with seeds of *Moringa* *oleifera* varies according to the mode of application of the coagulant or of the active cationic polyelectrolytes which are responsible for the clarification of the water.

Regarding electrical conductivity, the conductivities of the treated water are relatively higher than those of the same water at 2 hours. Analysis of variance did not show a statistically significant difference between the treatments. The homogeneity of the treatments between them suggests that *Moringa oleifera* powder, under these conditions, has no effect on the conductivity of the water. These results are consistent with those of Rakotoniriana [6] who also found a slight increase using the active ingredient. On the other hand, Ngbolua [6] and Noureddine [8] noted slight drops in EC after treating water with an aliquot of *Moringa oleifera* seed powder solution. These CE values comply with WHO and EU standards which are 250 µS / cm

The level of dissolved substances which was initially 15.21 mg/L experienced an increase of 9.93% (16.72 mg/L) with the drying temperature of 25 ° C. This slight increase may be due to the fact that 'part of the powder remains in suspension in the treated water. However, the TDS values, both for the initial water and for the treated water, are significantly lower than the WHO guideline value (1000 mg/L).

The treatment of the powder with the dose of 100 mg/L and at the respective temperatures of 25 ° C, 40 ° C and 50 ° C reduced the iron level respectively by 90.76%, 90.76% and 93, 46%. These results are close to those obtained by Fatombi [9] who had a 99% iron reduction rate. Our results confirm the effectiveness of *Moringa oleifera* seed powder in the iron reduction process in water. These different iron reduction values obtained all comply with the FAO guideline values for irrigation water and the EU which are respectively 0.3 and 0.2 mg/L [10]. Which initially has a rate of 0.114 mg/L, its treatment with almond powder has known according to the drying temperatures both an increase of 2.39 mg/L (40 ° C), of 0.903 mg/L (40 ° C) and total reduction (100%) of copper with the temperature of (25 ° C).

Rises in copper level may be due to the fact that copper is a constituent part of *Moringa oleifera*. [9] obtained a copper reduction of 99%, which is clearly greater than that of 100 mg/L obtained in this study with the dose of 100 mg/L stored at 25 ° C. The copper content in the water obtained after the treatments with *Moringa oleifera* almond powder at 100 mg/L complies with the WHO guideline value (2 mg/L) regardless of the drying temperature of the powder except for the copper content of the water treated with the powder stored at 40 ° C which slightly exceeds the FAO standards (2.39 mg /L).

The calcium content is 2.32 mg /L, with the treatment of this water, this rate increased by 34.48; 26.72 and 13.79% respectively the storage temperatures of 50, 40 and 25 ° C. But treated water is not different from one another in terms of calcium level. This increase in calcium would be due to the fact that the powder itself contains it. [11] also obtained an increase in calcium in low water content and a decrease in relatively high water. The calcium content of the water treated with *Moringa oleifera* almond powder in this study conforms to the FAO guideline value for irrigation water (100 mg/L).

The initial magnesium content of the raw water (2.94 mg/L) significantly decreased by 27.21, 27.89 and 39.96% after the treatment with 100 mg/L of *Moringa oleifira* almond powder stored at 50, 40 and 25 ° C, respectively. These results are similar to those of [11] who found a decrease of 37.03 to 97.95% in the magnesium content of water after treatment with *Moringa oleifera*. Which leads us to believe that the effectiveness of the reduction of magnesium is mainly dependent on its initial level in raw water. All magnesium ion concentrations fall within the WHO guideline value of 30 mg /L.

Raw water from the study pond which has a hardness of 17.9 mg / L, after treatment with the dose of 100 mg / L of dried *Moringa oleifera* almond powder at temperatures of 50, 40 and 25 ° C, this hardness decreased by 37.98, 39.94 and 36.03% respectively. These results are similar to those of [11] who noticed a drop in hardness of 18.75% for the Loumila pond water (Burkina) whose initial hardness is equal to 16 mg / L and of 97.04% for the Gana water whose the initial hardness is 913 mg / L. They conclude that the decrease in water hardness is mainly a function of the initial quality of the water and of the storage temperature of the almond powder from *Moringa oleifera* seeds. All the hardness values recorded in this study are lower than the FAO guideline value for irrigation water which is 400 mg / L.

