The influence of Cationic Surface Active Agent on Physical Properties of Some Egyptian Soils

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Abstract: Present work describes the effect of ethanediyl-1,2-bis (dimethyldodecylammonium chloride; CS12) as cationic surfactant on physical properties of sandy and calcareous soils from Cairo Alexandria desert road (Sadate city) and Amria region respectively. In this study, surface soil samples were collected, (CS12) was added at rates of 0.0, 0.2, 0.5 and 1.0% and mixed thoroughly with the tested soils portions. Then the soil was subjected to wetting and drying cycles for six weeks. Whereas, the lower and upper soil moisture contents were in the range of 5% to 15%, respectively. Data indicated that the presence of CS12 improved soil physical properties with increasing its ratio. Aggregate percentage, total porosity and available water were increased while hydraulic conductivity values were decreased in the sandy soil and increased in calcareous soil due to redistribution of soil pores. These findings indicate that an addition of CS12 improved physical properties of both soils used.

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1. Introduction:

Since the 1990_s, researchers have investigated using surface active agents in soil to combat soil matrix, but data are still lacking for making clear recommendations. Agricultural surfactants are well known as “spreaders and stickers” that help fertilizers, pesticides, and soil conditioners spread through the soil particles, sorb to soil, or adhere to plant leaves (**Ishiguro and Fujii, 2008**). The structure and function of the molecules of yet all posses a hydrophilic (head) group and a hydrophobic (tail) group (**Karagundus *et al.*, 2001**). Their heads bond strongly with water, while their tails adsorb to surfaces such as clay minerals, air molecules in pores, or organic substances in soil (**Micich *et al*., 1986; Kuhnt, 1993 and Tumeo *et al*., 1997).**

Laboratory tests have shown soil surfactants to affect infiltration rates and flow patterns. Vertical infiltration rates increased with the concentrations of two commercial soil surfactants applied to water repellent soil (**Feng *et al*., 2002**). In horizontal soil columns, flow was induced in direct proportion to surfactant concentration **(Henry *et al.*, 1999, Henry *et al.*, 2001 and Bashir *et al*., 2008**). Researchers have reported both increases and decreases in hydraulic conductivity due to surfactants, and the mechanisms of action have been debated (**Tumeo, 1997**). Also, surfactants either increase or decrease aggregate stability in soils, depending on soil composition (**Tumeo, 1997; Ross *etal.*, 1998 and Miokovics *et al*., 2011**).

This study aims to evaluate the effect of CS12 as cationic surfactant on improving soil physical properties in some Egyptian soils.

2. Materials and Methods

Soil samples (0-30 cm depth) were collected from Amria region and Alexandria desert road (Sadate city), respectively which prepared for research analysis.

Soil portions from each sample were mixing with 0.0, 0.2, 0.5 and 1.0% of CS12 which synthesized according to the method reported elsewhere **Zana** (**1997**) in applied organic chemistry department, faculty of science, Al-azhar university (girls branch). The soil samples were subjected to 12 drying and wetting cycles which ranged from 3- 5% to 9-15% soil moisture content, respectively for six weeks. Treated soil materials were left to air dryness and the estimated soil properties were listed in **Table (1).** Soil properties were estimated according to the general methods of **Black (1965).**

3. Results and Discussion

3.1. Effect of cationic surface active agent; CS12 on the soil bulk density, total porosity, pore size distribution and hydraulic conductivity for tested soil samples :

Data in **table (2)** showed that the values of bulk density decreased in both soils compared with the control by increasing the application rate of CS12.The bulk density values were decreased to 5.4% in sandy soil while in sandy loam soil reached to 9% after addition of %1 CS12 compared with control treatment. These finding confirm results that obtained by **Mohamed (2004)** who reported that DLBA as nonionic surfactant had improving effects on bulk density.

Also, data revealed that total porosity values were highly affected by CS12 additions. The values of total porosity for sandy soil increased from 36.60 (control) to 37.74 %, 38.49 and 40.00% after addition of 0.2, 0.5 and 1.0% of CS12, respectively.

