ISSN No:-2456-2165

Determination of the Fluoride Level in Groundwater Wells and Assessment of Health Associated Risks in the Aljfarah District Libya

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Abstract:- It is a well-known fact Libya is a desert and semidesert, has no significant perennial watercourses such as revers, or drinkable lucks, where Less than 2 percent of the country receives enough rainfall for settled agriculture. In the coastal lowlands and surrounded (less than ten percent of Libyan area), where 95 percent of the population are living (30), The climate is warm summers. The summer temperature in the northern coast between 26° C - 40° C and in desert interior is characterized by very hot summers between 40° C and 46° C and extreme diurnal temperature ranges. More than 97 % of Libyan population using groundwater for drinking, domestic and agriculture watering by digging wells. Due to increase of population last 50 years, the demand of groundwater is increased. On other side the ground water is suffering of human excessive use where the ground water become very deep (60 – 350 meter deep) , where many areas polluted by several minerals ions dissolved from deep rocks.The aim of this study is to evaluate and determine the concentration of fluoride ion in ground water at from 60 to 260 meter water well deep and focus on spatial distribution of fluoride in Aljfarh region and to discuss the geostatistical contamination and its effecting in fluoride generation and the relationship between excess consuming fluoride and the heath risk assessment via oral and dermal route exposure reveals that the consumers in majority of the region are at considerable non-carcinogenic at higher risk on children and adults. Also finding and helpful in identifying the affected areas at this study area and recommend that the safer options of drinking water should be adopted.

Keywords:- *High Fluoride Groundwater, Drinking Water Safety, Mechanism, Hydrogeochemistry, Human Health Risk Assessment.*

I. INTRODUCTION

Groundwater wells are important and essential source for domestic and agriculture use in Libya ((23) U.S. En. Prot. Age. 2003). Over 90% of population are located on the northern costal line of Libya and count on these resources for their daily life ((1) Wheida, E; Verheven, R. 2004). The use of such resources has dramatically increased during the recent decades however, such extensive use is not guided or controlled by proper local or government laws [(1) Wheida, E; Verheven, R. 2004].

Water for human use and consumption must fulfil strict guidelines of taste, smell and contents as well as certain parameters of components such as standard level of minerals (e.g. Cl, Na, F, Ca, Ph, NH_3), trace elements (e.g. Al, Cu, Pb, Fe, Cd, Cr) and components of hydrocarbons [(24): The Environmental Protection Agency, Ireland. 2001; Parameters of Water Quality 2001]. These standards can be affected and altered by many environmental and anthropogenic factors including microbial contamination, and pollution with chemical and waste products and deep underneath rocks leading to serious health problems [(25) Chidozie P. E., Imokhai T. T., Peter J. 2018]. For instance, the high or low concentrations of certain ions such as (fluoride $^-$, chloride, magnesium and calcium ions, can cause various diseases, illnesses and permanents damages in vital organs such as kidney, liver and skeletal system (26).

Fluoride ions usually present in water and soil and has high reactivity and electronegativity property [(2) Totsche et al. 2000]. It is essential for normal mineralization of bones and formation of dental enamel at standard and recommended level (i.e. between 0.5mg/l to 1.5mg/l) (WHO, 20??). However lower concentration (i.e. <0.5 mg/L) can induces dental caries [(8,9) Harrison, P. T. C. 2005, Gao, H., Jin, Y. & Wei, J. 2013], [(3) Bell and Ludwig 1970)]. Sorg 1978; Mahramanlioglu et al. 2002). Its recommended levels vary between countries leading to significant damages to human health [(27, 22) Biglari et al., 2016]. Fluorosis is referred to excess of fluoride ion causing serious clinical conditions and diseases. It is affecting more than 200 million people worldwide (among 25 nations) caused mainly by contaminated drinking water (Ayoob and Gupta 2006; Hong-jian et al. 2013 [30]; Moghaddam and Fijani 2008; Oruc 2008 [31]; Fordyce et al. 2007 [32]; Ghosh et al. 2013 [33]; Mesdaghinia et al. 2010[34]). For instance, in India and China fluoride level is often above 1.5 mg L- causing severe health problems (REF). Around 80 % of global diseases are associated with low income and poor countries of which fluoride contamination in drinking water is responsible for 65 % of endemic fluorosis (Felsenfeld and Robert 1991). According to the WHO, only 18 % of Libyan population consume standard level of fluoride in drinking water although the Libyan standards and management centre no 82/2015

ISSN No:-2456-2165

allows only 1.5 mg/l of fluoride in dinking water, but no official or available data on the harmful effect on human populations (28].

