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Effect of paraquat on the growth of *Ceratophyllum demersum* L.

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Abstract

This study was conducted to test the effectiveness of the chemical herbicide Paraquat in controlling (*Ceratophyllum demersum* L.), because of its damage in obstructing the flow of water in rivers, and irrigation channels, and blocking drainage channels, as well as increasing its spread of harmful insects, as well as their impact on human health, and the results showed a high efficiency of paraquat in reducing wet weight of plant. also reducing the number of branches and plant lengths with increasing the concentrations, when compared with control The results obtained that the number of branches and it reached to 9.83, 3.67, 0.00, respectively in control.

Keywords: *Ceratophyllum demersum*; Herbicide; Irrigation Channels; Paraquat; Photosynthesis

1. Introduction

Ceratophyllum spp. One of plants of the family, Ceratophyllaceae, it is considered one of the important aquatic plants, which is classified among the submerged aquatic plants [1]. There are four species of the genus Ceratophyllum , but the most prevalent is the type *Ceratophyllum demersum*, and spread in Asian regions such as China, Japan, Iraq, Egypt and Vietnam, as for the rest of the species, they are found in the United States of America, such as the type C. echinatum, and it is found in northwest America, while the type C. maricatum spreads in large areas in the states of Florida and northern California [2,3,4].

It is a large perennial aquatic plant, rootless, free floating, and the spread of *Ceratophyllum demersum* has increased in different regions of Iraq. Despite the many benefits that these aquatic plants offer in environmental habitats, their presence has become harmful when these plants begin to affect various human activities, and the most important of these effects It obstructs the flow of water in rivers, and irrigation canals, and clogs drainage canals, as well as leads to an increase in harmful insects. It also causes a change in the taste of water and increases the accumulation of clay materials [5].

It also affects human health and causes scratches and redness in the skin, although it is a freshwater plant. The spread of aquatic plants leads to a difference in the design velocities of the water current , between one area and another along the course, which leads to an increase in speed in a certain area , and an increase in sedimentation in another area , and leads to the growth and spread of aquatic plants lead to an increase in the water level in the pectoral parts of the streams , and a decrease in the other parts , in a way that does not guarantee a fair distribution, damages the properties of the soil and reduces its productivity. Aquatic plants and bushes close the outlets, irrigation holes and pump suckers and affect navigation, and aquatic plants cause increased water loss due to the processes of evaporation - transpiration. One of the most important methods used to combat the Ceratophyllum plant is mechanical removal, which means getting rid of the plant either by hands, or by specialized machines. As for the other method of combating this plant, it is biological control, which means using a living organism, or pest within controlled limits in a way that keeps its growth

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within limits without, economic harm against this aquatic plant. Chemical control has also been used with chemical pesticides, which is considered one of the most common methods in the world in eliminating water jungles [6,7,8]. In our current study, the most widely used and famous paraquat herbicide in the world and in Iraq was selected.

Paraquat is a non-selective herbicide, that is widely used in more than 100 countries in the world, and the third best-selling herbicide in the world [9]. The chemical structure was first described in 1882, It was commercially marketed in the United Kingdom in 1962, while it was registered, and used in the United States in 1964 [10]. The pesticide works to kill any part of the plant, as soon as it comes into contact with the plant, and it is quickly absorbed by the leaves. It also works to destroy the tissues of the plant by disrupting the photosynthesis process, and tearing the cell membranes, which always prevents water from reaching, leading to rapid drying of the leaves of the plant [11]. Therefore, this study aimed at the effect of paraquat on some characteristics of Ceratophyllum plant.

2. Material and Methods

2.1. Sample collection

Ceratophyllum demersum was collected from the Euphrates River near the area of hot water and waste disposal of the electric power station in Thi-Qar Governorate, taking into account that the plants are tender, and natural with the exclusion of the dead parts, then the samples collected from the river were placed in plastic bag containing river water, and brought to laboratory. The sample collection process was repeated at different intervals as needed in the research. The plant was diagnosed based on [12].

