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ANALYSIS OF SOIL CHEMICAL PARAMETERS OF AN UNCLEANED CRUDE OIL SPILL SITE AT BIARA, GOKANA L. G. A. OF RIVERS STATE, NIGERIA.

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ABSTRACT

Analysis of soil chemical parameters of an uncleaned crude oil spill site at Biara was carried out. Soil samples were collected at 0 -15 cm and 15 – 30 cm soil depths from both polluted and unpolluted sites for analysis. Significant increase in high total hydrocarbon content (1015±80.5 – 1150±90.1 mg/kg) in polluted site was observed as against 31.5±27.9 – 67±26.1 mg/kg of the unpolluted site. There were reductions in soil conductivity (6.7±0.3 – 7.0±0.6 µS/cm), nitrate (23.04±0.98 – 25.92±4.7 mg/kg) and phosphate (9.63±1.38 – 11.04±3.6 mg/kg) in polluted soil compared with 11.7±0.3 – 12.3±0.9 µS/cm, 61.76±5.4 – 111.3±7.6 mg/kg, and 19.28±2.7 – 20.6±6.3 mg/kg respectively in the unpolluted site. Results also showed pH ranged from 5.13±0.07 to 5.43±0.09, total organic carbon from (0.86±0.11% to 1.0±0.05%) and total organic matter from (1.49±0.11% to 1.71±0.05%) with no significant difference between polluted and unpolluted sites. Therefore, it was concluded that oil spill altered soil chemical properties of the polluted soil. Therefore, clean up of the impacted site should be undertaken.

Keywords: Soil, Pollution, Hydrocarbon, Biara, Crude oil.

INTRODUCTION

Crude oil spill is a mercurial and multi-dimensional problem in Nigeria especially in the Niger-Delta ecoregion where crude oil exploration is at its peak. The Department of Petroleum Resources (DPR) reported only 4,835 oil spill incidents between 1976 and 1996, with a loss of 1.8 million barrels of oil to the environment. However, according to UNDP, more than 6,800 spills were recorded between 1976 and 2001, with a loss of approximately 3 million barrels of oil (UNDP Report, 2006). Oil spill figures vary considerably depending on source and the reporting agency. The failure of the oil companies and regulators to deal with incidents of oil spill and the lack of effective clean-up greatly exacerbate the environmental impacts of such spills (Amnesty International, 2009).

Various activities of the oil industry ranging from the exploration and exploitation of crude oil have been associated with frequent oil spills. Factors responsible range from corrosion of oil pipes, over pressure failure and overflow process components; poor maintenance of infrastructure, spills or leaks during processing at refineries, tankers accidents, human error; and deliberate vandalism of oil facilities (Kinako and Awi-Waadu 2000). The miscellaneous/minor sources include disposal of waste oil by factories, private and mechanic workshops and vehicles service stations.

Crude oil spill (i.e. pollution) can occur in any ecosystem (terrestrial or aquatic) and when it does, affect all components of the ecosystem (biotic and abiotic). The effects range from physical and chemical contamination of soil, air and water to deleterious impacts on flora and fauna. In water, it could reduce oxygen diffusion into the water which may cause increase in biochemical oxygen demand (BOD) and reduce dissolved oxygen (DO) content of the system leading to death of aquatic organisms (Enujiugha and Nwanna, 2004).

Oil spill had been reported to alter soil physico-chemical properties by increasing soil water porosity and reduced soil capillarity, aeration and water holding capacity (Kayode *et al.,* 2009)). Reduction in soil essential nutrients content such as nitrogen and phosphorus have also been observed in crude oil polluted soil (Gighi *et al.,* 2012; Tanee and Kinako, 2008; Xu and Johnson, 1997). Osuji and Nwoye (2007) observed and reported that crude spill in a terrestrial environment increased soil total petroleum hydrocarbon (TPH) content, soil temperature and increased soil acidity. All these alterations in turn could affect plants by retarding seed germination and plant growth, stem density, photosynthesis and biomass accumulation or result in complete mortality (Pezeshki, *et al*., 2000; Anyanwu and Tanee, 2008) and Kinako *et al* (1993) observed that in crude oil polluted ecosystem, vegetation is destroyed and recovery takes quite a long time. Air pollution might also occur as a result of volatile hydrocarbon evaporating into the atmosphere.

