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Using of Agricultural Residues at Nanosize to Remove Tannery Effluent Salinity

Cross Mark

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ABESTRACT

The leather industry has a high economic return, but also has harmful effects on society and the environment**.** One of the most important of these harmful effects is the problem of salinity of water bodies, soil and groundwater. The main objective of the research is to improve the quality of industrial effluent for safe use in agricultural purposes. Green tea (GT), pomegranate peels (PP) and potato peels (Po) were washed with hot distilled water at 85°C several times until its color fades and dried in oven at 105°C and then burned at 400°C, the dried wastes were chemically activated with 1.0 M sulphuric acid for three hours and washed several times with distilled water and dried again. The obtained carbon was ground to very fine powder and characterization by transmission electron microscopy. Nanoparticles size of green tea spoil carbon(GTCn), pomegranate peels carbon (PPCn) and potato peels carbon (PoCn) ranged between 1-50 nm. The result indicated that the effect of green tea spoil carbon nanoparticles at three layers ($GTCn_3$) in addition to potato peels carbon nanoparticles at one layer (PoCn) on removal of salinity from tannery effluent was 99.85% and the parameters of EC, TDS, soluble cations and anions were less than permissible limits for discharge into water bodies. The agricultural residues carbon nanoparticles adsorb the hateful odor, remove yellow color and remove the turbidity.

***Keywords*:** tannery effluent, salinity**,** agricultural residues, nanotechnology.

INTRODCUTION

Chemical compounds resulting from human activities are the source of environmental pollution (Mandal *et al.*,2011). Organic and inorganic pollutants accumulate in the environment through industrial sources such as the mining industry, oil, petrochemicals and tanneries, causing pollution to soil, surface and groundwater (Almasoud *et al.*, 2015). The leather industry has a high economic return, but also has harmful effects on society and the environment (Tariq *et al.*, 2006). It consumes large quantities of water, estimated at about 34-54 $m^3ton^{-1}$of skin (Tariq *et al.*, 2010) and for example, tanneries in India produce about 100,000 m^3 of effluent that alters the chemical, physical and biological properties of the aquatic environment (Mohan *et al.*, 2006). Moreover, disposal tanning effluent in water bodies with excessive amounts of the high salinity and TDS may result in physiologically stressful conditions for some species of aquatic organisms due to change in osmotic conditions (Reda, 2016). While, the tannery effluent are mainly contain high salinity, high organic and inorganic components, and high Cr concentrations, causing potential toxic effects on environmental quality (Tariq *et al.*, 2006). Also, Das *et al.*, (2010) reported that a higher amount of TDS, EC, salinity and alkalinity in tannery effluent.

Several physico-chemical processes are involved in tannery industry and large quantities of organic and inorganic chemicals such as $Cr(SO_4)_3$, NaCl, $Ca(OH)_2$, H_2SO_4NaOH, $Ca(OH)_2$, $Mg(OH)_2$, and CaO are used during the tanning stages (Gowd *et al.,* 2010). The chemicals used in the tannery processes are disposal with effluents into the adjacent lands, damaging the different environmental compartments (Salama *et al.*, 2015). Therefore, there is an utmost necessity need to assess the risk of tannery effluent pollutants levels and sludge as well as affected lands and dumpsites were enriched with heavy metals and salts. Whereas, the high disposal of tannery effluents led to bad changes in soil solution composition and then an accumulation of leached cationic species was happened by clay surface adsorption at about 2.0 m depth (Surita *et al.*,2007). Most developing countries without any treatment directly discharge tannery effluent into aqueous system (Farenzena *et al.*, 2005). Human health, plants, fishes and other aquatic biodiversities are at risk of critical threat due to discharge of wastewater effluent (Mohanta *et al.*, 2010).

About one-third of the net dry matter in tea leaves (*Camellia sinensis, Theaceae*) contains mainly carboxylate, aromatic, phenolic, hydroxyl and oxyl groups. This composition is responsible for its ion-exchange behavior (Ahmaruzzaman and Gayatri 2010). Pomegranate peels (*Punica granatum L.*) containing considerable shares of polyphenols, lignin and cellulose that consider as a natural adsorbents and have the capacity to adsorb a number of heavy metal ions (Mirdehghan and Rahemi, 2007). Potato peel(*Solanum tuberosum* L.) contains various polyphenols and phenolic acids which are responsible for its antioxidant activities, whereas fatty acids and lipids showed antibacterial activities (Jeddou *et al.,* 2016). Preparation of agricultural wastes with high qualities in porosity surface area, penetration and adsorption capacity as friendly environmental material with less cost by applying nanotechnology (Zong *et al.* 2012). The adsorption efficiency of agricultural wastes can also be raised through chemical treatments to enrich the surface of these materials with certain functional groups (Kim *et al.,* 2017).