2.2. Design of glass aquariums

24 glass containers, each with a capacity of 20 liters, and dimensions of 30 cm in length, 30 cm in width and 30 cm in height, were designed to cover the laboratory study parameters, where each three container represented replicates for each concentration. The container was transferred to the laboratory and arranged horizontally. A fluorescent light source with a capacity of 40 watts was provided for each of them, for a period of ten light hours per day, and an air source was created for each container by placing an electric pump to pump the air

2.3. Effect of paraquat on *Ceratophyllum demersum*

15 glass containers divided into five groups were used, each group represents three containers, and each container is supplied with 20 liters of tap water, and 30 gm of Ceratophyllum, except for the container of the second group, which are free of plants, *Ceratophyllum demersum* and each is container equipped with a thermostat with a temperature of 32 OC, also each is container equipped with a fluorescent light source and an air pump. Concentrations of paraquat were added. The group container of were left without the addition of paraquat for comparison control. As for the second group, water, and herbicide at a concentration of 0.25% were used without adding Ceratophyllum. While the container of the third, fourth and fifth groups contained whole plant and paraquat at a concentration of 0.25, 0.22, 0.20 % respectively, this experiment lasted for eight days, after which the plants were remove from the container and dried using filter papers, their length and number of branches were measured, and the wet weight of the whole plant. Extraction of paraquat from *Ceratophyllum demersum* plant, and from water according to the method of [13], with some modifications, as follows:

2.3.1. Extraction of paraquat from Ceratophyllum plant

- 25 gm were taken from *Ceratophyllum demersum* treated with Paraquat, then dry and mix it with an electric mixer.
- Add 1 ml of 5% EDTA, then filter the sample by adding 150 ml of distilled water and using Whatman filter paper No. 1). The filtrate is received in a 250 ml flask.
- Add 50 ml of acetonitrile in the separating funnel and the distillation was done in the column for the purpose of saturating it until, the first drop from the tap opening at a flow rate of 3 ml / min.
- The filtrate is passed through the silica column at a rate of 7 ml/min, and the filtrate is received in a 250 ml beaker.
- The filtrate is placed in a water bath in 70 OC temperature and evaporated until its volume reached to 1 ml.
- This remaining filtrate is then transferred, and placed in glass test bottles, and placed in the freezer, until the analysis, and estimation of the amount of the herbicide has been established.

2.3.2. Extraction of paraquat from water

- 100 ml of water treated with paraquat were taken, then filter the sample using filter papers and receive the filtrate in a 250 ml flask.
- Add 1 ml of 5% EDTA for the purpose of removing ions and minerals.
- Add 50 ml of acetonitrile in the separating funnel, and the distillation was done in the column for the purpose of saturating it, until the first drop was drained from the tap hole at a flow rate of 3 ml / min.
- The filtrate is passed through the silica column at a rate of 7 ml/min, and the filtrate is received in a 250 ml beaker.
- The filtrate is placed in a water bath and evaporated until its volume reached 1 ml.
- Then this remaining filtrate is transferred and placed in glass test bottles and placed in the freezer, until the analysis and estimation of the amount of the paraquat has been established.

2.4. Determination of Paraquat Residues in Plant Samples and Treated Water by FTIR

After completing the extraction processes from plant samples, and water treated with paraquat, the samples were analyzed using an infrared spectrometer (FTIR) in the Department of Chemistry, College of Science – Thi-Qar University

2.5. Statistical analysis

Data results were analyzed based on a Complete Randomized Design (CRD). The results of the experiment were statistically analyzed using the statistical program Genstat verson 12, and the significant differences between the means were compared with the L.S.D test under the significance level of 0.05.

3. Results and discussion

3.1. Effect of paraquat on *Ceratophyllum demersum* L.

Table (1) showed that paraquat has a significant effect on the average amount of chlorophyll of the *Ceratophyllum demersum* plant. When comparing the rates of the treatments with the rate of the comparison treatment, we see that the 0.25 % treatment had a significant effect on the rate of chlorophyll, and it reached to 9.83 mg compared to the amount of chlorophyll of the *Ceratophyllum demersum* plant. In the comparison with control in the chlorophyll amount which amounted to 22.84 mg. As for the treatments 0.22 and 0.20 %, they also affected the average chlorophyll amount with rates of 10.01 and 12.95 mg, respectively,

Table 1 Effect of using different concentrations of Paraquat on some characteristics of *Ceratophyllum demersum* L.

