BIOLOGICAL EVALUATION OF SOME DOMESTIC WASTEWATER TREATED WITH COAGULANT AND FLOCCULENT USING WHITE NEW ZEALAND MALE RABBITS

Journal

J. Biol. Chem. Environ. Sci., 2008, Vol. 3(2): 27-43 www.acepsag.org

A.M. Fares[1]; E. A. Abdel-Rahim[2]; Y. M. Hafez[3] and M. E. Cobasy[2]

[1] *Wastewater treatment Dept., Chimi Art Co., Cairo, Egypt;*
[2] *Biochemistry Dept., Fac. Agric., Cairo Univ., Giza, Egypt;*
[3] *Animal Prod. Dept., Fac. Agric., Cairo Univ., Giza, Egypt.*

ABSTRACT

A total of 18 domestic wastewater samples were taken from three different domestic wastewater treatment plants (Helwan, Zenin, and Gabal El Asfar**)** were treated using Coagulant ($FeCl_3$) and Flocculent (polymer). Contaminants in domestic wastewater [Suspended Solids (SS), Organic Matters (COD or BOD_5), Nutrients (TN+TP) and Heavy Metals] were classified into dissolved and suspended.

From our previous work on the some wastewater, each domestic wastewater sample was treated using six different chemical treatments. Upon the chemicals analysis of the resultant water the best treatment was chosen as drinking water for animals in this study relative to tap water. All these contaminants were removed by coagulation/sedimentation. Results of analysis of domestic wastewater showed a great reduction after the chemicals treatment. Also, the microbiological test against total *Coliform* and *E. coli* showed a great reduction after treatment expressed as number of colonies per cubic centimeter.

A total number of 64 white New Zealand male rabbits were used to biologically examine the drinkability of the treated wastewater without any adverse effects.

Hematological and biochemical relevant parameters of white New Zealand male rabbits as affected by drinking wastewater treated with coagulant ($FeCl_3$) and flocculent (polymer) were in the normal physiological range without no obvious change. No significant changes in liver and kidney functions of the rabbits except a slight elevation in blood plasma creatinine in the fourth group (Gabal El Asfar treated wastewater). Weight gain, Feed conversion, and Feed efficiency did not significantly change among experimental groups. Slight increase in feed consumption in the rabbits drinking Gabal El Asfar treated wastewater and slight decrease in feed consumption in the rabbits drinking Helwan treated wastewater.

The study showed the drinkability of domestic wastewater treated with the recommended doses (10-20 ppm $FeCl_3$ + 5-15 ppm cationic polymer + 5 ppm Cl_2) of coagulant and flocculent in this research without any adverse effects on rabbits.

Keywords: domestic wastewater, heavy metal, dissolved matter, suspended solids, biological evaluation, rabbits.

INTRODUCTION

To overcome the traceability of water, the recycling of domestic wastewater is a must taking care of the cost of chemical treatment to make this water drinkable [Wang, *et al*. 2007].

Domestic wastewater is included those from homes and commercial establishments. The impurities of the domestic wastewater can removed by conventional and advanced treatments for the purposes of discharge or treated water reuse. The treatment processes consisted of primary treatment (physical process) and secondary treatment (biological process). Recently, enhanced primary treatment that utilized a chemical coagulant to assist the removal of suspended and dissolved impurities, has drawn wide attention for wastewater that are not amenable to conventional biological treatment [Semerjian and Ayoub, 2003 and Wang *et al,* 2007], especially in developing countries [Harleman and Murcott, 1999, 2001 and Gehr *et al,* 2003].

Primary and secondary treatment reduces the majority of contaminations found in wastewater [Sonune and Ghate, 2004]. Several studies have been done on the optimization of particle separation [Ødegaard, 1992 and 1978, Wang *et al,* 2007], Utilization of inorganic coagulants and polymers [Poon and Chu, 1999], post filtration [Van Bauren *et al,* 1999] and post disinfection [Gehr *et al,* 2003] in enhanced primary treatment process.

According to Letterman and Fero [1990] the synthetic polymer used in wastewater treatment is of long-chain type with high molecular-weight organic compounds that have a strong tendency to be adsorbed on the particle surfaces in aqueous suspensions. The cationic polymers are after referred to as primary coagulants because they enhance the coagulation of negatively charged particles by a process of adsorption surface charge neutralization [Reall *et al,* 2001]. Chemical primary treatment is also recommended as the first step of wastewater [Aiyuk *et al,* 2004 and Levine *et al,* 1985].

