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# Effect of continuous cultivation and soil texture on some soil properties

Hussein Razzaq Nayyef *

*Department of tissue culture and medicinal plants, Shatrah Technical College, Southern Technical University, Iraq.*

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## Abstract

The effects of soil continuous cultivation and soil texture on some of its properties, electrical conductivity, total porosity, and calcium carbonate content and soil penetration resistance. Six samples of soil material for a layer of 0-30 cm were collected from three different texture sites are Clay, Loam and Loamy Sand in Basra Governorate for three sites Abi al-Khasib, Karma and Zubair. Three of these samples represented the treatment of soil continuous cultivation, soil planted with alfalfa crop (Medicago sativa) for 7 consecutive years, and the other three samples from the same sites for uncultivated soil with three replications for each sample. The results showed a decrease in the values of electrical conductivity, calcium carbonate, soil penetration resistance, and an increase in soil porosity values in cultivated soils. The lowest EC values were 4.1, 5.3 and 6.2 dS. $m^{-1}$ for soils with textures Loamy sand, Loam and Clay, respectively, and for CaCO3 of 182.3 g. $kg^{-1}$ in Loamy sand, 266.7 g. $kg^{-1}$ and 310 g. $kg^{-1}$ for Loam and Clay soils, respectively, and for resistance to penetration of 550 KN.m-1 for clay soils. While it was 620 KN.$m^{-1}$, and 714 KN.$m^{-1}$, for loam soil and loamy sand soil, respectively, compared to uncultivated soil. While the soil porosity values increased for cultivated soils compared with uncultivated soils and the values of 43%, 48.53% and 53.4%, for soils with textures Loamy sand, Loam and Clay respectively, And for the average weighted diameter of 0.2537 mm, 0.2817 mm, 0.3640 mm, for soils with textures Loamy sand, Loam and Clay, respectively.

**Keywords:** Continuous cultivation; Soil texture; Soil porosity; Electrical conductivity

## 1. Introduction

Soil has physical and chemical properties that vary according to the soil type and where it is located, among the physical properties are; Soil horizon, soil color, soil texture, soil composition, soil consistency, and bulk density, as for the soil chemical properties, they are represented in the cation exchange capacity, soil interaction or the so-called pH [1],[2]. Soil structure can be determined naturally when it is not unusually dry or wet. There are four classes of soil structures; The first is structure less which gives individual grains when not cohesive, the second is weakly structured and aggregates in an unobservable formation, the third is moderately structured, which is well-formed and slightly firm, and the fourth is robust, which is firm and cohesive soil [3],[4]. The soil is directly or indirectly affected by the it's cover growing vegetation. This means that the vegetation cover is one of the important factors in soil formation and in its current and future characteristics. Many researchers, i,e. [5],[6]. Have shown that the vegetation cover is significantly related to soil quality, its characteristics and the prevailing topography in it. Also, the nature and texture of soil is of great importance in the distribution and growth of vegetation, and the reason is due to the effect of soil qualities and properties on its ability to water storage by affecting its other properties [7],[8]. The study of [9] showed that soils cultivated with plants and trees have a high infiltration rate as a result of the increase in soil porosity and the volume of pore size distribution, and a decrease in the hydrophobic characteristics and resistance to water movement in the soil, all of these compared to uncultivated soils. It was noted that alfalfa crop has a significant effect in improving the chemical and physical properties of soil and it is considered as a green fertilizer, and that the rate of nitrogen introduced when

* Corresponding author: Hussein Razzaq Nayyef

Department of tissue culture and medicinal plants , Shatrah Technical College, Southern Technical University, Iraq.

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planting alfalfa crop is between 300-500 kg. $ha^{-1}$ [10],[11]. Stated that the soils containing high levels of calcium carbonate losses large amounts of added nitrogen as an ammonia gas form. [12],[13]. Soil structure is affected by the quality and characteristics of the soil solution and the salts contents, which have positive or negative effects on soil structure[14],[15]. As the increase in the concentration of salts in the soil solution on the one hand, and the predominance of divalent ions on the other hand, leads to pressure layer The double diffusion that surrounds the clay particles, thus reducing the interference between the double layers, and this in turn reduces the repulsion between the clay particles and thus increases the stability of the soil aggregates [16],[17], [18]. Soil construction is affected by several factors, including the method of preparing the soil for cultivation, as well as the irrigation methods used, which greatly affect all the soil physical properties , which negatively affects the plant growth, throughout its life until full maturity. [19],[20], [21] The aim of this study is to determine the effect of continuous cultivation through the type of crop grown in it and its service operations during the period of Its growth and the effects of root secretions in the soil, especially the alfalfa crop (*Medicago sativa*). Also the effect of soil texture on some of its physical and chemical properties.

