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Assessment of fluoride content in cultivated and uncultivated soils in the western part of Jifarah plain area, Libya

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ABSTRACT: *The study area relies on the groundwater as the major source for crop irrigation and drinking purposes. However, there are some indications that the groundwater was assessed for fluoride concentration. No studies have been carried out on fluoride contents in the soils of the study area and its implication to the biotic components of the ecosystem. The objective of this study was to determine the concentration of fluoride in the cultivated and uncultivated soils in Jifarah plain area. Forty soil samples were collected at a depth of ranged from 0 cm to 40 cm and analyzed for fluoride (F), electrical conductivity (EC), pH and Nitrate (NO_3). Fluoride concentration for the cultivated soils was found between 0.03 and 41.05 with an average of 9.61 mg / kg soil whereas, its content in the uncultivated soils was in the range of 0.03 to 29.39 with an average of 7.42 mg / kg soil. It was revealed that 25% (5 samples)and 10 % (2 samples) of the cultivated and the uncultivated soils respectively crossed the toxic limit of 2.57 – 16.44 mg / kg in soil stipulated by world health organization(WHO) for fluoride. It also revealed that fluoride concentrations in the remains of the samples were below the recommended limit and the soils can be used for animal grazing and crops production.*
Key words:- *fluoride, soils , cultivated, uncultivated, Jifarah plain, Libya.*

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I. INTRODUCTION

Fluoride belongs to the halogen group of element in the periodic table and is one of the natural components of the ecosystem. Fluoride is the most electronegative of all chemical elements and is never encountered in the nature in elemental form. It represents concentration ranged between 0.06% and 0.09% in the crust of the earth. Fluoride is an important for all forms of the life. Fluoride pollution has drawn much worldwide attention due to the detrimental aspects of its excess in the biotic components of the ecosystem. According to the world health organization fluoride concentrations in the soils should not cross the limit of 2.57 – 16.44 mg / kg soil [1]. Several researchers have determined the levels of soluble fluoride in agricultural and non – agricultural soils worldwide [2 – 6].

The soils of northeast Wales and northern Pennines contain fluoride level up to 3650 mg / kg and 20.000 mg / kg respectively [7]. [8] indicated that the soils with high concentrations of fluoride can harm the growing plants. Whereas, [9] reported that fluoride at high levels of fluoride in the soils results in chronic toxicity in the grazing animals. [10] studied the content of fluoride in the cultivated soils and reported concentration level between 219.26 and 1163 01 mg / kg soil DW. Most soils around the globe contain an average of 329 ppm [11]. Fluoride content in the sandy soils in the humid regions is less than its content in the heavy clay soils and in soils derived from weathered rocks [7]. Whereas, [12] reported that clays contain a high levels of fluoride compared with silts which are enriched with much or less fluoride.

Fluoride presents in some minerals such as fluorite, cryolite, and floroapatite. It’s also added to the ecosystem by anthropogenic activities such as application of chemical fertilizers. [13] documented that the main source of fluoride in the soils of different parts in India is the application of phosphate fertilizers. [14] believed that some minerals such as biotite, muscovite, apatite, and tourmaline in the parent material were the major sources of fluoride in the soils. Fluoride occurs in soil through the application of phosphate fertilizers, sewage sludge [15 – 17].

While, [18] reported that the lichens are good biomonitors for fluoride levels in the environment. [19] assessed fluoride concentrations in some soil samples and indicated that the obtained values were within the range of 2.57 to 16.44 ppm soil available fluoride recommended by world health organization [1].

The water soluble fluoride was assessed in the Ethiopian soils and was found between 2.3 and 16µg /g [20]. The fluoride level was investigated in the cultivated soils in Kalwakurthy mandal, Mahabubnagar district, Telangana, India and it was found from 0.11 to 0.116ppm [21].

In a study carried out in and around Mathura, Uttar Pradesh, India the mean fluoride concentration was found to be 1.41 ppm[22]. [23] reported that fluoride in the soils influenced by several factors such as agricultural activities, climate, grazing and pH. Fluoride element in the ecosystem can be influenced by anthropogenic sources [24]. While[25] assessed the contamination of soil with fluoride in Central India and reported a mean value of 490± 19 mg / kg soil. Similarly, Fluoride levels were evaluated in agricultural soils in Nigeria, and was in the range of 0.075 and 0,200 mg / kg soil [26]. [27,28] reported that a part of fluoride is released into the environment via exhaust fumes, phosphate fertilizers production and use, brick and ceramic manufacturing. Whereas, [29] documented that fluoride can be lost naturally through weathering the minerals and in marine aerosols.