In calcareous soil, similar trend was obtained whereas their values changed from 41.13 % (control) to 43.40, 43.77 and 46.42 % at the same addition rates of CS12.

Pore size distribution data of sandy and sandy loam soils as affected by addition of CS12; **Table 2.** These results refer to good redistribution of soil pores.It was obvious that micropores (**<30µ**) and mesopores (**30-100µ)** were increased with the increase in the concentration of CS12.

Micropores and mesopores were increased in sandy soil from 9.98 to 14.90 % and from 6.0 to 9.0% for control and 1.0% treatments, respectively, while for calcareous soil ranged from 18.0% to 21.11% and from 5.13 to 9.11% for control and 1.0% treatment, respectively, at the expense of macropores in both sandy and calcareous soils. The highest increase in micropores was observed in sandy soils and in mesopores for calcareous soil.Similar results were obtained by **Mohamed (2004).**

Soil hydraulic conductivity depends on the type of soil, porosity and configuration of the soil pores. Data in **table 2,** showed that the values of hydraulic conductivity coefficient of sandy soil were decreased from 16.11 to 13.10 cm/h for control and 1.0% treatments**,** respectively which could be attributed to the decrease in drainable pores values in sandy soil. While their values were increased from 11.0 to 13.09 cm/ h on the calcareous soil for control and 1.0% treatments, respectively due to the mesopores values. Such result coincided with those obtained by **(Mohamed 2004**; **Sepaskhah *et al.*, 2002; Lentz, 2003 and Ishiguro *et al.*, 2008).**

3.2. Effect of cationic surface active agent; CS12 on moisture retention of soils used :

Data in **table 3** showed that the moisture constants values (water holding capacity**,** field capacity, witting point and available water) of both sandy and calcareous soils treatments increased by increasing the added doses of CS12 used.

The values of field capacity in sandy soil increased from 9.00% for control to 9.28, 10.01 and 11.00 %, while in calcareous soil the values were 16.00% for control to 15.33,17.11 and 18.66%, respectively at 0.2,0.5 and 1.0% of CS12 used.

Concerning the values of water holding capacity and wilting point, the same trends were observed. Available water percentage increased from 6.89% for control to 8.02% for 1.0% of CS12 treatment on sandy soil, while from 9.34% for control to 11.65 % for 1.0% of CS12 treatment on calcareous soil. Also, data indicated that increasing was observed in available water more in calcareous soil than in sandy soil. These results could be explained on the basis of the effect of the CS12 on redistribution of soil pores and aggregates formation. Also, these results are in good agreement with those obtained by **(Feng *et al.*, 2002; Mohamed, 2004; Urrestarazu *et al.*, 2008; Cooley *et al*., 2009 and Mobbs, 2012)**.

Table 1: Chemical and physical characteristics of the studied soil samples:

Soil location	Particle size distribution (%)				Textural class	O.M(%)	$CaCO_3$ (%)	E.C dSm^{-1}	pH	Soluble ions meq l^{-1}							
										Cations					Anions		
	Course sand	Fine sand	Silt	Clay						Ca	Mg	Na	K	CO_3	HCO_3	Cl	SO_4
Sadate	53.19	34.00	6.11	7.00	Sandy	0.55	2.40	0.44	7.3	1.8	1.5	2.3	0.43	- --	0.5	3.1	2. 30
Amria	35.33	38.00	9.95	16.91	Sandy loam	0.81	20.00	0.90	7.9	4.0	1.7	2.7	0.50	---	0.8	3.4	2.98

Table 2: Bluk density, total porosity, pore size distribution and hydraulic conductivity values for soils treated with cationic surface active agent :