## 2. Material and methods

In this study, soil samples were collected from three sites in Basra Governorate (Abi al-Khasib, Karma and Zubair), with different textures, namely Clay, Loam and Loamy Sand. Two kinds of samples were collected from each site of these soils cultivated with alfalfa crop (*Medicago sativa*) for 7 consecutive years,( continuous cultivation) and the second types of samples were collected from the same site and the same texture, but the soil was not cultivated, and thus the total number of samples became 6 samples, 3 samples were cultivated and 3samples uncultivated, and each sample with three replications. Soil samples were air-dried and sieved with sieve opening diameter of 2 mm. The texture of soil was estimated and the pH of the soil solution as shown in Table.1, as well as the measurement of EC, soil porosity, soil resistance to penetration and soil content of $CaCO_3$ for a layer of 0-30 cm.

**Table 1** Soil particle size distribution and pH of studied soil

| Cultivation | Soil texture | Sand | Silt | Clay | PH |
|---|---|---|---|---|---|
| | | Mgm.kg-1 | | | |
| Cultivated Soil | Clay | 60 | 340 | 600 | 7.36 |
| | Loam | 392 | 440 | 168 | 7.33 |
| | Loamy sand | 773.8 | 139.4 | 71.8 | 7.2 |
| Un cultivated Soil | Clay | 60 | 340 | 600 | 7.2 |
| | Loam | 392 | 440 | 168 | 7.55 |
| | Loamy sand | 773.8 | 139.4 | 71.8 | 7.4 |

### 2.1. Electrical conductivity (ECe)

The electrical conductivity ( dS $m^{-1}$ ) was measured in the saturated paste extract of soil using an Ec-Meter type WTW and according to the method used by [22],[20].

### 2.2. Soil porosity %

The total porosity was calculated from the relationship between the bulk density and the particle density as stated in the method used by [21], [22],[3].

$$f(\%) = \left(1 - \frac{pb}{ps}\right) \times 100 \ldots\ldots\ldots (1)$$

Where: *f*: total porosity. *Pb*: bulk density (Mgm. $m^{-3}$). *Ps*: the particle density (Mgm. $m^{-3}$).

### 2.3. Calcium Carbonate

It was estimated using 0.2 N of ammonium oxalate, according to the method of [23],[24].

### 2.4. Soil texture was estimated

Using the pipette method, which was described and mentioned by [21],[25], [26] to estimate the particle size distribution of the total soil particles and separated according to the USDA farming system.

### 2.5. Soil resistance to penetration

The penetration device (Pocket Penetrometer) model 700 CL with a cylindrical stem and a flat end with a diameter of 0.672 was used to measure the resistance of the soil to penetration. [27], [28]

### 2.6. Mean Weight Diameter (MWD)

The weighted diameter ratio was measured using the wet sieving method, by applying the equation proposed by ,[21], [29]. [30]

$$MWD = \sum_{I=1}^{n} XiWi \ldots\ldots\ldots\ldots (2\ )$$

Where:- Xi: the average diameter for any volumetric range of separated assemblies (mm), Wi: The weight of the remaining aggregates within one volumetric range as a proportion to the total dry weight of the soil model. MWD: weighted diameter ratio (mm).

The characteristics of this study were analyzed according to the method used by Alsahoeke, and Creama [31], Oehlert [32].