This work attempts to analyze the impact of uncleaned crude oil spill on soil chemical parameters. This will help determine any effect on soil chemical parameters and therefore contribute to existing knowledge on the impact of oil spill on terrestrial ecosystem as this may have far reaching implications on agricultural productions and sustainable livelihood of the people.

MATERIALS AND METHODS

This study was carried out at a crude oil spill site left uncleaned for over four years with geographical coordinates: latitude 4^0 42’ N and longitude 7^0 16’ E in Biara. Biara is a rural Ogoni Niger Delta community in Gokana Local Government Area, Rivers State, Nigeria. The spill site is a terrestrial environment with a fallow bush revegetating after agricultural cultivation. The vegetation is composed mainly of herbs and shrubs with few trees such as *Musanga cecropoides, Newbouldia laevis,* oil palm tree and some cluster stands of african bamboo tree.

At the polluted area, three sample spots 10 m apart along the central axis of the area were located. These spots were sampled at two soil depths: surface (0-15 cm) and sub-surface (15 – 30 cm) using soil auger. Another three sample spots 100 m away from the unpolluted site which served as control were randomly located and sampled at same soil depths as the polluted site. Soil samples collected were immediately placed in cellophane bags, tightly tied and labelled using masking tape and marker pen. The samples were preserved in rubber cooler and

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taken to laboratory for chemical analyses the same day.

Soil pH and conductivity were measured by meter methods from slurry of 50/50 w/v soil sample in water. Sample pH and conductivity displayed were recorded from pH meter (model: Jennway 3015)) and conductivity meter (HACH Ecttesr microprocessor series) respectively. Total hydrocarbon content (THC) was obtained through spectrophotometric method by oven-drying 1g of sample and total hydrocarbon content extracted using chloroform and its concentration measured using spectrophotometer. Total organic carbon (TOC) was measured by ascorbic acid method while total organic matter (TOM) was derived according to Combs & Nathan (1998). Phosphate and nitrogen contents were obtained by oxidation and Kjedahl methods as described by Stewarte *et al*. (1974).

The data generated from the analyses were subjected to statistical analyses such as mean, standard error mean (SEM) and analysis of variance (ANOVA) at p = 0.05.

Least significant difference was also used to separate mean according to SAS (1991). The results obtained were presented in composite bar graphs using Microsoft Excel 2007 package.

RESULTS

The results of soil chemical characteristics analysis of Biara abandoned crude oil spill site are presented in Figs. 1-7.

Soil pH result was shown in Fig. 1. The pH of both the polluted site and the unpolluted site at both the surface and subsurface soil depths were generally acidic; in the range of 5.13 and 5.43 with no significant difference between sites and soil depths.

There was a drastic reduction in soil conductivity at both surface (7.0 µS/cm) and subsurface (6.7 µS/cm) soil depths of the polluted site compared with the unpolluted site (Fig. 2). However, there was no significant differences between soil depths for the control (unpolluted) and polluted sites.