The main objective of the research is to improve the quality of industrial effluent for safe use in agricultural purposes. Using of friendly environment material at nanoparticles from different agricultural residues.

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MATERIALS AND METHODS

Green tea (GT), pomegranate peels (PP) and potato peels (Po) were collected from home consumption and then washed with hot distilled water at 85°C several times until its color fades and dried in hot oven at 105°C and then burned at 400°C, the dried wastes were chemically activated with 1.0 M sulphuric acid for three hours and washed several times with distilled water and dried again. The obtained carbon was ground by kitchen mill. The fine powder was passed throughout a sieve 0.25 mm, then, the passing powder was taken to re-grind it to obtain a nanoparticles. Figure (1) showed that the characterization of green tea spoil, pomegranate peels carbon and potato peels powders were observed for its morphology and size by transmission electron microscopy (TEM) HRTEM, JEOL 3010.

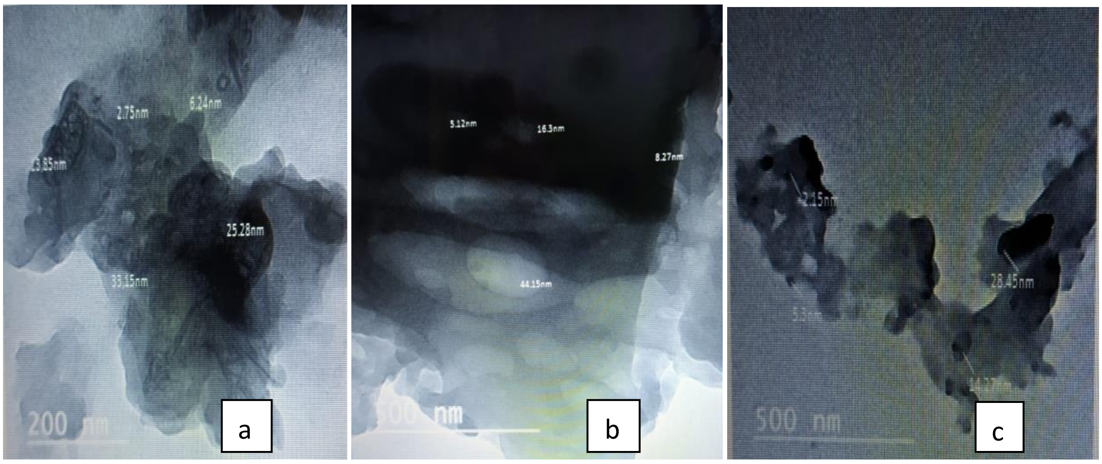

Fig. 1. TEM images of (a) green tea(GTCn), (b)pomegranate peel(PPCn) and (c)potato peels carbon nanoparticles.

The GTCn, PPCn and PoCn were washed with distilled water until the color removal before conducting an experiment.

Tannery effluent sample was obtained from El Roubiky City for Leather Industry, North of Badr City, Cairo Governorate, taking into consideration the necessary precautions for the validity of the sample for analysis like, transferred the sample into the storage bottle without agitation or aeration. Before to sampling, the polyethylene bottle was cleaned with nitric acid and washed and rinsed with distilled water. Finally, both effluent and water samples were stored in icebox and transported to the laboratory for analysis. Wastewater samples analysis was done following the standard methods of (APHA, 2012). The physico-chemical characteristics such as pH (using pH meter model WTW Series pH 720), EC (using EC meter model WTW Series Cond 720), TDS (total dissolved solids) cation and anion according to Jackson *et al.*, (1973). Potassium and sodium were determined using Flame-photometer (model JENWAYPFP7), according to Jackson *et al.*, (1973). Heavy metals were determined using Atomic Absorption Spectrophotometer (model, analyticjenanovAA 350).The wastewater sample was filtered before an experiment using Whatman No. 1 filter paper. The wastewater samples were kept in the refrigerator until conducting the experiment.