Average number of branches	average plant height (cm)	Amount of chlorophyll (mg)	Amount of herbicide added %	pelvis number
5.00	30.0	22.84	without	1
0.00	3.67	9.83	0.25	2
0.33	4.33	10.01	0.22	3
0.67	5.00	12.95	0.20	4
1.50	10.75	13.91		Average
0.94	5.244	2.373		L.S. D

Table (1) showed that paraquat had the same effect when calculating the results of the length of samples collected after the treatment, and all treatments had a significant effect on the length of the *Ceratophyllum demersum* plant, when compared with control, which gave a length of 30.00 cm, while the rate of the treatments were 0.25 ,0.22, 0.22 % length in the *Ceratophyllum demersum* samples rate were 3.67, 4.33, 5.00 cm, respectively.

The results of Table (1) showed that when measuring the average number of branches in the *Ceratophyllum demersum* samples treated with Paraquat, it appeared that this herbicide affected in all treatments when compared with control, where the average number of branches in the treatments was 0.00, 0.33, 0.67 branches, while the average number of branches was in the control respectively it is 5 dens.

The results showed a significant decrease at the probability level of 0.05 in the amount of chlorophyll in the plant tissues used in the experiment , and exposed to different concentrations of paraquat during the duration of the experiment, and this was confirmed by many studies such as the study of [14] this is due to the fact , that the higher of the concentration pesticide in the tissues of plants, the lower its content of chlorophyll, due to its effect on the work of the enzymes that contribute to the process of chlorophyll synthesis, and as it is known that chlorophyll is the green pigment responsible for the process of photosynthesis in plants to produce energy, and this pigment is present inside the plant cell in chloroplast, and it is possible to infer the nutritional level of the aquatic environment , and the level of growth by measuring the total content of chlorophyll [15,16]. The significant moral effect that the paraquat had on the growth parameters used may be due to the effect of the paraquat on a number of important vital plant activities such as photosynthesis, as the paraquat interacts with the electron-carrying compounds present in the first photosystem I. As it works to acquire the electron released from this system and converts it to oxygen, forming a high-energy oxide. This oxide initiates several reactions of free radicals and causes great cellular damage. Thus, the herbicide works to disengage the energy resulting from photosynthesis, and the cellular biosynthesis process [17]. The results of this experiment agreed with the opinions of many researchers including [18,19].

Paraquat is considered an herbicide according to its strong absorption on soil particles. It was mentioned [20] that Paraquat is a non-selective herbicide that works by contact, as it kills any part of the plant as soon as it comes into contact with the plant. It is quickly absorbed by the leaves, and it also destroys plant tissues by disrupting the photosynthesis process, and ruptures cell membranes, which always prevents water from reaching, leading to rapid drying of plant leaves [11].

3.2. Determination of Paraquat Residues in Ceratophyllum Samples and Treated Water by FTIR

Figures (1-5) showed the transformations of the standard of the paraquat in water container by using infrared spectroscopy technique as we note in Figure (2) a change in the herbicide and the complete disappearance of the peaks in the area (500-1500), as we note the disappearance of a number of values in the area (1000-3500) and the emergence of new and broad peaks in the same area, which indicates that there is acid in the middle and thus indicates analysis of the active substance at a concentration of 0.25 % in container of water without adding *Ceratophyllum demersum* and in a large proportion it was observed in Figure (3-5) the disappearance of a number of peaks in the region between (500-3500) and the emergence of new and broad peaks in the same region, which indicates that there is acid in the middle and thus indicates the analysis of the active substance added with a concentration of (0.25 ,0.22 ,0.20 %) respectively in a container of water with the addition of *Ceratophyllum demersum* , and this may indicate the formation of hydrochloric acid, ester, ethanol and other chemicals that decompose this herbicide, and this is consistent with the findings of [21].