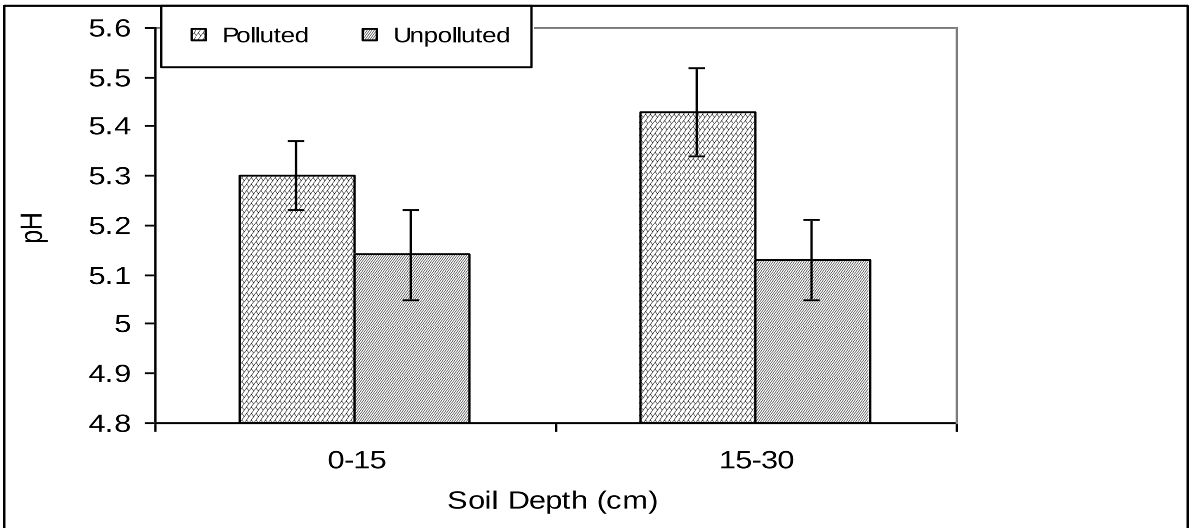

Fig. 1: effect the spill on pH of the polluted site

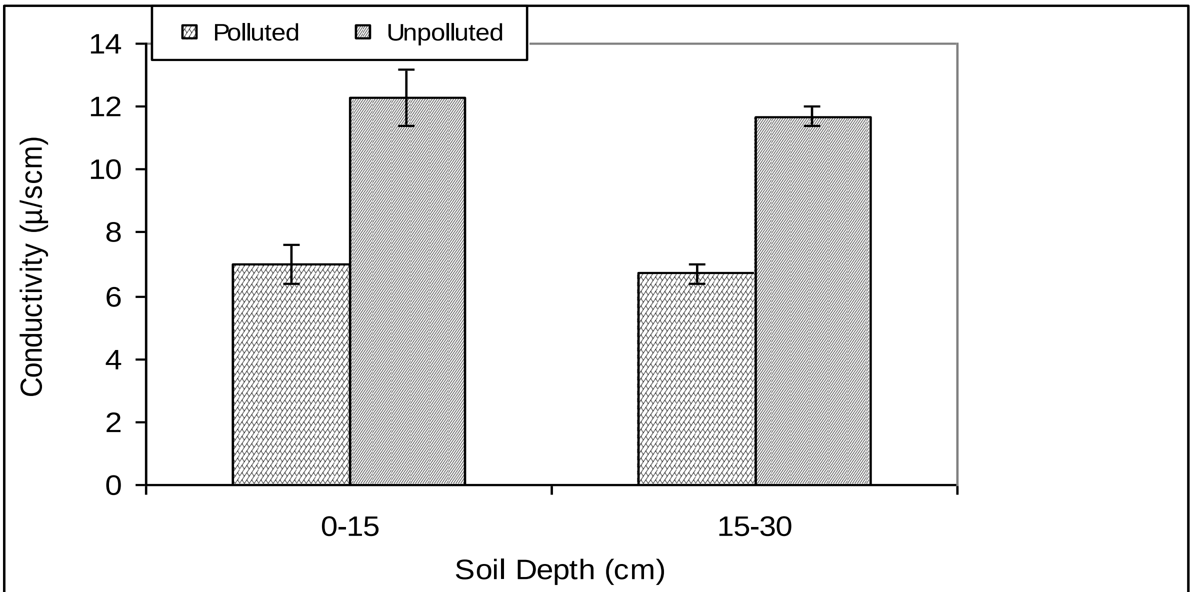

Fig. 2: effect of the spill on conductivity of the polluted site

Total hydrocarbon contents results (Fig. 3) were high (1118.5 mg/kg and 948 mg/kg) at surface and subsurface soil respectively in the polluted site compared with 31.5 mg/kg and 67 mg/kg for surface and subsurface soil respectively of the unpolluted site. High hydrocarbon content negatively affects soil-gaseous diffusion which has far reaching implications for biotic community of affected ecosystem and soil fertility (Osuji and Ezebuiro, 2006). Fig. 4 showed the total organic carbon obtained at surface and subsurface soil depths of the polluted and the unpolluted sites. Statistics revealed no significant differences in TOC between sites and soil depths. The result of total organic matter (TOM) followed the same pattern as TOC (Fig. 5).