However, there are some indications that the groundwater was assessed for fluoride concentration in the study area. There are no reports in the literature indicating the level of fluoride in the Libyan soils. Therefore, this study was designed and carried out to build a database for fluoride levels in the cultivated and uncultivated soils in Jifarah plain area.

II. METHODOLOGY

Jifarah plain area located between latitude 32° 30` and longitude 12° 30`, Northwest of Libya . It covers an area of 20000km^2 and is heavily populated mostly along the coast. The area is bounded on the north by the Mediterranean sea coast, on the south by Nafusah mountain .It also shares an international boundary with Tunisia to the west (Fig 1) . The area topographically is a low lying ; its topography rises slowly from the sea level along the coast to 200 m at the foot of the escarpment of Nefusa mountains. The maximum temperature is about 45°C and minimum 20°Cwith an average annual rainfall varies between 300 and of 100mm. It has a dry climate with hot summer and cold winter. Groundwater is considered the main source of water supply in the area. The dominant soils are sandy, clay and salty soils. Economically, Jifarah plain is considered one of the most important plains in Libya, the described area is known as an urban and rural area that the society mostly depends on its land resource for the human consumption. A round 60% of the irrigated areas are situated in this region. The agriculture is considered one of the most important activities in the area where barley, wheat, peanuts, vegetables and fodder crops are grown. The present study was planned to assess the concentration of fluoride in the soils and to generate a database for the levels of fluoride in the soils in the study area.

In the current study a total of 40 soil samples were collected from cultivated and uncultivated soils using Global positing system (GPS). The samples were taken within a depth range of 0 to 40 cm in January, 2018 at the selected sites from the western part of Jifarah plain area, Libya (Fig 1). The surface of each soil sampled hole was examined carefully to ensure that no stocks and remains of plants were present. The samples were collected by digging vertically and were kept in labeled clean polyethylene plastic bags and brought to the laboratories of nuclear research center, Tajoura, Libya. Analysis such as fluoride (F), electrical conductivity (EC), Nitrate (NO_3) and pH were performed using standard methods(Table 1). The concentrations of fluoride and nitrate were expressed in terms of mg / kg soil DW whereas, electrical conductivity in (µs / cm).

Table 1: Methods and instruments used to analyze the soil samples

S.N	Parameter	Test method	Instrument
1	F	(Alizarin Red Zirconyl Chloride) (1 : 10) ratio, air saturated water	UV-Vis spectrophotometer
2	NO_3	(1 : 2) ratio, 2M KCl	UV-Vis spectrophotometer
3	pH	(1 : 2) extract, measured at phases contact	Toledo MP220
4	EC	(1 :2) extract solution	WTW730