Making a water filter that relies on layers to remove salinity from tannery effluent.

required supplies, plastic bottle with a cap, jar to receive the leachat, carbon (GTCn, PPCn and PoCn), fine sand and small gravels. Sand and gravel washed well several times until the washing water becomes colorless before used. The bottom of the plastic bottle was cut and punched holes in the cap then put a piece of cotton cloth in the mouth of the bottle and tighten the cap over it. The cap hold the piece of cotton cloth in place. The bottle was filled with layer of gravels, second layer was sand then carbon followed by layer of sand and the last one was gravels. The thickness of each layer was about 0.2 cm. The bottle cap-side-down was put into a jar to receive the leachat. The agricultural wastes carbon nanoparticles (GTCn, PPCn and PoCn) layers were arranged in the plastic bottle as follows:

At any case, begin with a cotton tissue, followed by a layer of gravel, followed by a layer of sand, and the variable was the following:

1- Layer of GTCn with a layer of gravel and another of sand
2- Layer of GTCn + layer of PoCn followed by layer of gravel and another of sand.
3- Two layers of GTCn followed by layer from gravel and another of sand.
4- Two layers of GTCn + one layer of PoCn followed by layer from gravel and another of sand
5- Three layers of GTCn followed by a layer from gravel and another of sand.
6- Three layers of GTCn + layer of PoCn followed by layer from gravel and another of sand as shown in Figure (2)

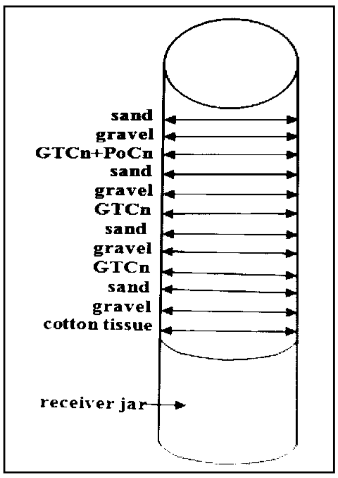

Fig. 2. A pictorial view of installing a salinity treatment filter from tanneries' industrial effluent

Weight of each layer of agricultural wastes carbon at nanoparticles was 5 g. The same arrangement is followed with PPCn as above mentioned.

Finally, the data were statistically analyzed using one-way analysis of variance test by the least significant difference (LSD at 0.05) according to method described by Gomez and Gomez (1984) using IBM SPSS (2020) Statistics 20.0 program.

RESULTES AND DISCUSSION

The images of the electronic characterization to agricultural wastes carbon (GTCn, PPCn and PoCn) in Fig. 1 indicate that the particles size lies in the range of 1 to 50 nanometers, which was the most effective and active range in removing salinity from tannery effluent. Generally, nanotechnology was related to the creation, processing, characterization and application of materials at the nanoscale (1–100 nm) in diverse areas (Biswas *et al.*, 2019 and Nuge *et al.*, 2020).

Chemical properties of tannery effluent

The chemical properties of tannery effluent were presented in Tables 1 and 2, respectively.

The results in Table 1 indicated that the color of the tannery effluent was opaque yellow color with foul smell odour (Noorjahan, 2014). The effluent color could be due to the presence of biodegradable and non-biodegradable organic compounds and high amounts of inorganic chemicals like sodium and chromium used during processing and the odour may be due to the putrefaction of organic residues from the processed skins (Bhatnagar *et al.*, 2013).The pH value was 8.3 might due to a result of lime, sodium sulphide and caustic soda and soda ash used in skin processing (Reda, 2016). The standard pH value for industrial effluents discharged to water bodies set by FEPA (1991) and EEPA (2001) which is 6-9. However, the pH value which is 8.3 was within the permissible discharge limit.

On the other hand, total heavy content were within the permissible limits according to FAO (2006), except of chromium concentration (142.31mgl^{-1}), it was higher than the permissible limit.