Rabbit's production plays a considerable role in solving the problem of meat shortage in Egypt, particularly on the level of the small-scale farmers and new reclaimed areas. But the most obvious limitation to rabbit production in hot climate area is the susceptibility of this species to heat stress and availability of clean healthy and good quality drinking water, which lead to the impairment of production and feed efficiency [Marai *et al*., 2004**;** Ahmed, et *al.* 2005 and 2006]. Also, the cost of buying clean drinking water in rabbit farms can affect the feasibility of rabbit production.

Therefore, the objective of this research was to biologically evaluate the quality of different sources of domestic wastewater (Helwan, Zenin, Gabal El Asfar) chemically treated with coagulant ($FeCl_3$) and flocculent (polymer) using white New Zealand male rabbits.

MATERIALS AND METHODS

The raw domestic wastewater samples used in the present study was obtained from Helwan (south Cairo), Zenin (middle Giza) and Gabal El Asfar (east Cairo) domestic wastewater plants, Egypt. During the experimental period, the samples before and after treatment quality items included [Suspended Solids (SS), Organic Matters (COD or BOD_5), Nutrients (TN+TP) and Heavy Metals] were determined according to the standard methods for the examination of water and wastewater [SMEW, 1995]. Heavy metals content was determined by atomic absorption model 2380 according to [Page *et al,* 1982].

The present study was carried out at Chimi Art Co. Lab., 6th October City, Giza, Egypt. and Animal Physiology Lab., Faculty of Agriculture, Cairo University, Giza, Egypt.

A total of 18 domestic wastewater samples were taken from 3 different treatment plants in Great Cairo, (Helwan domestic wastewater treatment plant-South Cairo., Zenin domestic wastewater plant-middle Giza and Gabal El Asfar domestic wastewater treatment plant- East Cairo).

Domestic wastewater samples used in the present work were primary treated with coagulant ($FeCl_3$ obtained from Chimi Art Co., Cairo, Egypt) and flocculent (Polymer obtained from SNF, Saint Etienne, France), then followed by secondary treatment with chlorine liquid (Cl_2 obtained from Misr for chemical industries, Alexandria, Egypt) as described by Abdel-Rahim *et al,* [2008] which differed according to the wastewater sources. Each domestic wastewater sample from each plant were treated with coagulant ($FeCl_3$) and flocculent (polymer) and upon the chemical analysis of the resultant water, the best treatment was chosen as drinking water in this study, as described in our previous studies [Abdel-Rahim *et al,* 2008].

Table 1. Experimental rabbit ration composition.

Ingredients	Composition
Berseem hey	34%
White corn	28.13 %
Barley	20 %
Soya bean meal	13%
Molasses	3%
CaCO3	1%
* Vitamins minerals mixture	3%
NaCl	0.5%
DL methonine	0.07%

* **Vitamins** VITA . VITD. VITE and VITK (K dihydrogen Phosphate),**Minerals** Magnesium sulphate , cobalt Chloride and Zinc sulphate .

*Vitamins and minerals per 1 ml diluted in 1 litter drinking water contains: Vit. A 50000000 I.U., Vit. D3 5000000 I.U., Vit. E 4000 mg., Ascorbic acid 100000 mg., Mn 6000 mg., Zn 7200 mg., Fe 1500 mg., Cu 500 mg., I 120 mg., Se 100 mg., Co 100 mg., Mg 1000 mg., Na 14000 mg., K 7500 mg. and P 10000 mg.()

A total number of 64 White New Zealand male (NZW) rabbits aging 6 weeks old were used. The animals were housed during the experimental period (70 days) in metal batteries with automatic drinkers. All experimental rabbits were kept under normal healthy conditions and fed commercial pellets diets prepared by Atmeda, Dakahlia, Egypt. The composition of the rabbits feed mixture is in table 1.

Feed allowances of rabbits were calculated according to NRC requirements [NRC, 2005]. Water was provided *ad libitum*.

After feeding on the diet and tap water for one week , (adaptation period) rabbits were divided randomly into four groups (16 rabbit each) according to the following scheme to evaluate the effect of drinking wastewater chemically treated as following :-

First animal group: Control group, which provided tap water.

Second group : Rabbits provided treated wastewater from Helwan (treated by 20 ppm $FeCl_3$ + 5 ppm cationic polymer +5ppm Cl_2).

Third group : Rabbits provided treated wastewater from Zenin (treated by 10 ppm $FeCl_3$ + 5 ppm cationic polymer + 5ppmCl_2).

Forth group: Rabbits provided treated wastewater from Gabal El Asfar (treated by 10 ppm $FeCl_3$ + 15 ppm cationic polymer + 5ppm Cl_2)

During the experimental period (10 weeks), the consumed diet and body weights were recorded every week and at the same time, blood was collected using a heparenized vaccutainer tubes from the ear marginal vein. Whole blood hemoglobin (Hb,g/dl) and packed call volume (PCV%) were quantified immediately then blood was centrifuged at 3000 rpm to obtain the plasma and keep it at – 20˚C till further analysis.