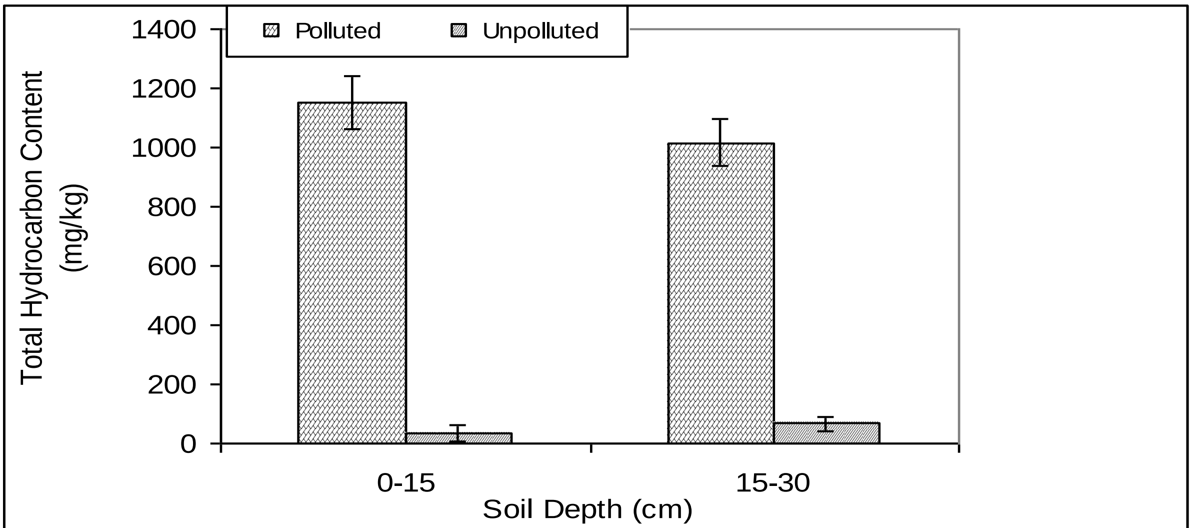

Fig. 3: effect of the spill on total hydrocarbon content of the polluted site

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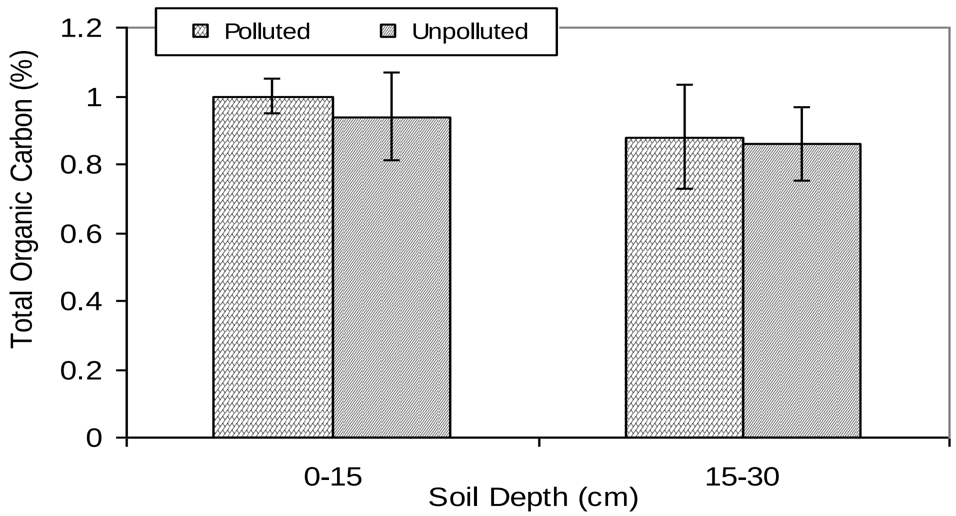