Table 1. Some chemical properties of tannery effluent

Color	Odour	pH	Total heavy content (mgl^{-1})								
			Fe	Mn	Zn	Cu	Cd	Co	Ni	Pb	Cr
Opaque yellow	Foul smell	8.3	0.25	0.14	0.38	0.002	0.104	0.75	0.65	0.64	142.31
Permissible limits			5.00	0.20	2.00	0.20	0.01	-	0.20	5.00	0.01

Permissible limits according to FAO (2006)

The data in Table 2 showed that the EC was worthy measure of the amount of ions dissolved in tannery effluent. Also, the value of EC was 74.2 dSm^{-1} in wastewater which disposal into water body. The obtained value of EC in tannery effluent was higher than the FEPA (1991) (2.5 dSm^{-1}). The high value of EC could be due to different dissolved salts used in the tanning industry. About for cations and anions, they were be higher than the permissible limits for discharge into water bodies according to FEPA (1991) and Ayers and Westcott (1985), this could due to the chemicals using in the process of tanning skins, especially sodium chloride which using with a large quantity of common salts for keeping and pickling processes of skins, and this explains the high concentration of both Na^+ and Cl^- and also explain the high salinity in tanner's wastewater. The high concentration of Cl^- ions increases the salinity of the tannery effluent, and discharge this effluents in water bodies pollutes the drinking and irrigation water making it an ideal environment for microbes growth and become a source of waterborne diseases according to Sugasini and Rajagopala (2015).

Also, the data in Table 2 revealed that the total dissolved solids (TDS) can be consider as an indicator for the water quality. In the present study, the concentration of TDS value was 59360 mgl^{-1} in the tannery effluent.

Otherwise, the TDS was calculated by follow equation:

Total Dissolved Solids (TDS) mgl^{1} = EC dSm^{-1} x 640 (1)

When EC ranges (0.1 to 5 dSm^{-1})

Or Total Dissolved Solids (TDS) mgl^{-1} = EC dSm^{-1} x 800 (2)

When EC >5 dSm^{-1} according to USSL Staff (1954).

Table 2. Chemical properties of tannery effluent

EC dSm^{-1}	Soluble cations (mmol$_c$$^{-1}$)				Soluble anions ((mmol$_c$$^{-1}$)				TDS (mgl^{-1})
	K^+	Na^+	Ca^{2+}	Mg^{2+}	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	
74.2	203.15	413.22	60.25	65.38	41.74	44.53	582.58	73.15	59360
2.5^F	-	3-9^A	0.05^F	2.34^F	-	1.5-8.5^A	4-10^A	7.81^F	2000^F

Permissible limit according to Ayers and Westcott (1985)^A and FEPA (1991)^F

The value of TDS was higher than the permissible discharge limit of FEPA (1991) (2000 mgl^{-1}) for the effluents to be discharged into water body. The high values of TDS might be due to carbonates, bicarbonates, chlorides, sulphates, calcium, magnesium, sodium and potassium in the wastewater. High level of TDS mgl^{-1} in wastewater is limits the water's suitability as a source for drinking or irrigation supply (Awofolu *et al.*, 2005 and Reda ,2016).

Effect of different agricultural residues carbon nanoparticles at one layer on removal tannery effluent salinity

Data in Table 3 show that the effect of carbon nanoparticles of green tea spoil and pomegranate peels in addition to potato peels at one layer on salinity removal from tannery effluent. The data revealed that there was positive response of GTCn$_1$+PoCn at one layer and gave the best result in reducing the values of both EC and TDS to 52.51% in removal of salts from tannery effluent compared to the rest treatments. The nanoparticles carbon of agricultural residues decreased the EC and TDS from tannery effluent with values were 39.92, 36.95, 52.51 and 49.60 % for GTCn$_1$, PPCn$_1$, GTCn$_1$+ PoCn and PPCn$_1$+ PoCn, respectively. Also, the agricultural residues carbon nanoparticles adsorb the hateful odor, eliminating the fungi which formed on the water surface, remove yellow color and remove the turbidity, so that the color of the wastewater turns to a clear transparent (Zarzar *et al.*, 2015).

Despite, Fig. 3 showed that the decreased in EC and the TDS with values ranged between 35.24 and 46.78 dSm^{-1}, 28192 and 37424 mgl^{-1}, respectively and consequently the soluble cations and anions also decreased, but it was still higher than the permissible limits for discharge into water bodies according to FEPA (1991) and Ayers and Westcott (1985). Regard to GTCn$_1$+ PoCn treatments positive was obtained for decreasing EC with value was 35.24 dSm^{-1}.