Body weight gain, food intake and feed efficiency were recorded and calculated. Blood plasma AST (aspartate trensaminase) and ALT (alanine transaminase) activities were determined also. Total protein, albumin, glucose, urea, creatinine and billirubin of plasma were determined. Globulin was calculated by subtracting albumin from total protein. Table2. Represent the methods and kits of blood analysis.

Statistical analysis

Data set was analyzed using the general linear model of SAS [SAS, 1999]. Differences among means were tested using Duncan [Duncan, 1955].

Table 2. Methods and kits used to quantify the relevant blood biochemical parameters.

Parameters	Methods	Company	Reference
Hemoglobin, g/dl	Colorimetric	Stanbio Laboratory (Antonio , Texas , 78202 USA)	Henry (1964)
Total Protein, g/dl	Colorimetric	Stanbio Laboratory(Boerne , Texas, 78202 USA)	Cannon (1974)
Albumin, g/dl	Colorimetric	Stanbio Laboratory(Boerne , Texas, 78202 USA)	Dumas and Biggs (1972)
Glucose, mg/dl	Enzymatic Colorimetric	Diamond diagnostics	Trindder (1969)
Bilirubin , mg/dl	Colorimetric	Bio Adowic	Chapman *et al.*, (1959)
AST&ALT (RFU/L)	Colorimetric	Quimica Clinica Aplicada S.A. (Ampposta, Spain)	Reitman and Frankei (1975)
Urea,mg/dl	Colorimetric	Bio Adowic	Tabacco (1979)
Uric Acid,mg/dl	Colorimetric	Bio Adowic	Fabiny and Ertinghausen (1971)
Creatinine ,mg/dl	Colorimetric	Bio Adowic	Fabing and Ertinghausen (1971)
SS (Suspended Solids)	Gravimetric	(GB 11901-89)	Wang, *et al.*,(2007)
COD (Chemical oxygen demand)	Dichromate	(GB 11904-89)	Wang, *et al.*, (2007)
BOD5 (Biological oxygen demand)	5-days BOD test		Wang, *et al.*, (2007)
TN (Total nitrogen)	Alkaline potassium per – sulfate digestion UV spectrophotometric	(GB 11894-89)	Wang, *et al.*, (2007)
TP (Total Phosphorus)	Ammonium molybdate spectrophotometric	(GB11893-89)	Wang, *et al.*, (2007)

RESULTS AND DISCUSSION

The potentiality of applying polymer, instead of ferric chloride as coagulant/flotation aid was studied in our previous work [Abdel-Rahim *et al,* 2008]. Polymer dosages necessary for water and wastewater flocculation are usually much smaller than those used when FeCl3 is applied; Consequently, FeCl3 with polymer use was investigated aiming to the best reduce of the sludge production, applying smaller dosages of chemicals. The results obtained in table3 indicated the best efficiencies observed with 20 ppm $FeCl_3$ + 5 ppm cationic polymer + 5 ppm Cl_2, for Helwan wastewater, 10 ppm $FeCl_3$ + 5 ppm cationic polymer + 5 ppm Cl_2, for Zenin wastewater, 10 ppm $FeCl_3$ + 15 ppm cationic polymer + 5 ppm Cl_2, for Gabal El Asfar wastewater.

Domestic wastewater samples were treated to remove the total suspended solids (SS), and dissolved fractions included heavy metals. The average removal of (SS) was 95.6 %, regarding chemical oxygen demand (COD) and biological oxygen demand (BOD) the overall removals were 94.6 % and 94.2 %, respectively.

Table 3. Represent the chemical analysis of tap water and domestic wastewater before and after treatment. The contaminants in domestic sewage can be divided into four categories: suspended solids (SS), organic matter (chemical oxygen demand or biochemical oxygen demand), nutrients (nitrogen and phosphorus), and heavy metals, which are the substances to be removed by conventional and / or advanced treatment for the purposes of discharge or treated water reuse. The three best treatments resulted in the highest total removal percentage of the heavy metals, in which the treatments removed about the all amount of Cu, Ni, Pb, Zn, Cd, and Cr but removed the other metals Ca, Fe, and Mg of about half their amounts of the wastewater. In case of Na and K the treatment removed about ¼ their amount in the studied samples. The wastewater before and after treatments were free from Hg and Ar. It means that, the treatments with $FeCl_3$ + polymer + Cl_2 seemed to be the most suitable and efficient for removed or reduction the contaminants or impurities of domestic wastewater [Abdel-Rahim *et al,* 2008].

Table3. Analysis of resultant water from sources (Helwan, Zenin, and Gabal El Asfar domestic wastewater plants) before and after chemical treatment.