## 3. Results and discussion

The statistical analysis of the F-test Table.2, indicate a highly significant effect of each of the two factors of soil continuous cultivation and its texture, and their interaction in the electrical conductivity values of the soil solution. Figure 1A shows that the EC values were 48.4 dS. $m^{-1}$ in soil Ucu with a highly significant difference with soil cu 5.2 dS. $m^{-1}$. As for the effect of soil texture factor on EC values, it was significant (Fig.1B), where it is noted that the highest values were in Clay soils 35.6 dS. $m^{-1}$ and decreased to 27.7 dS. $m^{-1}$ and 17.2 dS. $m^{-1}$, for Loam and Loamy sand soils, respectively. [6],[17]. Figure 1AB shows the significant difference between the interaction treatments, as it was found that the lowest value of the EC is 4.1 dS. $m^{-1}$ and 4.1 dS. $m^{-1}$ in cultivated soils with loamy sand, compared to 5.3 dS.$m^{-1}$ and 6.2 dS.$m^{-1}$ for soils with Loam and Clay textures, respectively. While the uncultivated soil gave the highest values at 30.2 dS.$m^{-1}$, 50 dS.$m^{-1}$ and 65 dS. $m^{-1}$ for soils with textures Loamy sand, Loam and Clay, respectively. This decrease is due to the improvement of the physical properties of the soil due to an increase in the total porosity and a decrease in the values of the bulk density of the soil, which in effect improves the soil structure and permeability, leading to an increase in salt leaching processes outside the root zone and thus preventing the accumulation of salts in the soil profile [10],[ 8]. The statistical analysis of the F-test.Table. 2, show that there is a highly significant effect of the factors of soil cultivation and its texture and the interaction of these two factors in the values of soil porosity *f*, as figure 2A shows the high values of *f* in the treatment of soil cultivation Cu 48.31%with a highly significant difference compared with Uncultivated treatment Ucu 43.57%. As for the effect of soil texture factor, it is illustrated in Figure 2B where significant differences are observed between soil textures. The highest values of *f* were in Clay soils 49.8% and decreased in Loam and Loamy sand textures and were 46.42% and 41.6%, respectively. Figure 2AB shows the interaction between the two factors of soil cultivation and its texture, as the differences were significant between the treatments and the lowest values were 40.2% in the uncultivated soil with Loamy sand texture, while the highest values were 53.4% in the cultivated Clay soil and this is due to the amount of changes caused by the cultivation process and exploitation soil has many physical characteristics, especially the porosity of the soil, in light of the soil texture, which depends on the type of the cultivated crop [19],[20], [21]. The results of the statistical analysis of the F-test Table.2, show that there is a significant effect of each the factors of continuous cultivation soil and its texture, and the interaction of the two factors in $CaCO_3$ values. Where the cultivated soil gave the lowest values 253 gm.$kg^{-1}$ with a significant difference with the uncultivated soil 302.6 gm.$kg^{-1}$. Fig. 3A. As for the effect of soil texture on caco3 values, it is shown in.Fig. 3B, as it was the highest values were in clay soil 345.8 gm.$kg^{-1}$, with a significant difference with the two textures Loam and Loamy sand 283.8 and 203.7 gm.$kg^{-1}$, respectively. Fig 3AB shows the interaction between the two factors of continuous cultivation and soil texture. The highest values were 381.7 gm.$kg^{-1}$ for uncultivated soils and the lowest values were for cultivated soils 182.3 gm.$kg^{-1}$. The reason for the value decreasing in the cultivated soils may be attributed to the increase in the growth and distribution of the root system, which in turn works to bind the soil particles through the gummy secretions that it poses and the mechanical effects caused by the root hairs during their growth and penetration of the interfacial pores that are smaller than them, which helps to converge the soil particles with each other. Thus, increasing their association with each other to form stable soil aggregates, as well as the attraction and convergence that occurs between soil particles due to the forces of adhesion and cohesion, which leads to an increase in the stability of their aggregates and thus reduce caco3 ratios [19],[26]. The decreases of $CaCO_3$ in the Uncultivated soil is due to the lack of leaching as a result of leaving the soil with uncultivated (bare soil), which leads to poor structure and a decrease in its organic matter content [12],[25]. The results of the statistical analysis of the F test Table 2. that there is a significant effect of the factors of soil continuous cultivation and texture and the interaction of these two factors at the values of soil resistance to penetration, as Fig. 4A, shows the increase of soil penetration resistance in the treatment of uncultivated soil cu 1063.3 $KN.m^{-2}$, with a highly significant difference compared with treatment cu 628 $KN.m^{-2}$. While the effect of the soil texture factor was shown in Figure 4B, where significant differences were observed between the soil textures. The highest values of soil resistance to penetration were Loamy sand 968 $KN.m^{-2}$, and decreased in Loam and Clay, and it was 811.5 $KN.m^{-2}$, 757.5 $KN.m^{-2}$ respectively. Figure 4AB shows the interaction between the two factors of soil cultivation and its texture, as the differences were significant between the treatments, and the lowest values were 550 $KN.m^{-2}$ in the cultivated Clay soil, while the highest values were of 1222 $KN.m^{-2}$ in the uncultivated Loamy sand. The reason for decreasing the values of soil resistance to penetration into cultivated soils may be attributed to the effect of soil exploitation, agricultural operations and irrigation processes, which reduce the level of salts and increase soil porosity, as well as the increase in the proportions of soil aggregates as a result of cementing agent and secretions resulting from the roots of the alfalfa crop ( *Medicago sativa)* and the organic matter rich in nitrogen [4],[2], [23]. The results of the statistical analysis of the F-test.