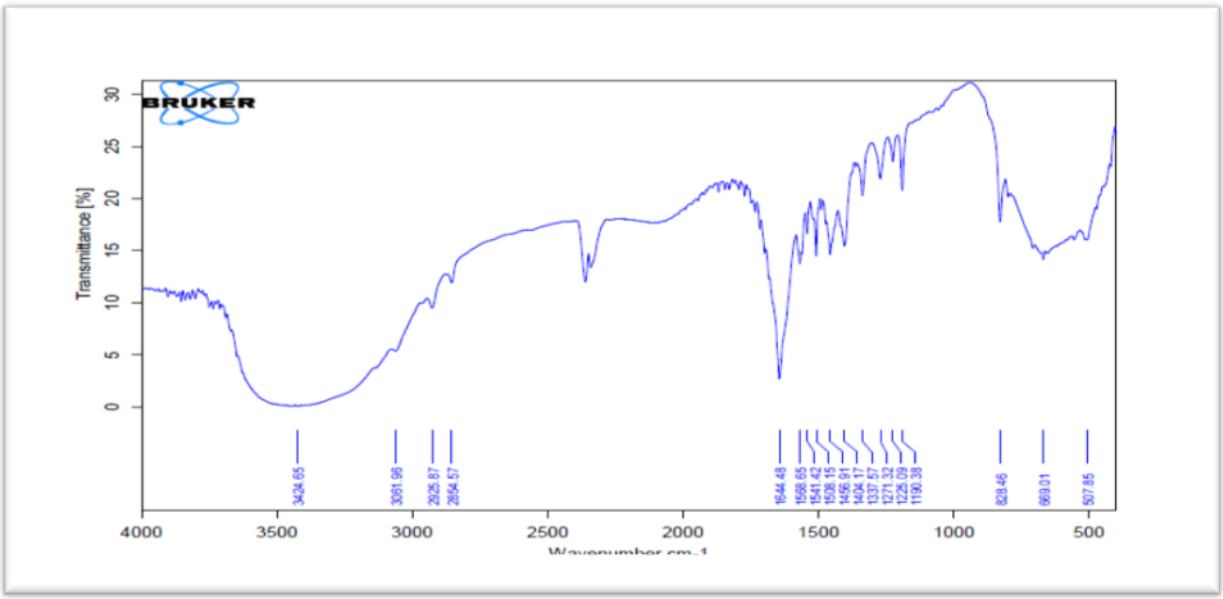

Figure 1 Standard of paraquat herbicide by using infrared spectroscopy (FTIR)

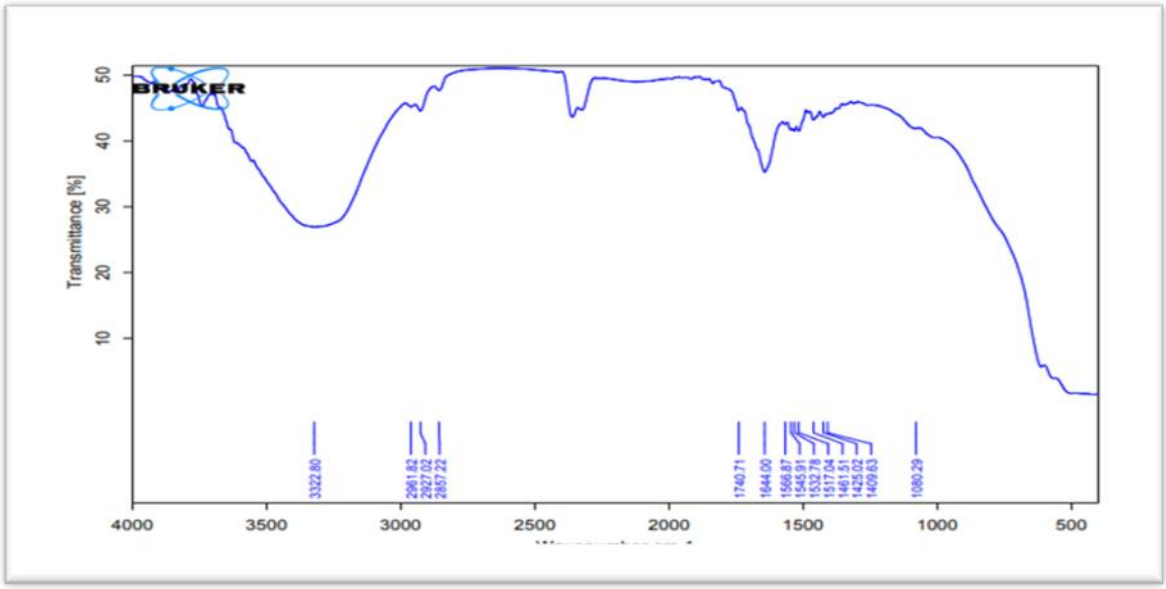

Figure 2 Residues of paraquat herbicide in concentration 0.25 % by using infrared spectroscopy (FTIR) without adding *Ceratophyllum demersum* L