Fig. 4: effect of the spill on total organic carbon of the polluted site

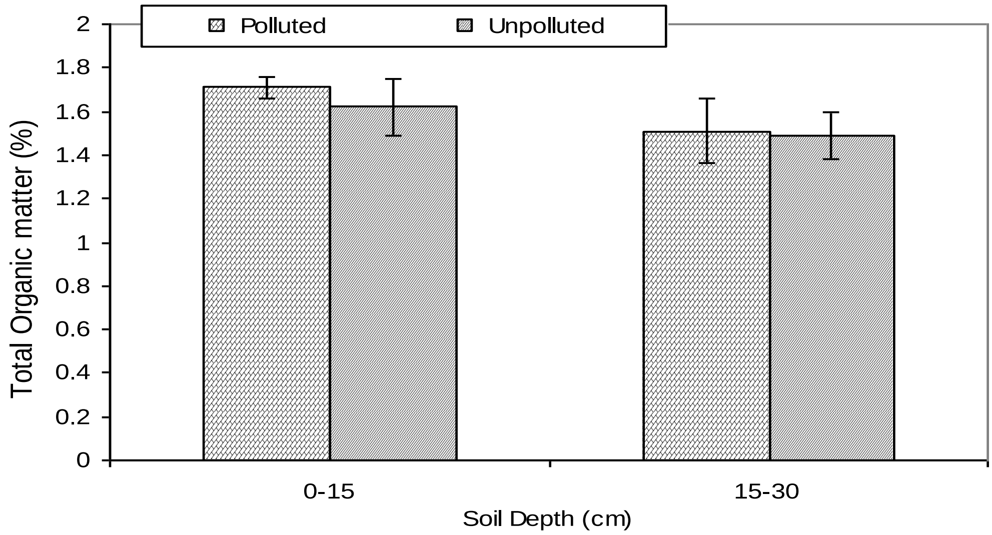

Fig. 5: effect of the spill on total organic matter the polluted site

Crude oil spill drastically reduced soil nitrate content of polluted site compared with the unpolluted site at both soil depths (Fig. 6). Reductions of 76.7% and 62.7% nitrate content in polluted soil were recorded at both 0-15 cm and 15-30 cm soil depths respectively (Fig. 7). Similar results were obtained for soil phosphate with higher phosphate content in the unpolluted soil. The highest soil nitrate concentration was observed at 15-30 cm soil depth of unpolluted soil which may be the result of nutrient leaching down soil profile.