**Table 2** The result of analysis of variance (ANOVA) values for studied soil properties

| source | df | Electrical conductivity $ds.m^{-1}$ | porosity % | $caco_3$ $gm.km^{-1}$ | soil penetration resistance ($KN.m^{-2}$) | Weighted diameter rate (mm) |
|---|---|---|---|---|---|---|
| Cultivated | 1 | 273.18** | 54.59** | 196.17** | 794.92** | 650.23** |
| Soil texture | 2 | 16.72** | 54.91** | 541.10** | 66.85** | 575.08** |
| Cu*S.t | 2 | 13.13** | 4.07* | 10.23* | 5.90* | 6.16* |

s.t :- Soil texture Cu:- Cultivated

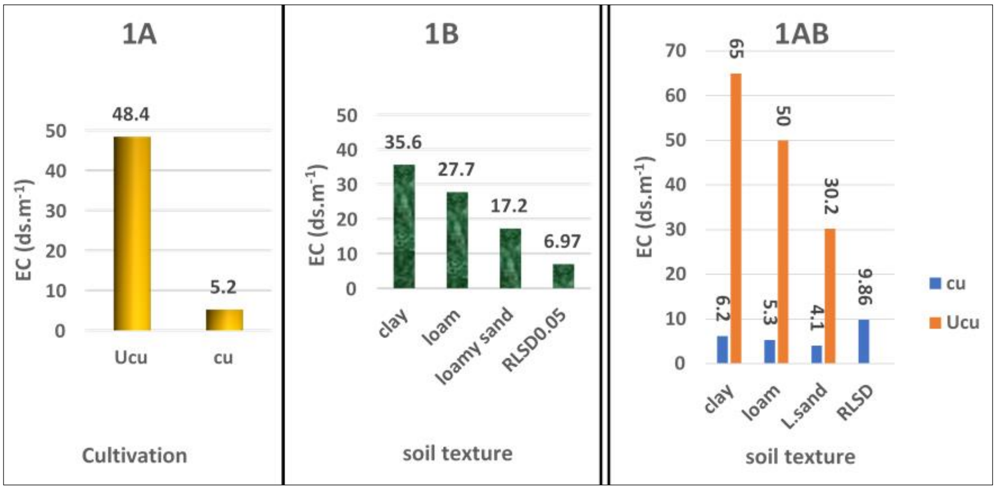


**Figure 1** Effect of continuous agriculture and soil texture factors at electrical conductivity of the soil

Table. 2, show that there is a significant effect of the factors of soil cultivation and its texture and the interaction between them in the values of the weighted diameter rate, as it is clear from Fig A5, an increase in the weighted diameter rate in the treatment of soil cultivation cu 0.2998 mm, with a highly significant difference Compared with the treatment Ucu 0.2307 mm. While the effect of the soil texture factor was evident in Figure B5, where significant differences were observed between the soil textures. The highest values for the weighted diameter average in the soil were Clay 0.3263mm, decreased in the two textures Loam and Loamy sand and were by 0.2538 mm and 0.2155 mm, respectively.. Fig. AB5, shows the interaction between the two factors of soil cultivation and its texture, where the differences were significant between the treatments, and the highest values were 0.3640 mm in the cultivated Clay soil, while the lowest values were 0.1773 mm in the uncultivated Loamy sand. The reason may be attributed to the increase in the growth and spread of the root system, which in turn works to bind the soil particles through the gummy secretions that it poses and the mechanical effects caused by the root hairs during their growth and penetration of the smaller interfacial pores of them, which helps to converge the soil particles with each other and thus increase their connection with each other To form stable soil aggregates, as well as the attraction and convergence that occurs between soil particles due to the forces of adhesion and cohesion, which leads to an increase in the stability of its aggregates [22],[20], [26].