Chemical analysis		Tap Water (T1)	Helwan (T2)			Zenin (T3)			Gabal El Asfar (T4)		
			Before	After	**Reduction %**	Before	After	**Reduction %**	Before	After	**Reduction %**
HEAVY METALS	pH	7.90	7.0	6.93	**1.00**	7.2	6.95	**3.40**	7.30	7.2	**1.36**
	Ca, ppm	0.40	7.90	4.30	**45.60**	4.60	3.30	**28.26**	-------	-------	------
	Cu, ppm	Nil	0.32	0.14	**56.25**	0.20	0.01	**95.00**	0.04	0.0001	**99.75**
	Fe, ppm	0.20	8.80	5.00	**43.00**	2.80	2.40	**14.29**	3.20	2.10	**34.78**
	Ni, ppm	Nil	0.42	0.18	**57.14**	0.18	0.03	**83.33**	0.001	Nil	**100.00**
	Mg, ppm	0.10	6.10	3.50	**42.62**	2.20	1.60	**27.27**	16.00	12.00	**25.00**
	Pb, ppm	Nil	0.33	0.10	**69.70**	0.09	0.02	**77.78**	0.10	0.0001	**99.99**
	Zn, ppm	Nil	2.30	0.96	**58.26**	0.80	0.10	**87.50**	0.10	0.0010	**99.00**
	K, ppm	4.20	19.30	14.90	**27.80**	13.2	9.80	**25.75**	4.00	3.10	**22.50**
	Na, ppm	7.40	18.60	13.30	**28.50**	11.20	9.50	**15.18**	24.00	21.00	**12.50**
	Cd, ppm	Nil	0.40	0.06	**85.00**	0.06	0.01	**83.33**	0.006	Nil	**100**
	Cr, ppm	Nil	0.10	0.03	**70.00**	0.02	0.006	**70.00**	0.02	Nil	**100**
	Hg, ppm	Nil	Nil	Nil	------	Nil	Nil	------	Nil	Nil	-----
	Ar, ppm	Nil	Nil	Nil	------	Nil	Nil	------	Nil	Nil	-----
Suspended Solids (SS)		Nil	617	15.00	**97.60**	215	14.00	**93.49**	342	14.00	**95.90**
organic matters	BOD5	Nil	394	24.00	**93.90**	292	14.00	**95.20**	321	17.00	**94.70**
	COD	Nil	940	55.00	**94.15**	676	40.00	**94.00**	760	42.00	**94.47**
Nutrients	TP, ppm	Nil	3.40	2.20	**35.29**	2.60	1.30	**50.00**	2.80	1.90	**32.14**
	TN, ppm	Nil	25.00	14.00	**44.00**	23.00	14.00	**39.13**	21.00	15.00	**28.57**

T1=Tap Water, T2=20 ppm $FeCl_3$+5 ppm cationic polymer+5 ppm Cl_2, T3=10 ppm $FeCl_3$+5 ppm cationic polymer+5 ppm Cl_2, and T4=10 ppm $FeCl_3$+15 ppm cationic polymer+5 ppm Cl_2.

SS= Suspended Solids , [organic matters= COD (Chemical oxygen demand) + BOD (Biological oxygen demand)] , [Nutrients = TP (Total nitrogen) + TN (Total Phosphorus)].

Bacteriological test of the drinking water were done against total *Coliform* and *E. Coli* The results in (table 4) of the Bacteriological test showed that total *Coliform* and total *E. Coli* were 20 and 2 colony/cm^3 in tap water, respectively.

Table 4. Bacteriological analysis of experimental water.

Total Bacteria	Tap Water (T1)	Helwan (T2)			Zenin (T3)			Gabal El Asfar (T4)		
		Before	After	Reduction %	Before	After	Reduction %	Before	After	Reduction %
Total Coliform, Colony/Cm^3	20	60000	40	99.93	75000	49	99.93	55000	35	99.93
E. Coli, Colony/Cm^3	2	40000	4	99.99	68000	6	99.99	38000	3	99.99

Table 5, 6, and 7 represent the relevant blood biochemical parameters of rabbits drinking wastewater treated with:

T1= Tap Water as control group,
T2= 20 ppm $FeCl_3$ + 5 ppm cationic polymer + 5 ppm Cl_2,
T3= 10 ppm $FeCl_3$ + 5 ppm cationic polymer + 5 ppm Cl_2,
T4= 10 ppm $FeCl_3$ + 15 ppm cationic polymer + 5 ppm Cl_2.