To the best of our knowledge, there are a lack of literature in Libya with no previous investigation in the studied region in this regard and determine of fluoride ion. Therefore, the aim of this study is to evaluate and determine the concentration and focus on spatial distribution of fluoride in this region and to analyse and discuss the interrelationship between fluoride and other water quality parameters. Also adopt geostatistical contamination and its effecting in fluoride generation. Finally, assess the health risks associated with fluoride concentration in groundwater. To establish a more realistic base for judgement, ingestion and dermal pathways were investigated. This study will assist in adding relevant data to local rural water management, policy and decision makers to take adequate measures in safeguarding the lives of residents in endemic. A total of eight different areas inside AlJfarah district were selected and a total of twenty-one groundwater wells at these towns and villages were included in the study. The study took place between in February-March 2020. The area of study is located in the north west region of Libya and boarded from north to the Libyan capital-Tripoli and Mediterranean Sea. It has one of highest population in the country and has several towns and villages surrounded by farms. The consumed water in this area originates mainly from drilled wells aim to support human consumption as well as agricultural and industrial needs.

II. METHODS AND RESULT

- *Collection of water samples*

Water samples were collected from each groundwater well using clean plastic containers. They had been rinsed then filled with 200 ml of water sample and closed firmly. All samples were packaged and stored at room temperature in clean dry box and transported to the Laboratory of the Food and Drug Control in Tripoli for analysis within 24h. Samples were Evaluation of odour, colour, transability and drinkability of water wells**.**

- *Chemical analysis*

The fluoride concentration in water samples was determined at the Food and Drug Control Laboratory using Thermo Scientific Orion Star A214 Benchtop pH/ISE meter, using the USEP ion selective electrode method. A volume of 2 ml of total ionic strength adjusting buffer grade III (TISAB III) was added to 20 ml of water sample. All analysed samples showed their normal physical proports, they were free of any odour and colour and have full transability, but slightly different taste. The chemical analysis of fluoride determination showed that most of ground water at AlJfarah district (Fig 1) has excess of fluoride content practically south part of this area particularly in Alnasryah , Alaziziyah towns and surrounded , specially at the deep water wills. Table 1 gives a clear indication of affective of depth on fluoride contents.

