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Spectroscopic analyses of soil samples outside Nile Delta of Egypt

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ABSTRACT

Soil in Egypt, especially around Delta is exposed to various pollutants which are affecting adversely soil fertility and stability. Humic Acids (HA) as a main part of soil organic matter (SOM) represent the heart of the interaction process of inorganic pollutants with soil. Consequently, Fourier transform infrared spectroscopy (FTIR) and Nuclear magnetic resonances (NMR) were used to characterize soil, sediment and extracted HA. Resulting data confirmed that the HA was responsible for transporting inorganic pollutants from surface to subsurface reaching the ground water, which may represent a high risk on public health. The transport process is coming as carboxyl in surface soil changed into metal carboxylate then transferred into the carboxyl in bottom soil.

1. Introduction

Anthropogenic activities are considered the main source for soil contamination. Increasing the level of pollutants in soil environments and further accumulation of it represented one of the main factors affecting public health [1]. Consequently, serious problems will occur when the metals interact with soil surfaces or when the concentrations of metals exceed the adsorption capacity of soil [2–3]. Subsequently, soil contamination became dangerous due to the continuous degradation of soil organic matter SOM into the environments [4]. HA are considered the main part of SOM. It is reported that HA can support many types of interactions with heavy metals forming a complex structure [5–11]. Soil samples contaminated with motor oil were studied and indicated that the fertilization of soil with HA has been lost by oil contamination [12]. For the identification of soil molecular structure, Fourier transform infrared spectroscopy (FTIR) is a useful tool to be used [13–14]. FTIR among other spectroscopic techniques were utilized in order to study the effect of contamination on the aquatic environment [15–19]. FTIR was utilized for characterizing 166 soil samples collected from five different Mediterranean soils, 56 soil samples from different depths, 13 samples forest and Brazilian savanna region [20–25]. Furthermore, X-ray diffraction (XRD) and FTIR were used to characterize the mineralogy of 40 sediment samples of the Ponnaiyar River in India [26]. Also, 100 soil samples were collected from East of U.S. from the surface to 3.4 m below [27]. In addition, FTIR is one of the most important tools used in the identification of internal structure of SOM [28–33]. Moreover, UV, X-Ray fluorescence, XRD, Elemental analysis and ^{1}H, ^{13}C NMR spectroscopy allows one to gain information about SOM especially HA [33–41]. Molecular modeling and FTIR indicated that soil organic matter enhances the transport of pollution [42]. Accordingly, this work is conducted to study surface soil, sub-surface and sediment from both agricultural land and agricultural drainage outside the Nile Delta from El-Qalyobia Governorate, Egypt. Both FTIR and NMR were utilized to study soil and soil organic matter extracted from soil.

2. Materials and methods

2.1. Samples collection and preparation

Sediment and soil samples were collected from agricultural land close to an agricultural drainage outside the Nile Delta from El-Qalyobia Governorate, Egypt. Samples were classified into three groups; 5 samples from surface, 3 sediment samples gathered from the drainage and then 11 samples were collected at various depths from the surface at 0.25 m, 0.5 m, 1 m, 2 m, 3 m, 8 m, 10 m, 11 m, 17 m, 22 m, 29 m respectively.

Samples were collected by means of the stainless steel sediment sampler; the possible contamination from the metal material of the sampler could be avoided as sub-samples were taken from its centre with a fluorocarbon plastic tube. All soil and sediment samples were air dried at room temperature for 24 h then sieved to remove large particles such as leaves, twigs and rocks.

For soil and sediment sample characterization, all samples were dried in oven at 105 °C for 24 h then subjected to FTIR.

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Measurements were carried out using JASCO FTIR 300 E spectrometer, in the range 400–4000 cm^{-1}. FTIR discs were prepared using 2 mg of soil samples and 198 mg of dried KBr, which were placed under vacuum and pressed.