Blood biochemistry profile was used for the diagnosis of certain problems and defects that may be encountered with drinking the treated wastewater. Values of hematological parameters of experimental rabbits were in the normal physiological range being the highest in rabbits drinking tap water and the lowest in the fourth treatment. Blood metabolites values such as plasma proteins, albumin, globulin, A/G ratio and glucose concentration were also in the normal physiological range reported by [Kaneko *et al*. 1997]. These findings reflect that the three treatments of the three sources of domestic wastewater are efficient to make this water drinkable.

Table 5. Some blood hematological and biochemical parameters (M±SD)of White New Zealand male rabbits as affected by drinking domestic wastewater treated white Coagulant and Flocculent.

Blood Parameters	Tap Water (T1)	Helwan (T2)	Zenin (T3)	Gabal El Asfar (T4)
Hb, g/dl	9.51^{a}±1.71 (5.37-14.39)	8.86^{b}±1.97 (5.00-14.00)	8.81^{c}±1.68 (4.17-13.19)	7.77^{d}±2.02 (4.17-13.19)
PCV, %	41.39^{a}±5.55 (30.00-59.00)	41.31^{a}±6.11 (21.00-59.00)	39.99^{b}±5.26 (28.80-57.80)	39.35^{b}±5.85 (19.80-57.80)
Total Protein ,g/dl	6.9^{b}±0.15 (6.61-7.40)	7.02^{ab}±0.12 (6.78-7.32)	7.07^{a}±0.11 (6.89-7.32)	7.06^{a}±0.10 (6.87-7.32)
Albumin, g/dl	3.86^{b}±0.0.36 (2.96-4.66)	4.15^{a}±0.32 (3.87-5.06)	4.16^{a}±0.51 (3.11-5.08)	4.06^{a}±0.14 (3.79-4.44)
Globulin, g/dl	3.10^{a}±0.38 (2.22-3.96)	2.86^{b}±0.49 (1.98-4.13)	2.91^{b}±0.49 (1.98-4.13)	2.98^{ab}±0.17 (2.06-3.33)
A/G, ratio	1.28^{b}±0.27 (0.76-2.10)	1.50^{a}±0.38 (1.19-2.92)	1.50^{a}±0.47 (0.75-2.53)	1.37^{ab}± 0.12 (1.17-1.66)
Glucose, mg/dl	100.18^{a}±1.99 (96.00-104.00)	100.50^{a}±1.55 (97.00-103.00)	100.76^{a}±1.64 (98.00-103.00)	100.13^{a}±1.87 (96.00-104.00)

Means having different superscript letters differ significantly ($P<0.05$)

Between parentheses is the range.

T1=Tap water, T2=Helwan wastewater treated with 20 ppm FeCl3 + 5 ppm Polymer + 5 ppm Cl2 , T3=Zenin wastewater treated with 10 ppm FeCl3 + 5 ppm Polymer + 5 ppm Cl2, T4=Gabel El Asfar wastewater treated with 10 ppm FeCl3 + 15 ppm polymer + 5 ppm Cl2.

Values of liver and kidneys function are presented in table 6. Activities of Alanine amino transferase (ALT) , aspartate amino tranferase (AST) and ALT/AST ratio showed that there were no significant differences among experimental groups.

In addition, Activities of liver enzymes were in the normal physiological range reported by [Kaneko *et al.* 1997] and [Harkness and Wagner 1995]. Other kidneys function tests were in the normal physiological range reperted by [Kaneko *et al.* 1997].

Table 6. Some Liver and Kidneys function parameters (M±SD) of white new Zealand male rabbits as affected by drinking wastewater treated with Coagulant and Flocculent.

LIVER and KIDNEYS FUNCTION	Tap Water (T1)	Helwan (T2)	Zenin (T3)	Gabal El Asfar (T4)
AST, RFU/L	12.37^{a} ±0.18 (11.99-12.72)	11.99^{a} ±1.57 (2.32-12.42)	12.23^{a} ±0.17 (11.87-12.62)	12.20^{a} ±0.15 (11.89-12.61)
ALT, RFU/L	13.93^{a} ±0.12 (13.57-14.12)	13.89^{a} ±0.15 (13.54-14.11)	13.94^{a} ±0.22 (13.56-14.88)	13.95^{a} ±0.55 (13.08-17.02)
AST/ALT, ratio	0.89^{a} ±0.10 (0.79-0.99)	0.86^{a} ±0.12 (0.79-0.98)	0.88^{a} ±0.20 (0.76-0.99)	0.87^{a} ±0.31 (0.75-0.98)
Bilirubin,RFU/L	0.70^{b} ±0.06 (0.56-0.82)	0.69^{b} ±0.12 (0.10-0.81)	0.73^{b} ±0.62 (0.59-0.82)	0.80^{a} ±0.58 (0.58-4.00)
Urea,mg/dl	13.81^{a} ±0.47 (12.79-14.56)	13.11^{b} ±0.95 (10.99-14.12)	13.01^{b} ±0.83 (10.79-14.00)	12.92^{b} ±0.76 (11.79-14.20)
Uric Acid,mg/dl	4.06^{a} ±0.20 (3.61-4.77)	4.04^{a} ±0.10 (3.80-4.21)	4.04^{a} ±0.12 (3.69-4.23)	4.06^{a} ±0.10 (3.79-4.22)
Creatinine ,mg/dl	0.83^{b} ±0.04 (0.74-0.91)	0.84^{b} ±0.04 (0.77-0.91)	0.85^{b} ±0.04 (0.78-0.91)	1.11^{a} ±1.61 (0.73-10.00)