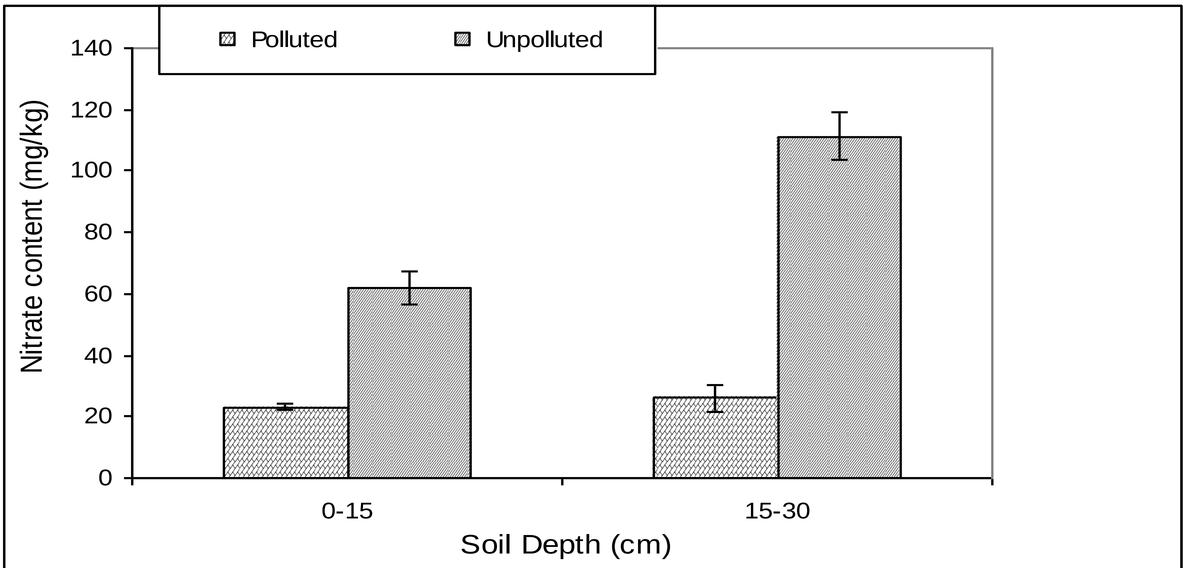

Fig 6: effect of the spill on nitrate content of the polluted site

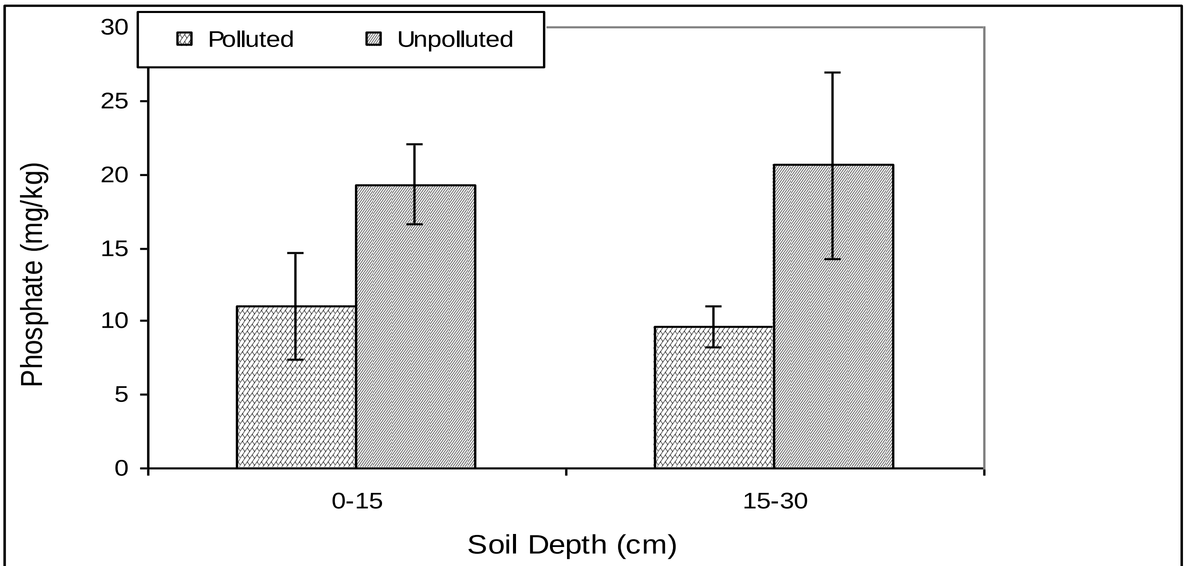

Fig. 7: effect of the spill on phosphate content of polluted site

DISCUSSION

pH result is consistent with the findings of Benka-Coker & Ekundayo (1995); Osuji & Nwoye (2007); Abii & Nwosu (2009) who reported similar results from studies on crude oil polluted sites in Niger Delta. This result showed that oil spill did not have any significant effect on soil pH. According to Kinako *et al.*, (1993), weak acid pH of soil was natural characteristics of tropical soils as it results from leaching due to the high rainfall of the area. Reduction in soil conductivity corresponds with the findings of Adebola *et al*. (2012) and Gighi *et al.* (2012). This might be due to reduction in concentration of available cations or increased concentration of anions from the pollutant.

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High hydrocarbon content of polluted soil has been severally reported to result from crude oil pollution. This affects soil properties, which in turn negatively affects the agricultural potentials of polluted soils (Ezebuiro, 2004 and Osuji *et al.*, 2004). The high THC result of polluted site might have arose as the result of the impact of the spill of crude oil on the polluted site as hydrogen and carbon are major elements of crude oil (USEPA, 2011). The high THC is an indication of the degree of impact on the ecosystem. Akubugwu *et al.* (2009) explained that increase in TOC and TOM of crude oil polluted soil result from metabolic processes that follow oil spillage that facilitates addition of organic carbon from crude oil, the pollutant by reducing the carbon mineralizing capacity of impacted site microflora.

The findings from the analyses revealed that crude oil spill has no significant effect on pH, TOC and TOM of impacted site. The significant increase in total hydrocarbon content and reduction in soil conductivity, nitrate and phosphate showed that crude oil spill altered soil chemical parameters of polluted soil. It is imperative therefore, that clean up of impacted site still necessary in order to restore the soil to its natural status.

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