2.2. Soil humic acids (HA) extraction method

The air dried soil (sediment) samples collected from surface and drainage were selected for HA extraction. For extraction, 20.00 g of

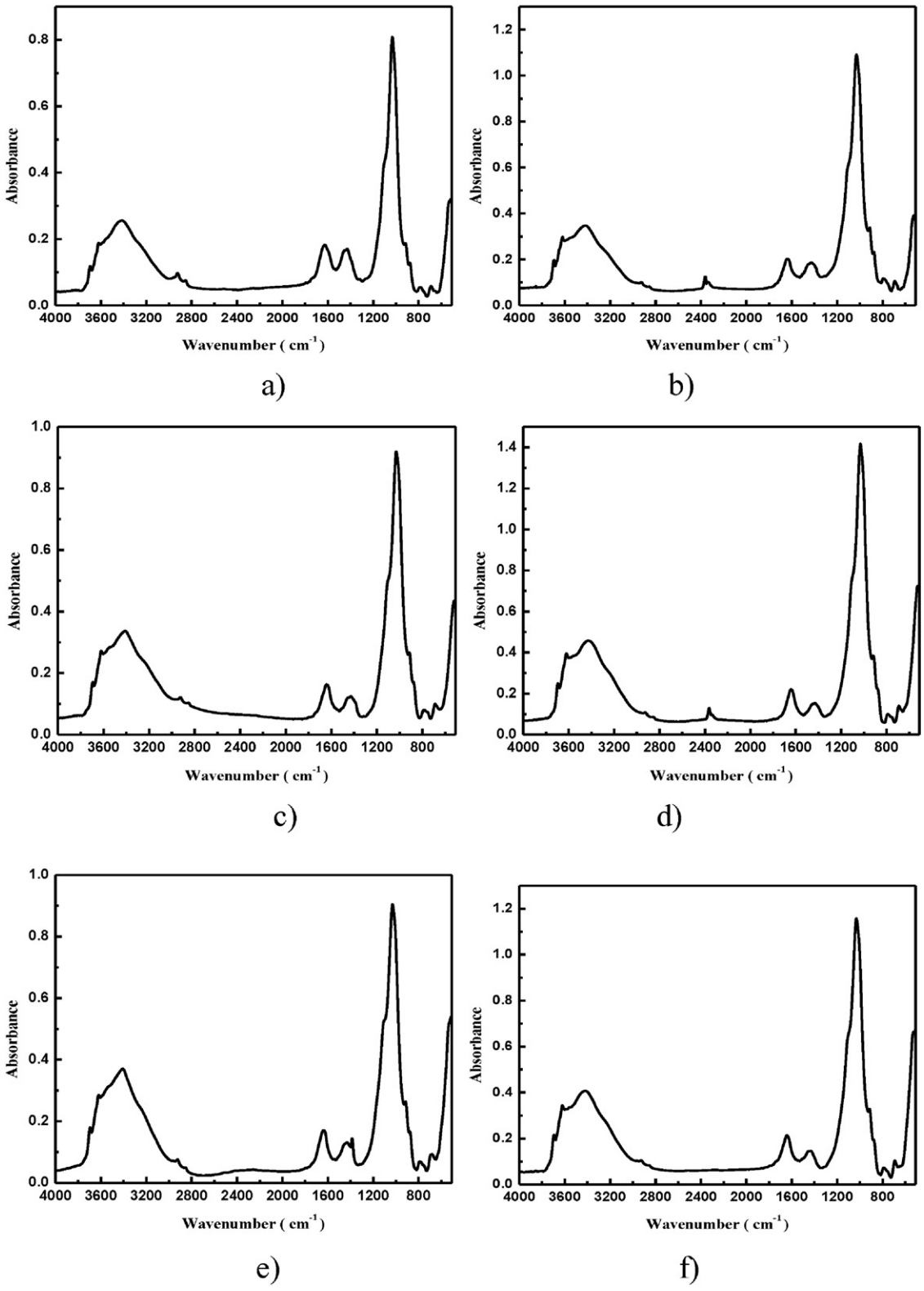

Fig. 1. FTIR absorption spectra in the range from 4000 to 400 cm^{-1} for soil (sediment) samples from a) Drainage (1) b) Drainage (2) c) Drainage (3) d) Surface e) Surface (1) f) Surface (2) g) Surface (4) h) Surface (5) i) 0.25 m j) 0.5 m k) 1 m l) 2 m) 3 m n) 8 m o) 10 m p) 11 m q) 17 m r) 22 m s) 29.