Means having different superscript letters differ significantly (P<0.05)

Between parentheses is the range.

T1=Tap water, T2=Helwan wastewater treated with 20 ppm FeCl3 + 5 ppm Polymer + 5 ppm Cl2 , T3=Zenin wastewater treated with 10 ppm FeCl3 + 5 ppm Polymer + 5 ppm Cl2, T4=Gabel El Asfar wastewater treated with 10 ppm FeCl3 + 15 ppm polymer + 5 ppm Cl2.

These functions showed that there were no harmful effects on rabbit liver and kidneys due to drinking domestic wastewater treated with coagulant and flocculent.

Feed consumption throughout the experimental period (offered feeds - residual feeds) are presented in table7. Rabbits consumed feeds throughout experimental period ranged between 15.35 and 17.75 Kg. Slight increase in feed consumption was noticed in rabbits drinking water treated with 10 ppm $FeCl_3$ + 15 ppm cationic polymer (T4) and slight decrease in feed consumption was noticed with group drinking treated wastewater with 20 ppm $FeCl_3$ + 5 ppm cationic polymer (T2). Total feed consumption is within the normal requirements and allowances [NRC, 2005].

Feed conversion (daily feed intake/daily weight gain) and feed efficiency (daily weight gain/daily feed intake) is a good indicator of any stresses that the animal weight suffers due to the quality of drinking water. Values of both feed conversion and feed efficiency indicate that there are no significant differences among experimental groups. There was almost no change among the experimental groups in rabbits weight gain except slight decrease in (T2) 20 ppm $FeCl_3$ + 5 ppm cationic polymer. Weight gain of control rabbits were within the range reported in growing rabbit [Abdel-Shafy, 2007].

Feed efficiency and Feed conversion values were in the normal range reported by [Marai, *et al*, 2004] and [Abdl-Shafy, 2007] and did not also affected by drinking the treated wastewater.

It can be concluded that the drinkability of domestic wastewater treated with the recommended doses (10-20 ppm $Fecl_3$ + 5-15 ppm cationic polymer + 5 ppm Cl_2) of coagulant and flocculent in these studies without any adverse effects on rabbits.

Table7. Some feed parameters (M±SD) of white new Zealand male rabbits as affected by drinking wastewater treated with Coagulant and Flocculent.

Total feed parameters , Kg	Tap Water (T1)	Helwan (T2)	Zenin (T3)	Gabal El Asfar (T4)
Feed consumption , Kg	$16.85^{b}\pm2.32$ (12.75-20.25)	$15.35^{c}\pm3.52$ (11.70-24.00)	$16.41^{b}\pm2.43$ (10.95-19.50)	$17.75^{a}\pm3.57$ (12.75-30.00)
Weight gain , Kg	$3.17^{a}\pm1.58$ (0.43-7.07)	$2.67^{a}\pm2.24$ (-7.29- +6.43)	$3.24^{a}\pm2.37$ (-5.36- +12.64)	$3.07^{a}\pm1.92$ (-2.14- +7.71)
Feed conversion	5.32	5.75	5.06	5.78
Feed efficiency	0.19	0.17	0.20	0.17

Means having different superscript letters differ significantly ($P<0.05$)

Between parentheses is the range.

T1=Tap water, T2=Helwan wastewater treated with 20 ppm $FeCl_3$ + 5 ppm Polymer + 5 ppm Cl_2 , T3=Zenin wastewater treated with 10 ppm $FeCl_3$ + 5 ppm Polymer + 5 ppm Cl_2, T4=Gabel El Asfar wastewater treated with 10 ppm $FeCl_3$ + 15 ppm polymer + 5 ppm Cl_2.