Table 3. Effect of GTCn, PPCn at one layer in addition to PoCn at one layer on salinity tannery effluent removal/100ml

Treatments	EC (dSm^{-1})	Soluble cations ($mmol_c^{-1}$)				Soluble anions ($mmol_c^{-1}$)				TDS (mgl^{-1})
		K^+	Na^+	Ca^{2+}	Mg^{2+}	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	
$GTCn_1$	44.58	121.90	247.95	36.35	39.60	25.44	26.92	349.55	43.90	35664
$PPCn_1$	46.78	127.99	260.33	37.99	41.50	26.30	28.05	367.33	46.13	37424
$GTCn_1$+PoCn	35.24	93.81	198.35	28.90	31.36	18.30	21.37	279.64	33.11	28192
$PPCn_1$+PoCn	37.40	101.58	206.61	32.13	33.69	22.87	23.27	291.29	36.58	29920
Permissible limit	2.5^F	-	3-9^A	0.05^F	2.34^F	-	1.5-8.5^A	4-10^A	7.81^F	2000^F
LSD at 0.05	5.59	16.37	30.59	4.20	4.84	3.67	3.19	43.26	6.11	4436.11

Permissible limit according to Ayers and Westcott (1985)^A and FEPA (1991)^F

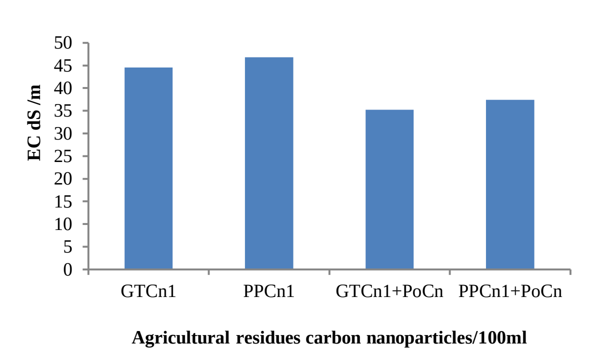

Fig. 3. Effect of agricultural residues carbon nanoparticles on electrical conductivity of tannery effluent

Finally, statistical analysis of data obtained indicated that the variation there was a significant among the treatments of organic agricultural residues carbon nanoparticles used.

Effect of different agricultural residues carbon nanoparticles at two layers on removal tannery effluent salinity

Also, the data in Table 4 showed that a significant effect of removal salinity from tannery effluent by using agricultural residues carbon nanoparticles at two layers in addition to PoCn at one layer. The removal effect of salinity from tannery effluent with two layers agricultural residues carbon nanoparticles in addition to PoCn at one layer ranged between 85.69 to 91.52% for $PPCn_2$ and $GTCn_2$+PoCn, respectively.

Table 4. Effect of GTCn, PPCn at two layers in addition to PoCn at one layers on salinity tannery effluent removal/100ml

Treatments	EC (dSm^{-1})	Soluble cations($mmol_c^{-1}$)				Soluble anions ($mmol_c^{-1}$)				TDS (mgL^{-1})
		K^+	Na^+	Ca^{2+}	Mg^{2+}	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	
$GTCn_2$	7.15	19.50	39.67	5.88	6.48	4.17	4.31	55.93	7.12	5720
$PPCn_2$	10.62	29.24	58.67	8.75	9.55	6.05	6.45	83.12	10.60	8496
$GTCn_2$+PoCn	6.29	15.95	35.70	5.41	5.85	2.81	3.85	50.34	5.92	5032
$PPCn_2$+PoCn	9.69	26.75	53.51	7.85	8.78	5.80	5.97	75.44	9.72	7752
Permissible limit	2.5^F	-	3-9^A	0.05^F	2.34^F	-	1.5-8.5^A	4-10^A	7.81^F	2000^F
LSD at 0.05	5.59	16.37	30.59	4.20	4.84	3.59	3.19	43.26	6.11	4436.11

Permissible limit according to Ayers and Westcott (1985)^A and FEPA (1991)^F

Whatever, the results in Table 4 showed that the TDS, soluble cation and anions values was at same trend of decreasing as EC from tannery effluent but sill higher than the permissible limits for discharge into water bodies according to FEPA (1991) and Ayers and Westcott (1985).