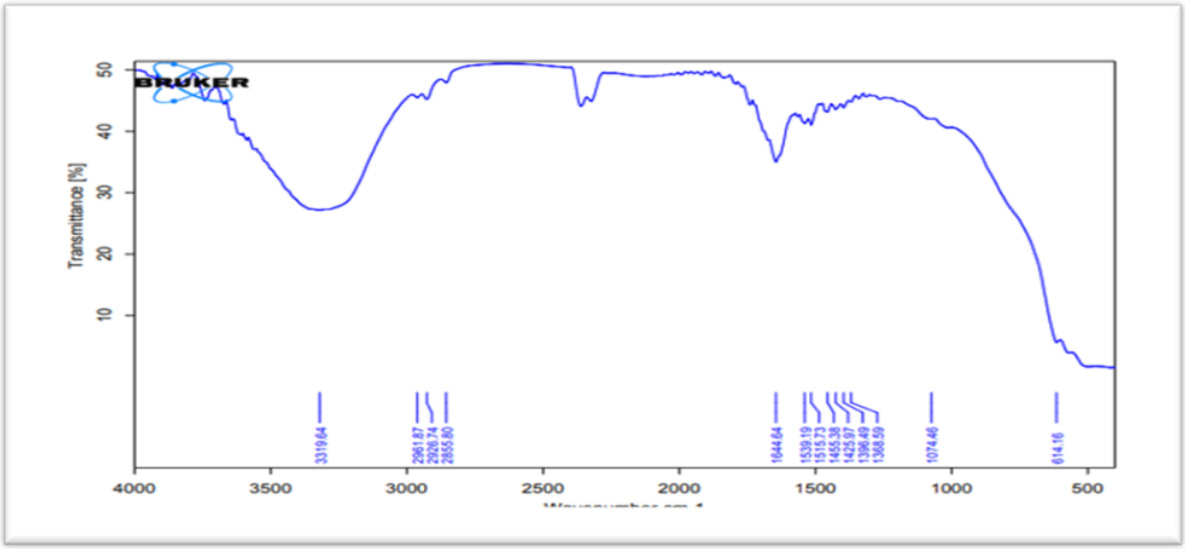

Figure 3 Residues of paraquat herbicide in concentration 0.25%. by using infrared spectroscopy (FTIR)