REFERENCES

Abdel-Rahim, E. A. ; Hafez, Y. M. ; Cobasy, M. E.; And Fares, A. M. (2008).*Evaluation of Coagulant and polymer as flotation technique in Egyptian domestic wastewater*. J. App. Sci (in press)

Abdel-Shafy, H. (2007). Effect of early heat exposure and rbST on some physiological parameters and productive performance of male rabbits. M.Sc. thesis , Faculty of Agriculture , Cairo University, Egypt

Ahmed, Nagwa, A. ; Azamel A.A. ; Barkawi, A.H and Morsy, A.S. (2006). Thermo- respiratory responses and hormonal profiles of male rabbits injected with vitamin C under high and low ambient temperatures in Egypt. Egyptian Journal of Rabbit Science.16: 61-75

Ahmed, Nagwa, A.; Ismail,A.M.; and Abdel-Kafy, E.M. (2005). Effect of heat exposure and feed restriction on performance of pregnant rabbit-does with emphasis on heat shock protein detection. *Second International Conference of Veterinary Research Division,* National Research Center, 27-29 June,Cairo, Egypt.PP.27:37.

Aiyuk S.; Amoako J.; Raskin L.; van Haandel A.; Verstraete W. (2004). Removal of carbon and nutrients from domestic wastewater using a low investment, integrated treatment concept. Water Res., 38(13): 3031–3042.

Canon, D. C. (1974).Clinical Chemistry-Principles and Techniques, 2nd Ed. Henry *et al.,* Eds. Harper and row, Hagerstown, MD, pp 411-441.

Chapman, D.G. ; Castilla, R. and Campbell, J.A. (1959). *Evaluation of protein in food*.I.A. method for the determintination of protein efficiency ratio. Can. J. Biochem.Phsiol.1:679-686.

Dumas, B. T. and Biggs, H. G. (1972).Standard method of clinical Chemistry. Academic press, New York, USA.pp.175.

Duncan, D.B. (1955). Multiple range and multiple F tests. Biometrics 11:1-42.

Fabiny, D.L. ; and Ertinghousen, G. (1971). Creatinine standard and measurement of serum creatinine with picric acid. Clin. Chem. 17:696.

Gehr, R.; Wagne, M.; Veerasubramanian, P.; and Payment, P (2003). *Disinfection efficiency of per acetic acid, UV and ozone after enhanced primary treatment of municipal wastewater* Res.37(19)4573-4586.

Harkness, J.E. ; and Wagner, J.E. (1995). *The biology and Medicine of Rabbits and Rodents.* 4th ed. Lea & Febiger, Philadelphia, USA.

Harleman, D. R. F. and Murcott. S. (1999). *The role of physical-chemical wastewater treatment in the mega-cities of the developing world.* water Sci. Technal 40(4-5):75-80.

Harleman, D. R. F. and Murcott. S. (2001). *Aninnovatine approach to urban wastewater treatment in the developing world.* water 21:44-88

Henry, R.J. (1964). Colorimetric method to determine serum total protein.Clin. Chem. 7:181

Kaneko, J.J. ; Harvey,J.W. ; and Bruss, M.L. (1997). *Clinical Biochemistry of Domestic Animals.* 5th ed. Academic Press. New York, USA.

Letterman, R. D. and Pero, R. W. (1990). *Contaminations in polyelectrolytes used in water treatment.* J. AWWA Res. Technal, 11:87-97.

Levine A. D.; Tchobanoglous G.; and Asano T. (1985) Characterization of the size distribution of contaminants in wastewater: Treatment and reuse implications. J. WPCF, 57(2): 805–812.

Marai, I.F.M. ; Habeeb, A.A.M. ; and Gad, A.E. (2004). Growth performance traits and the physiological background of young doe rabbits as affected by climatic conditioned and lighting regime, under sub-tropical conditions of Egypt. Eighth World Rabbit congress, 7-10 September, Puebla, Mexico. PP. 288-279.

NRC (2005).*Nutrient requirements of rabbits.*National Research Center Washington DC. USA.

Ødegaard H. (1978). Optimised particle separation in the primary step of wastewater treatment. Water Sci. Technol., 37(10): 43–53.

Ødegaard H. (1992). Norwegian experiences with chemical treatment of raw wastewater. Water Sci. Technol., 25(12): 255–264

Page, A. L. ; Miller, R. H. And Keeney, D.R.(1982). *Methods of soil analysis.* Part 2 Soil Sci. Am., Inc. Madison, Wisc. USA.

Poon C. S. and Chu C. W. (1999). The use of ferric chloride and anionic polymer in the chemically assisted primary sedimentation process. Chemosphere, 39(10): 1573–1582

Reall, A. P. M.; Penetra, R. G., and Carvalho, M. E. (2001). *Flotation technique with coagulant and polymer application applied to the post-treatment of effluents from anaerobic reactor treating sewage.* Water Sci., Tech. 44:205-212.

Reitman, S.; and Frankel, S. (1975). A colorimetric method for the determination of serum Glutamate-Oxalacetate and Glutamate pyruvate transferase. Am. J. Clin.Path.28:56.