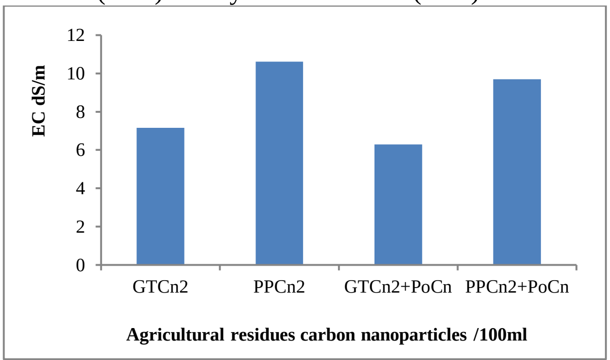

Fig. 4. Effect of agricultural residues carbon nanoparticles on electrical conductivity of tannery effluent

Figure (4) showed that there was high significant effect with applied $GTCn_2$ and $PPCn_2$ in addition to PoCn to decrease values of EC of with values to 6.29 and 9.69 dSm^{-1}, but $GTCn_2$+ PoCn was more response.

Finally, regard to statistical analysis data obtained indicated that there was variation among the treatments of organic agricultural residues used.

Effect of different agricultural residues carbon nanoparticles at three layers on removal tannery effluent salinity

Data in Table 5 revealed that the GTCn and PPCn at three layers in addition to PoCn at one layer was highly significant effect to removal salinity from tannery effluent. Further, the results indicated that the use of $GTCn_3$+PoCn at one layer were more effective to decrease salinity with EC and TDS values were 0.11 dSm^{-1} and 70.4 mgl^{-1}, respectively, where the total soluble salts as a generally decreased to more than 99% compare with the initial values of EC (74.2 dSm^{-1}) and TDS (59360 mgl^{-1}). Also, data in Table 5 showed that the EC and TDS values of other treatments ranged between 1.74 to 3.08 dSm^{-1} and 1113.6 to 1971.2 mgl^{-1}, respectively.

Table 5. Effect of GTCn, PPCn at three layers in addition to PoCn at one layer on salinity tannery effluent removal/100ml

Treat.	EC (dSm^{-1})	Soluble cations ($mmol_c^{-1}$)				Soluble anions ($mmol_c^{-1}$)				TDS (mgL^{-1})
		K^+	Na^+	Ca^{2+}	Mg^{2+}	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	
$GTCn_3$	1.74	5.68	7.52	2.40	1.81	3.24	4.13	8.42	1.71	1113.6
$PPCn_3$	3.08	8.48	17.02	2.54	2.77	1.76	1.87	24.11	3.07	1971.2
$GTCn_3$+PoCn	0.11	0.40	0.61	0.10	0.11	0.05	0.06	1.00	0.10	70.4
$PPCn_3$+PoCn	2.41	9.80	7.86	4.22	2.21	6.42	5.49	9.54	2.65	1606.4
Permissible limit	2.5^F	-	3-9^A	-	2.34^F	-	1.5-8.5^A	4-10^A	7.81^F	2000^F
LSD at 0.05	0.58	2.58	3.64	1.51	1.94	3.67	4.01	5.69	1.46	559.6

Permissible limit according to Ayers and Westcott (1985)^A and FEPA (1991)^F

Removing salinity using agricultural wastes of the normal size and its natural material reached to 8%, by activating these wastes, the removal of salts reached to15% (Kim *et al.,* 2017), while using these wastes as a carbon nanosize, the removal of salts reached to more than 99% (Butt, 2020). Nanoparticles are considered most significant and appropriate for water treatment and purification as they are highly reactive, have great surface area to volume ratio and have a good affinity for target substances and their extremely small size makes them most appropriate purification agents (Ali *et al.*, 2020 and Butt, 2020).

Anyway, the TDS values decreased with all treatments to below the permissible limits. As for EC values also decreased to less than the permissible limits with all treatments under study except $PPCn_3$ (3.08 dSm^{-1}) as shown in Figure 5, while the soluble cations and anions decreased to less than the permissible limits.