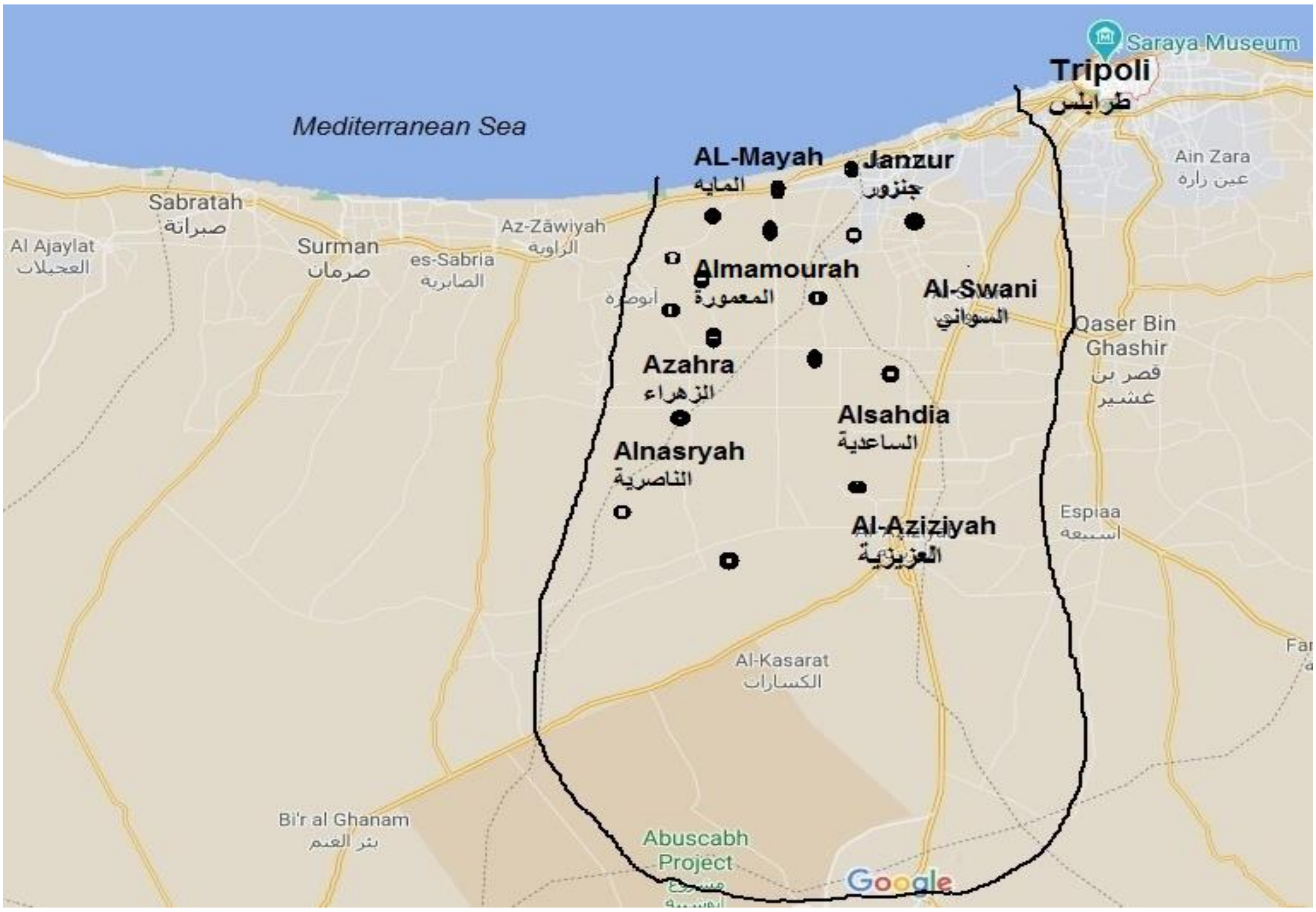

Fig 1 The Location of study area at Al-Jfarah district

Table 1 shows the relationship between the fluoride contents, location and depth of water well.

Table 1. Result of fluoride analysis

Sample No.	Sample location	Depth in meter	Fluoride in mg/l	WHO F^- 1.5mg/l
1	Al-Zahra (AZ)	220	5.60	+ 4.10
2	Al-Swani (AS)	150	1.02	- 0.48
3	Al-zahra centre (AZ)	180	5.2	+ 3.70
4	North Al-mamourah (MA)	60	0.02	- 1.48
5	Al-mamourah (MA)	120	1.00	- 0.5
6	Al-swani (AS)	240	3.80	+ 1.30
7	Al-nasryah (AN)	240	10.00	+ 8.50
8	Al-sahdia (ASA)	180	7.20	+5.70
9	West Al-aziziyah (AZI)	240	4.40	+ 2.9
10	South Janzour (JA)	160	1.53	+ 0.03
11	Janzour (JA)	60	0.02	- 1.48
12	South Al-Zahrah (AZ)	240	5.60	+ 4.1
13	West Al-aziziyah (AZI)	200	4.72	+ 3.22
14	West south Al-aziziyah (AZI)	120	4.76	+ 3.26
15	Al-aziziyah centre (AZI)	220	5.90	+ 4.4
16	Al-mayah gov. water (AM)	N/A	4.24	+ 2.75
17	West Al-zahra (AZ)	180	5.04	+ 3.54
18	South Al-zahra (AZ)	180	5.68	+ 4.18
19	Al-mayah (AM)	70	0.24	- 1,26
20	South Al-nasryah (AN)	280	8.75	+ 7.25
21	Nasryah Gov. water	N/A	10.5	+ 9.0