SAS.(1999).Statistical Analysis System. SAS statistics. Guide release, version 8.00 TS level OOMO, SAS Institute Inc., Cary , NC, USA.

Semerjian, L. and Ayoub, G. M. (2003). *High-pH-magnesium coagulant-flocculation in wastewater treatment*. Advansces in Environmental Research 7 (2):389-403.

Sonune, A. and Ghate, R. (2004). *Developments in wastewater treatment methods.* J. Desalination, 167:55-63.

Standard Methods for the exminationof water and wastewater(SMEW) (1995). 19th (ed), American public health association/ American water works association/ Water- Environmental federation. Washington. Dc. USA.

Tabacco, A. (1979). Detrmintion of Urea in blood serum Clin. Chem. 25:336.

Trinder, P. (1969). Enzymatic determination of glucose in blood serum. Ann Clin. Biochem. 6:24.

Van Buuren, J. C. L.; Abusam, A.; Zeeman, G. and Lettingavan, G. (1999). *Primary effluent filtration in small-scale installation.* Water Sci-Technol, 39(5)195-202.

Webster, D. ; (1974).Colorimetric method to determined serum, albumin Clin. Chim. Acta 53:109-112.

Wang, X.; Jin, P.; Zhao, H., and Meng, L. (2007). *Classification of contamination and treatabilility evaluation of domestic wastewater.* Event. Environ. Sci.Engin. China, 1(1)57-62.

التقييم الحيوى لمياه الصرف الصحى المعالج بالترسيب و التخثر بإستخدام ذكور أرانب نيوزلندى أبيض.

البير موريس فارس[1]؛ امام عبدالمبدىء عبد الرحيم[2]؛ ياسين محمد حافظ[3]ومحمد إبراهيم قبيصى[2].

[1]قسم معالجة مياه الصرف، شركة كيمى آرت، القاهرة، مصر؛ [2]قسم الكيمياء الحيوية الزراعية، كلية الزراعة، جامعة القاهرة، مصر؛ [3]قسم الانتاج الحيوانى، كلية الزراعة، جامعة القاهرة، مصر.

تم معالجة 18 عينة مياه صرف صحى من ثلاث محطات معالجة مختلفة (حلوان – زنين – الجبل الأصفر) باستخدام الترسيب (كلوريد الحديديك) والتخثر (البوليمر) معاً.

تم تقسيم ملوثات مياه الصرف الصحى الى مواد ذائبة ومواد عالقة وتنقسم المواد العالقه الى (جوامد عالقة– مواد عضوية– مغذيات- معادن ثقيلة) تم التخلص من هذه الملوثات بالتخثر والترسيب وأوضحت نتائج تحليل المياه المعالجة انخفاض كبير جدا فى هذه الملوثات بعد المعالجة الكيميائية .

كما أوضحت نتائج الفحص البكتيريولوجى ضد البكتريا السبحيه وبكتيريا القولون الى حدوث انخفاض كبير فى أعداد المستعمرات البكتيريه لكل سم^3 من المزعه البكتيريه .

تمت معالجة عينات مياه الصرف الصحى باستخدام 6 معالجات مختلفة وبناء على التحليل الكيميائى للمياه الناتجة فإن أفضل معالجة استخدمت كمياه شرب للحيوانات التجريبية.

استخدم فى هذه التجربة 64 ذكر أرنب نيوزلندى أبيض لبحث تأثير شرب مياه الصرف الصحى المعالج كيمائياًعليهم وأوضحت النتائج أن جميع المقاييس الهيماتولوجية والبيوكيميائية لدم الأرانب التى شربت مياه صرف معالج كيمائياً بالتخثر والترسيب كانت فى المدى الفسيولوجى الطبيعى ولم يحدث أى تغيير معنوى فى وظائف الكلي والكبد لحيوانات التجربة ما عدا ارتفاع طفيف لكرياتينين الدم فى المجموعة الرابعه (الجبل الاصفر). ولم تحدث أى اختلافات معنوية فى الزيادة الوزنية والتحول الغذائى وكفاءة استخدام الغذاء بين المجاميع التجريبية المختلفة. بينما حدثت زيادة طفيفه فى استهلاك الغذاء لأرانب المجموعة الرابعه (الجبل الاصفر) وإنخفاض طفيف لأرانب المجموعة الثانية (حلوان).

نستخلص من هذه الدراسة قابلية استخدام مياه الصرف الصحى المعالج كيمائياً للشرب(10 – 20 جزء فى المليون كلوريد حديديك + 5 – 15 جزء فى المليون بوليمر كاتيونى + 5 جزء فى المليون كلور) للأرانب محل الدراسة دون حدوث أى تأثيرات عكسية عليها.