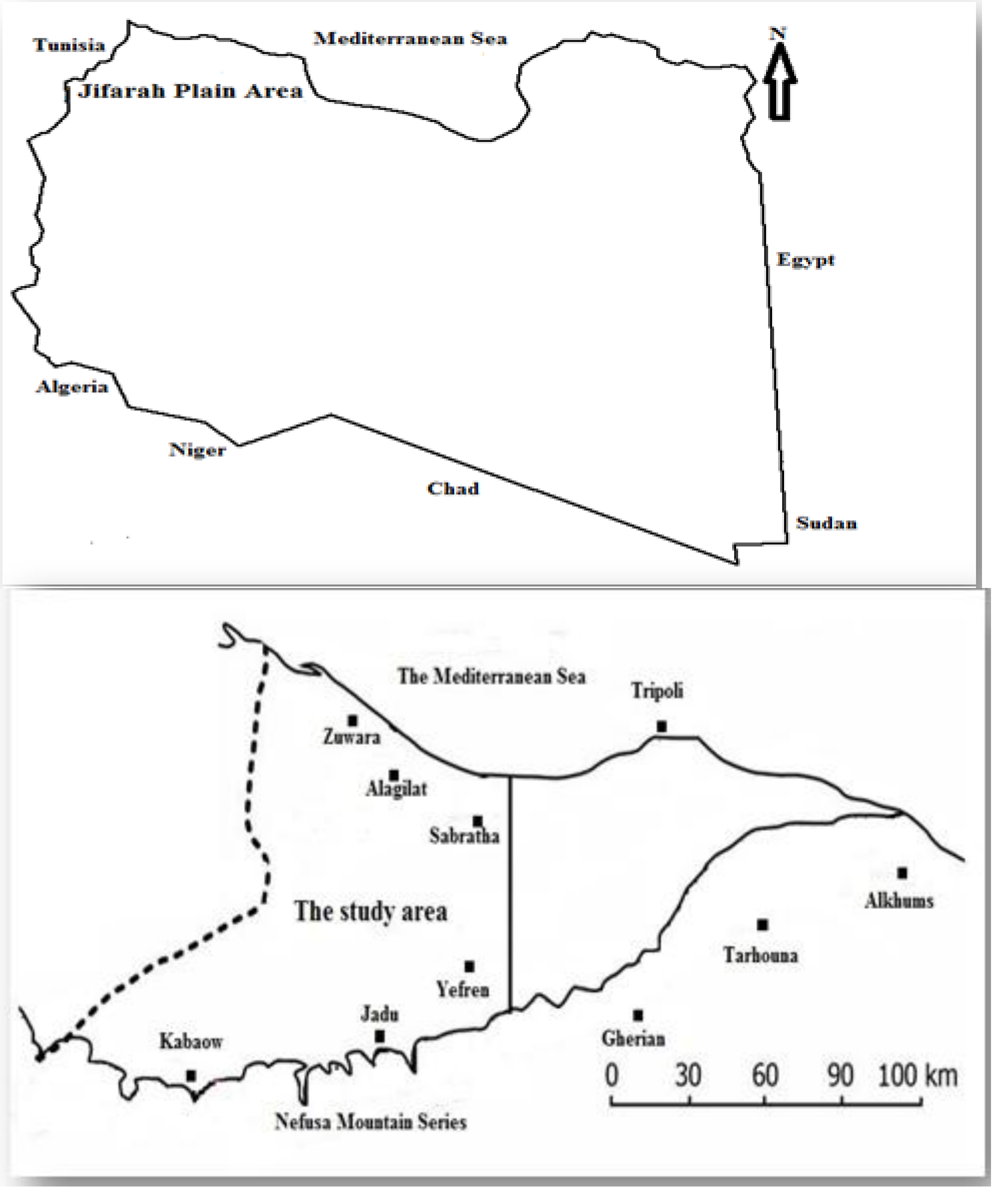

Fig 1. Map of Libya showing Jifarah plain area

III. RESULTS AND DUSSCUTION

Fluoride concentrations of cultivated and uncultivated soils in forty sites of Jifarah plain area, Libya are presented in Tables 1 and 2. Fluoride concentration in the cultivated soils samples varied from 0.03 to 41.05 mg / kg soil with an average of 9.61 mg / kg soil. The lowest value was observed in the sites numbered 2,4,6,7 and 16 whereas the highest level was recorded in site numbered 1. The results showed that around 25 % (5 samples) crossed the toxic limit of 2.57 – 16.44 mg / kg soil available fluoride stipulated by world health organization for fluoride [1]. The high levels of fluoride in the cultivated soils suggest that phosphate fertilizers have been applied to the soils in the study area.

Fluoride content in the uncultivated soils was found between 0.03 and 29.39 mg /kg soil with an average of 7.42 mg / kg soil. The minimum limit was estimated in the sites numbered 4,5,15 and 16 and the highest one was measured in site numbered 10. The obtained results revealed that the level of fluoride in 10 % (2 samples) of the total were beyond the limit 2.57 – 16.44 mg / kg soil available fluoride recommended by world health organization in soil for fluoride [1]. The results also revealed that high concentrations of fluoride in the uncultivated soils are probably due to the atmospheric depositions of gaseous and particulate emissions which can be transported from the sources by winds. In the current study, fluoride concentrations of the cultivated and uncultivated soils were found to be higher than [26,30] but less than fluoride levels reported by [25].