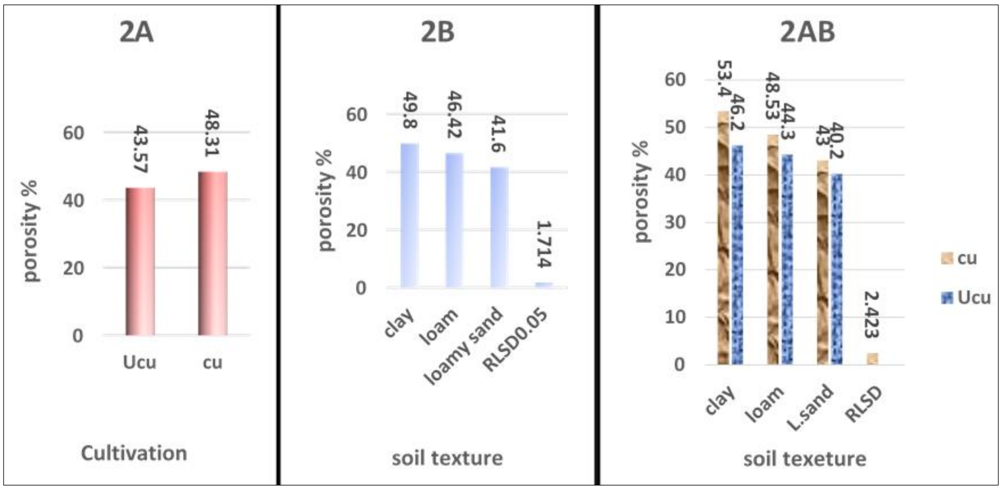


**Figure 2** Effect of continuous agriculture and soil texture at soil porosity %

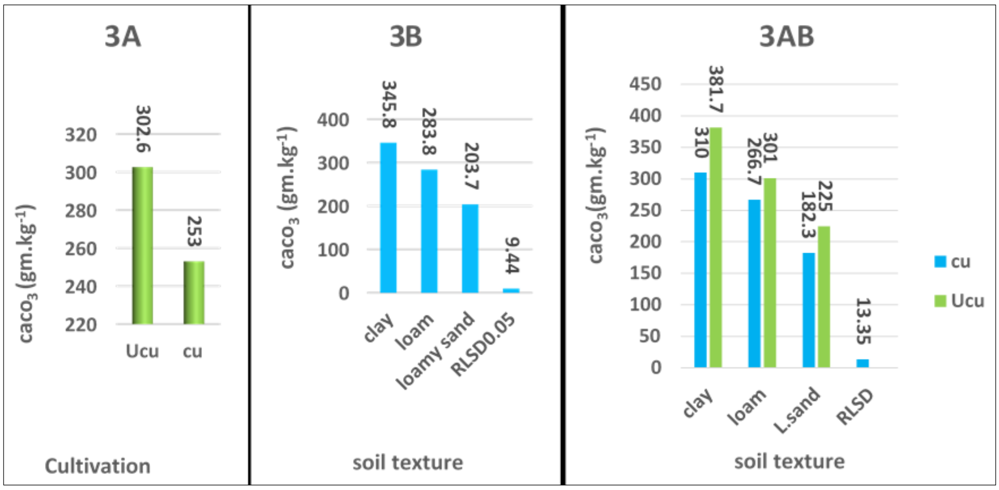


**Figure 3** Effect of continuous agriculture and soil texture at $CaCO_3$ ( $gm.kg^{-1}$ ) of the soil

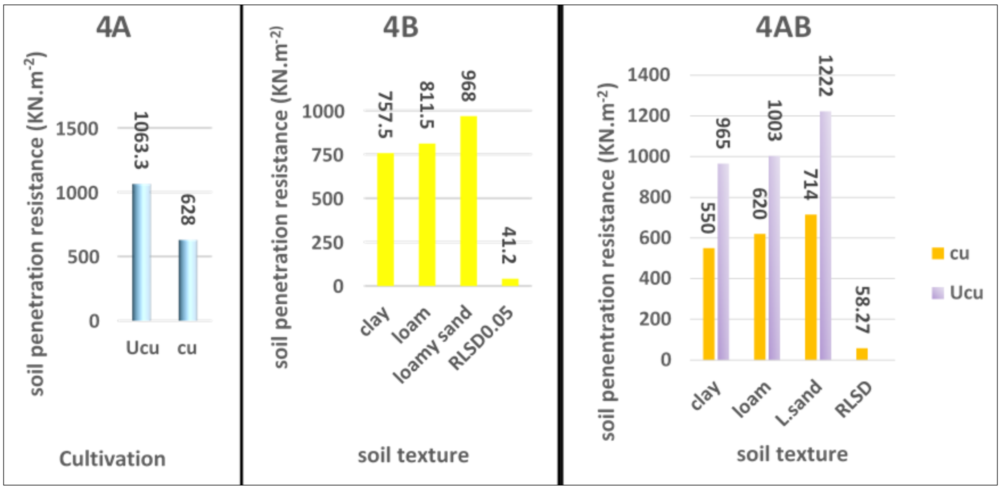


**Figure 4** Effect of continuous agriculture and soil texture at soil penetration resistance (KN.m$^{-2}$)

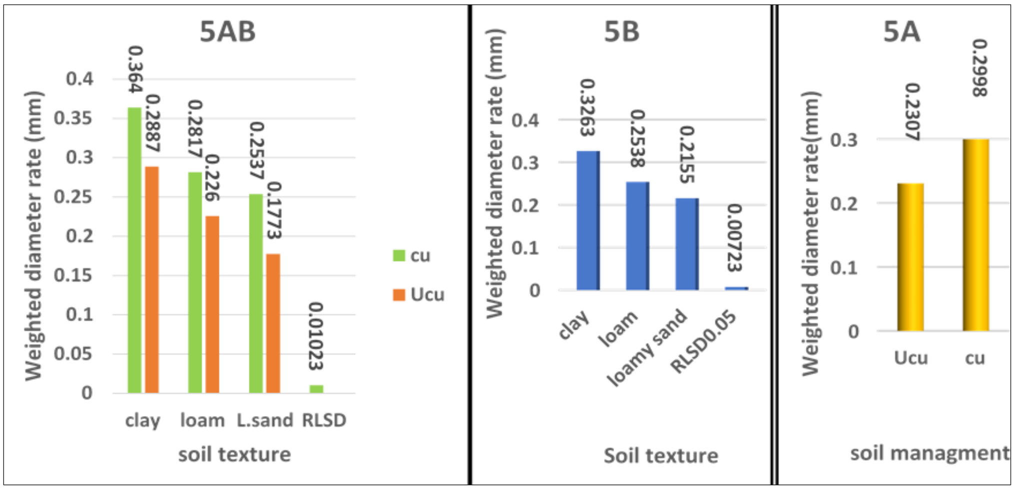


**Figure 5** Effect of continuous Agriculture and soil texture at weighted diameter rate (mm)

## 4. Conclusion

Most of the central and southern Iraq soils are characterized by the deterioration of their physical and chemical properties, due to their low content of organic matter and high salinity. This deterioration increases by not cultivating these soils and leaving them for several consecutive years, which leads to an increase in salinity with capillary rise and thus deterioration of its properties. Therefore, the results of this study showed that the effect of the continuous cultivation process by cultivating leguminous crops such as alfalfa crop and the accompanying irrigation operations and different crop service throughout the growing seasons, which led to the improvement of some soil characteristics, including reducing soil salinity, increasing soil porosity, reducing its content of caco3 and soil resistance to penetration directly or indirectly. This effect varies with soil texture. It has been observed that the interaction between the factors of continuous cultivation and the increase of its content of clay and silt leads to an improvement in the properties of the soil under study as well as an increase in soil productivity.

## Compliance with ethical standards

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*Author Contributions*

HRN: proposed the research and finalizing the manuscript, data collection, analysis and drafted the manuscript. author provided critical feedback and helped to shape the manuscript

*Disclosure of conflict of interest*

The author declare no conflicts of interest.

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