Initially of 1.3 ° F, the Complete Alkalimeter Title was reduced by 9.23; 0, 76 and 5, 38% respectively at temperatures of 50, 40 and 25 ° C for a settling time of 2 hours. The TAC values of treated water and raw water are statistically homogeneous

Finally for the bicarbonate, the raw water having a rate of 15, 86 mg /L la slightly lowered after the treatment with the dose of 100 mg /L of the powder stored at 50, 40 and 25 ° C. This drop recorded after 2 hours of settling is respectively 9, 26, 0, 81 and 5, 42%. These values fall within the range of maximum admissible concentrations in irrigated agriculture, which is 30 to 50 mg / L [12].

4. CONCLUSION

The results obtained within the framework of this study more closely reflect the role that Moringa oleifera can play in improving the physico-chemical quality of the waters of the Kongou Gorou Zarmagandey pond. The effectiveness of the treatment depends more on the dose of powder than on the storage temperature of the latter. Regarding the parameters observed, two evolving trends have emerged. This is the low reduction of about 5.67% of pH, 3.86% of temperature, 37.98% of hardness, 5.17% of bicarbonate, and 5.12% of TAC of on the one hand and the 8.19% increase in TDS, 24.99% in calcium on the other hand. The treatment of the water with powdered Moringa oleifera almonds then has a comparative advantage in that it significantly improves the physico-chemical quality of the raw water from the pond. However, the increase in the rate of organic matter in the treated water deserves to conduct a study on the effect of the presence of these dissolved organic matter on the bacteriological quality of the treated water which could cause the problem of clogging of the drippers. .

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Michiels C, Vanderstichele G, Eijkelenburg A. Challenges and Prospects for the management of drinking water in rural areas. Experiences of Belgian cooperation in the field of rural and peri-urban hydraulics in Africa. Belgian development agency, Dossche Printing. Brussels. 2009;58.
2. Beck M, Girardet D. The water resources of Dallol Maouri in the district of Gaya: geophysical aspect, Institute of Geophysics, University of Lausanne (Switzerland); 2003.
3. Driss K, El Mostage L. The project for the collective reconversion of gravity irrigation into localized irrigation in Morocco: the Tassaouat Amont perimeter, Oulad Gaid sector. Preliminary study - "Water and Environment" License thesis, University of Marrackech-Morocco. 2012;65.
4. UAE. Differences between pH, TH and TAC. Opinion of the Professional Chamber. 2013;2.
5. Eman NA, Suleyman A, Muyibi HM, Salleh, Zahangir AM, Mohd RM. Production of Natural Coagulant from *Moringa oleifera* Seed for Application in Treatment of Low Turbidity Water. Water. Journal of Water Resource and Protection. 2010;2:259-266.
   DOI: 10.4236 / jwarp.2010.23030
6. Rakotoniriana HJ, Randriana NR, Ramaroson J, Randrianarivelo F, Herihajaniavo AM, Andrianaivo L. Comparative study of coagulants in water treatment. MADA-HARY. 2015;67-77.
   ISSN 2410-0315.
7. Ngbolua K, Pambu AL, Mbutuku LS, NzapoH.K, Bongo GN, Muamba NB, Falanga CM, Gbolo1 ZB, Mpiana PT. Comparative study of the flocculant activity of Moringa oleifera and Vetivera zizanoides in the clarification of pond water at the Batéké plateau, Democratic Republic of Congo. International Journal of Innovation and Scientific Research. Flight. 24 No. 2, pp. 379-387Ottosson J., 2003. Hygiene aspects of greywater and greywater reuse. Stockholm, Royal Institute of Technology, Department of Land and Water Resources Engineering. Stockholm, Sweden; 2016.
8. Noureddine B. Contribution à l'étude de l'efficacité de la graine de Moringa oleifera dans la dépollution des eaux d'Oued Safsaf. Mémoire de fin d'étude pour l'obtention du diplôme d'Ingénieur d'Etat en Agroforesterie, option: Technologie des Industries Agro- alimentaires. Faculté des sciences de la vie et de la nature et sciences de la terre et de l'univers. Université Aboubekr belkaid – tlemcen. 2015;48.
9. Fatombi JK, Roger GJ, Valentin W, Taofiki A, Bruno C..Physico-chemical parameters of Opkara water treated with Moringa oleifera seeds. J. Soc. West-Afr. Chim. 2017;23:75–79.

10. Chocat B. Is tap water different from bottled water? Méli Mélo. LGCIE - INSA Lyon. 2015;14.
11. Kaboré A, Savadago B, Rosillon F, Straoré AS, Dianou D. Optimization of the efficiency of Moringa oleifera seeds in the treatment of drinking water in sub-Saharan Africa: Case of water from Burkina Faso. Journal of Water Sciences. 2013;26(3).
12. Couture I. Water Analysis For Irrigation. Mapaq Montérégie- Est. 2004;8.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/62143