The results revealed that pH in the cultivated soils varied from 8.03 to 9.1. The lowest pH value was noticed in site numbered 6 while the highest one was in site 1. pH values in uncultivated soils ranged between 8.14 and 9.23 with an average of 8.72. The minimum value was observed in site numbered 2 and the maximum was noticed in site15.The electrical conductivity in the cultivated soils was in the range of 82.5 and 2840µs/cm with an average of 569.07 µs/cm. The lowest and the highest values were estimated in sites 13 and 4 respectively. On the other hand the electrical conductivity in samples collected from uncultivated soils was found between 95 and 1710µs/cm with a mean value of 244.48µs/cm. The lowest value of EC was measured in site numbered 3 and the highest one in site 5. The nitrate concentrations in the cultivated and uncultivated soils varied from 8.62 to 70.75 mg / kg and from 5.75 to 32.56 mg /kg respectively. As can be seen from the results illustrated in tables (2,3) the electrical conductivity values and the concentrations of nitrate in the samples collected from cultivated soils were higher than the levels in uncultivated soils and that probably due to the fertilizer application for prolonged period of time. There is positive coefficient correlation of fluoride concentrations with pH in the samples collected from cultivated and uncultivated soils (r = 0.571 and r = 0.457) respectively. This means that the available fluoride is influenced by soil pH, in agreement with previous observation made by [15]. Whereas EC values were negatively correlated with fluoride concentrations in the samples collected from cultivated soils (r = -0.238 and uncultivated soils (r = -0.077). This suggesting that fluoride level decreases with electrical conductivity . Similar, findings were found by [19]. The correlation coefficient between fluoride and nitrate was very poor in the both soils.

IV. CONCLUSION AND RECOMMENDATIONS

On the bases of the results, it can be concluded that the available fluoride levels investigated in the most of the samples collected from cultivated and uncultivated soils were below the critical limits of 2.57 – 16.44 mg / kg soil recommended by health organization for fluoride in soil. It also can be concluded that the natural and anthropogenic sources of fluoride have no serious deleterious effect on the biotic components of the ecosystem in the study area. Therefore, we recommend that the soils can be used for animal grazing and crop production. We also recommend that frequent analysis should be carried out to monitor fluoride levels in the soils and in the groundwater.

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Table 2: Chemical parameters in the cultivated soils of the study area

Location No	Fluoride (mg/kg)	EC(µs/cm)	NO_3 (mg / kg)	pH
1	41.05	111	14.66	9.1
2	0.03	312	19.83	8.6
3	26.98	332	12.27	8.9
4	0.03	2840	16.61	8.05
5	3.86	495	34.36	8.73
6	0.03	1746	20.25	8.03
7	0.03	1139	20.10	8.40
8	7.17	563	29.06	8.70
9	11.85	225	70.75	8.60
10	3.67	117.5	36.07	8.62
11	17.96	246	19.80	8.25
12	2.87	275	10.23	8.13
13	6.46	82.5	10.30	8.43
14	4.16	93.0	8.62	8.61
15	19.62	1791	18.12	8.50
16	0.03	240	11.43	8.56
17	8.17	86.4	11.56	8.48
18	8.12	384	20.20	8.76
19	7.58	115.1	28.70	8.28
20	22.53	187.8	12.37	8.53

Table 3: Chemical parameters in uncultivated soils of the study area

Location No	Fluoride (mg/kg)	EC(µs/cm)	NO_3 (mg / kg)	pH
1	14.08	132	16.75	8.97
2	7.95	117	23.25	8.14
3	6.94	95	11.52	9.01
4	0.03	168	8.85	8.80
5	0.03	1710	7.18	8.23
6	14.26	99.1	26.07	9.21
7	26.90	138.2	18.51	9.11
8	9.03	108.3	14.50	8.99
9	6.72	107	32.56	8.80
10	29.39	478	12.45	8.87
11	0.33	121.5	14.02	8.19
12	6.87	122.5	22.90	8.53
13	8.28	206	7.07	8.79
14	1.50	108.5	5.75	8.51
15	0.03	182.1	11.73	9.23
16	0.03	117.8	14.60	8.58
17	1.18	113.9	28.91	8.44
18	6.43	99.8	10.57	8.74
19	1.51	130.9	11.86	8.66
20	6.94	534	12.49	8.60

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