Soil treatment	Bulk density gm /cm^3	Total porosity%	Pore size distribution%			Hydraulic conductivity h / cm
			Micropore <30µ	Mesopores 30-100µ	Macropores >100µ	
	Sandy Soil					
Control	1.68	36.60	9.89	6.00	20.62	16.11
0.2%	1.65	37.74	12.00	8.21	17.53	15.00
0.5%	1.63	38.49	13.00	8.53	16.26	14.39
1.0%	1.59	40.00	14.90	9.01	16.09	13.10
	Calcareous Soil					
Control	1.56	41.13	18.00	5.13	18.00	11.00
0.2%	1.50	43.40	18.78	6.01	18.61	11.88
0.5%	1,49	43.77	20.19	6.97	16.61	12.56
1.0%	1.48	46.42	21.11	9.11	16.20	13.09

Table 3: Effect of cationic surface active agent on moisture constants of treated soils.

Soil treatment	Soil constants %			
	W.H.C	**F.C**	**W.P**	**A.W**
Sandy Soil				
Control	18.99	9.00	2.11	6.89
0.2%	19.90	9.28	2.38	6.90
0.5%	23.78	10.01	2.50	7.51
1.0%	25.00	11.00	2. 98	8.02
Calcareous Soil				
Control	27.11	16.00	6.66	9.34
0.2%	28.99	15.33	6.77	9.56
0.5%	30.00	17.11	6.83	10.28
1.0%	32.03	18.66	7.01	11.65

W.H.C: Water Holding Capacity **F.C**: Field Capacity **W.P**: Witting Point **A.W**: Available Water

Table 4: Effect of cationic surface active agent used on aggregation characteristics.

Soil treatment	Aggregate size distribution%				T.A %	M.W.D mm
	5.o-2.0 mm	**2.0-0.84 mm**	**0.84-0.42 mm**	**0.42-0.25 mm**		
Sandy Soil						
Control	2.00	4.09	5.00	9.02	20.11	0.19
0.2%	6.00	6.50	7.30	10.80	30.60	0.38
0.5%	8.44	7.53	8.91	11.00	36.43	0.49
1.0%	8.80	9.15	10,00	13.11	41.06	0.54
Calcareous Soil						
Control	2.95	5.00	8.00	10.27	25.22	0.26
0.2%	4.18	6.39	10.00	13.00	32.57	0.33
0.5%	6,25	6.00	11.50	16.25	40.00	0.43
1.0%	7,00	7.88	12.53	18.00	45.41	0.49

T.A: Total Aggregates; **M.W.D**: Mean Weight Diameter

3.3. Effect of cationic surface active agent; CS12 on aggregation percentage, distribution and mean weight diameter for the soil sample used:

Data in **table 4** indicated that mean weight diameter values and total aggregate percentages increased with increasing of CS12 doses to both soils compared with the control.

In the sandy soil, data showed that the values of mean weight diameter increased from 0.19mm for control to 0.38, 0.44 and 0.54 mm for the treatment of 0.2, 0.5 and 1.0% addition rates, respectively. The same trend was obtained for the aggregation %, whereas for control it was 20.11% and for the treatments they were 30.60, 36.43 and 41.06%, respectively.

Concerning the calcareous soil the values of M.W.D were increased from 0.26 mm for control to 0.33, 0.43 and 0.49 mm for the studied rates of CS12, respectively. Also, the aggregation percentages was increased from 25.22 for control treatment to 32.57, 40.00 and 45.41% for the investigated treatments, respectively. This increase could be due to the effect CS12 on the co-agulation of soil particles. The aggregation percentages due to the 1.0% of CS12 treatment were 40.46 and 45.41% for the sandy and calcareous soils, respectively. Similar study; **Mohamed (1990)** who found that the addition of agrosoke by the rate of 0.4% led to 40.20 and 38.11% aggregation for sandy and sandy loam soils, respectively. While **Mohamed** (**2004),** found that the use of DLBA by the rate of 0.5% led to 41.19 and 44.39% aggregation for sandy and calcareous soils, respectively. These results are in good agreement with those obtained by **(Law *et al*., 1966**; **Mbagwu *et al*., 1993 and Northeult 1996).**

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