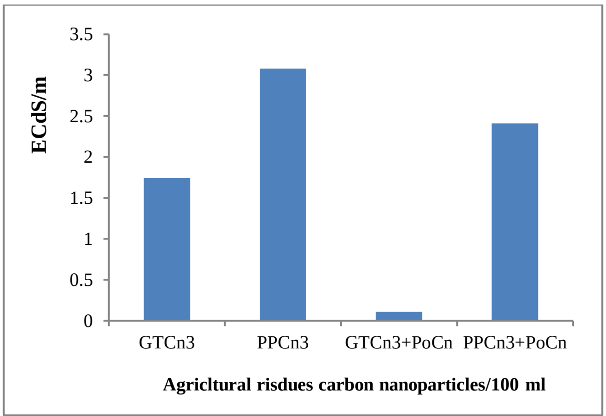

Fig. 5. Effect of agricultural residues carbon nanoparticles on electrical conductivity of tannery effluent

Finally, statistical analysis indicated that there was variation and significantly affect among the treatments of organic agricultural residues used.

The adsorption of ions occurs on the adsorbents at all pH states, but with different proportions, and there are some mechanisms that controlled of adsorption process, including electrostatic attraction and ion exchange according to the pH state, and agricultural residues have an affinity with some ions such as green tea and sodium ion according to Kim *et al.*,(2017). Furthermore, green tea spoil, pomegranate peels and potatoes peels are contain polyphenols, lignin, cellulose and hemicellulose compounds which contain effective groups that have the ability to adsorb salts ions on its surfaces and the presence of these residues in the nanosize increases its ability to reduce the concentration of salts to more than 99%. The values for polyphenols are 6.50, 5.30 and 2.92% for green tea spoil, pomegranate peels and potatoes peels, respectively, this agree with Mirdehghan and Rahemi (2007), Yang *et al.,* (2008) and Javed *et al.*, (2019).The adsorption improves at neutral pH, most likely due to the deprotonation of active sites that allows a better electrostatic interaction with ions, also, the decrease in the associated ions of sodium chloride in the solution enhances the binding of sodium with the adsorbents so the EC value was decreased according to Kim *et al.*, (2017).

CONCLUSION

It could be concluded that used of carbon nanoparticles from green tea spoil, pomegranate peels and potato peels in removal salinity tanning wastewater led to remove more than 99%, as well as adsorb the hateful odor, eliminating the fungi which formed on the water surface, remove yellow color and remove the turbidity, so that the color of the wastewater turns into a clear transparent.

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استخدام المخلفات الزراعية بحجم النانو لإزالة ملوحة مياه المدابغ

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صناعة الجلود لها عائدا اقتصاديا مرتفع، ولكن لها أيضًا آثار ضارة على المجتمع والبيئة. ومن أهم هذه الآثار الضارة مشكلة ملوحة المسطحات المائية والتربة والمياه الجوفية. الهدف الرئيسي من البحث هو تحسين جودة النفايات السائلة الصناعية للاستخدام الآمن في الأغراض الزراعية. تم غسل تفل الشاي الأخضر (GT) وقشور الرمان (PP) وقشور البطاطس (Po) بالماء المقطر الساخن عند 85 درجة مئوية عدة مرات حتى يتلاشى لونها وتجفيفها في الفرن عند 105 درجة مئوية ثم حرقها عند 400 درجة مئوية، تم تنشيط المخلفات المجففة كيميائياً باستخدام 1,0 مولار من حامض الكبريتيك لمدة ثلاث ساعات وغسلها عدة مرات بالماء المقطر وتجفيفها مرة أخرى. تم طحن الكربون الناتج إلى مسحوق ناعم جدًا وتوصيفه عن طريق الفحص المجهري الإلكتروني. تراوحت أحجام الجسيمات النانوية لكربون تفل الشاي الأخضر (GTCn) وكربون قشور الرمان (PPCn) وكربون قشور البطاطس (PoCn) بين 1-50 نانومتر. تشير النتائج إلى إن تأثير جزيئات الكربون النانوية لتفل الشاي الأخضر بثلاث طبقات ($GTCn_3$) بالإضافة إلى قشور البطاطس بطبقة واحدة (PoCn) في إزالة الملوحة من مياه الصرف الصحي كانت 99.85٪ وكانت قيم كل من التوصيل الكهربي والمواد الصلبة الذائبة الكلية والكاتيونات والأنيونات الذائبة أقل من الحدود المسموح بها للتصريف في المسطحات المائية. تدمص حبيبات كربون البقايا الزراعية بحجم النانو الرائحة الكريهة وتزيل اللون الأصفر وتزيل العكارة من مياه صرف المدابغ.