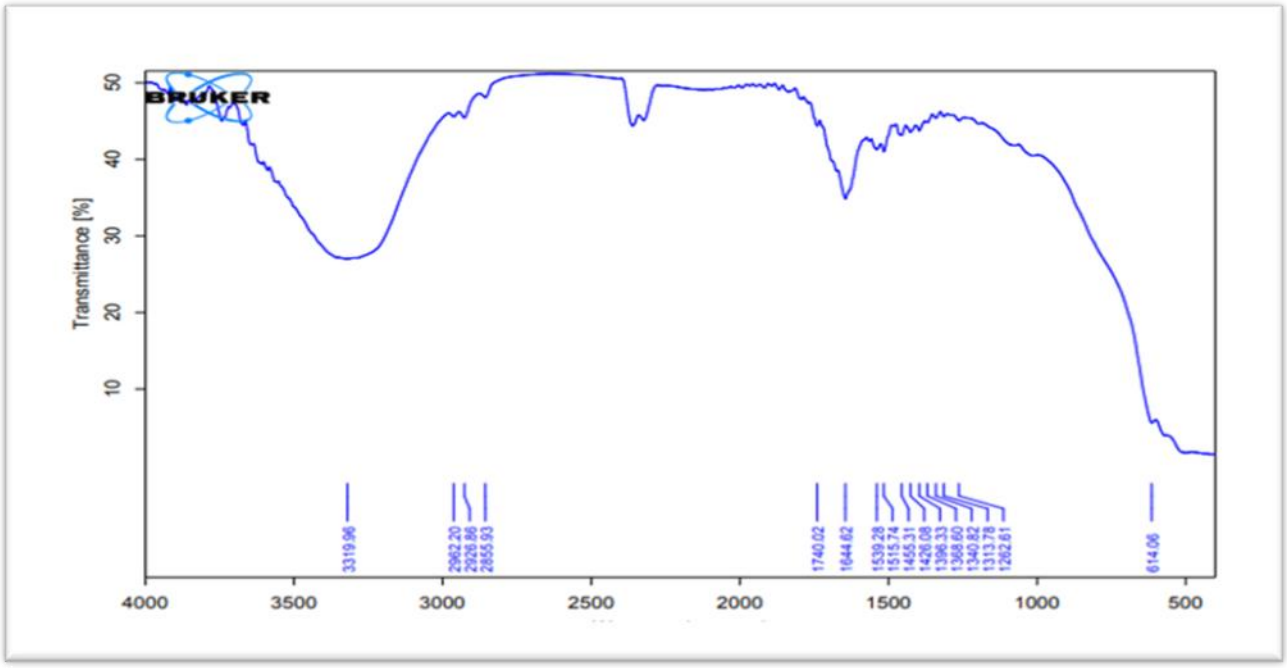

Figure 4 Residues of paraquat herbicide in concentration 0.22% by using infrared spectroscopy (FTIR)

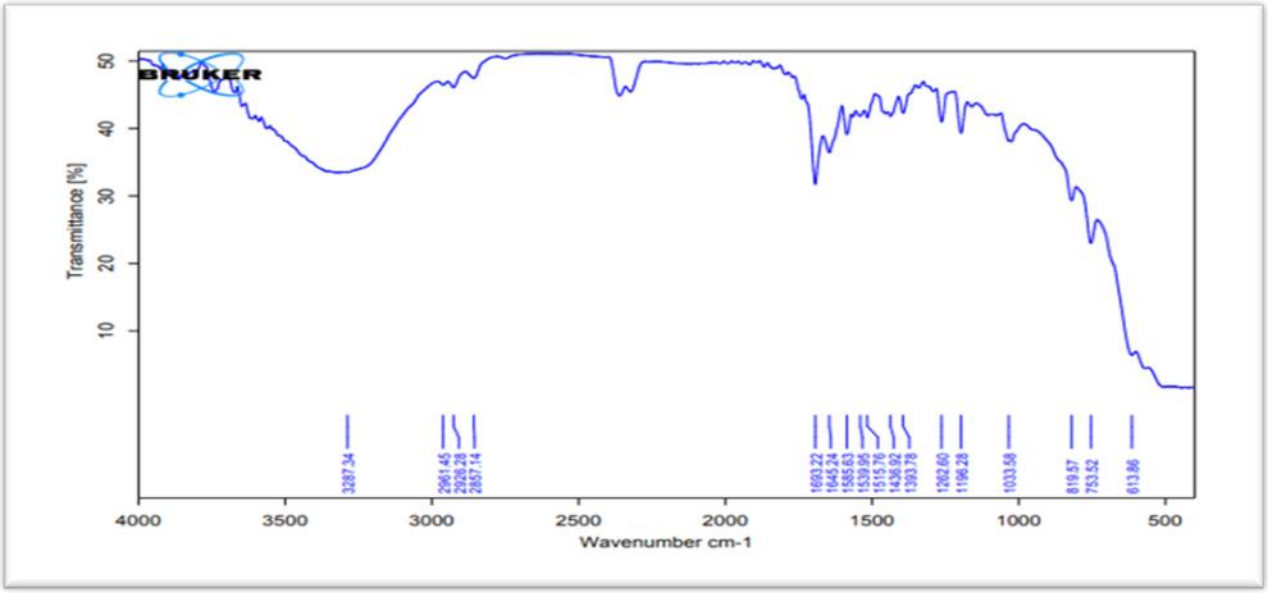

Figure 5 Residues paraquat herbicide in concentration of 0.20 % by using infrared spectroscopy (FTIR)

4. Conclusion

Chemical pesticides, despite the damage they cause to the environment and to humans, but they remain effective in controlling many weeds, water weeds and harmful plants, and give positive results compared to other control methods. It was also concluded that Paraquat herbicide cannot quickly degrade in the environment and is absorbed in clay clamps. Which requires urgent environmental treatment, and for this many techniques have been developed, but chemical methods remain the potential role.

Compliance with ethical standards

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Disclosure of conflict of interest

All authors declare no conflict of interest of regarding the publication of this paper.

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