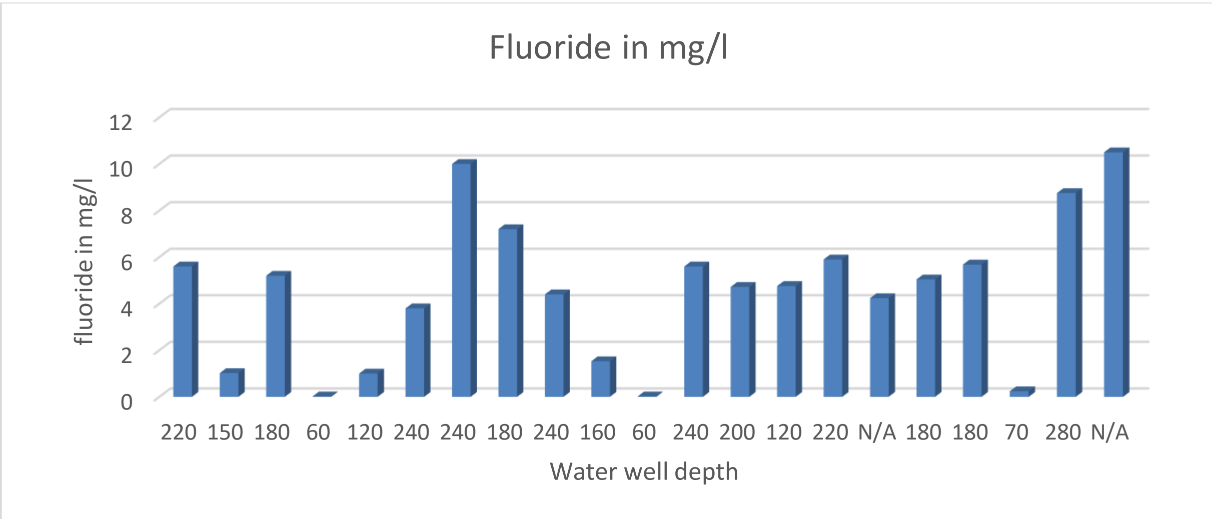

Fig 2

III. DISCUSSION

Groundwater can be contaminated by fluoride ion due to process occurring from untreated wastewater from industrial plants, solid disposal and agrochemicals and any other storage leakage. While the natural contamination of groundwater causing due to geological environments including volcanos and soil rocks, caused by weathering of the fluorine-rich rocks such as fluorapatite (Ca5(PO4)3F, fluorite (CaF2) and, cryolite (Na3AlF6) in the deep water well [Ramamohana Rao et al., 1993b; Subba Rao, 2017)]. The geochemical process or mobilization of fluoride in groundwater is still not understood clearly (Hem 1985). However, groundwater with rich bicarbonate type water in a weathered rock formation/rock water interaction always accelerate the dissolution of fluoride-bearing minerals, thereby release the fluoride into groundwater (figure 2). This will lead to increases the concentration of fluoride in the groundwater and causing the main natural contamination, where they can be an affecting factors that limit its usage for human consumption [(6) Brindha, K. and Elango, L. (2011)].

$$CaF_2 + 2HCO_3 \longrightarrow CaCO_3 + 2F^- + H_2O + CO_2$$

It has been proposed that regularly consuming water with fluoride concentrations of at least 0.9 mg/l is the cause of at least 37% of dental fluorosis cases [(17) McGrady et al., 2012)]. Also correlated fluoride in drinking water with bone diseases (Osteo-sarcoma) in adolescents and children [(18) Levy and Leclerc (2012)]. Sun L. discovered that cases of hypertension in adults could be linked to fluoride present in drinking water [(19) Sun L. et al. (2013)].

The fluoride determination results of Al-Jfarah district ground water showed variety features between 0.02 and 10.5 mg/l. At the north area and at the dept between 60 and 150 meter the ground water is under the Libyan and WHO standard (1.5mg/l). In the towns of Janzour, Almayah, Almamourah, Alswani and Alzahra the fluoride level is under the WHO standerad if the drilled water well where between the upper water level and 150 meter dept, but the fluoride increases if the drilling more than 160 meter dept. In Alnasryah, Alsahdia and Alaziziyah where the level of ground water is more than 150 meter dept, the fluoride content increases to more than 5 mg/l. At 240 meter dept and more the fluoride contents reached 10.5 at Alnasryah village.

Due to its strong electronegativity, fluoride is attracted by positively charged calcium in bones and teeths [(6) Susheela et al. 1993)]. Also causes nervous system damage [(12) Kaoud and Kalifa, 2010)], reduced fertility [(13) Izquierdo-Vega et al., 2008)], intellectual impairment in children [(14,15) Ding et al., 2011; Shivaprakash et al., 2011)-, urinary tract disease [(16) Jha et al., 2011)], as well as intensive dental and skeletal fluorosis in children (Maguire, 2014). In turn, this can lead to significant lower back pains (Namkaew and Wiwatanadate, 2012). it also increases the risk or susceptibility to cancer bone deformities depending on the duration and dosage of fluoride consumption [2,5–12]. could cause an increase in plasma Endothelin-1 (ET–1) levels. Liu also identified a link between fluoride exposure from drinking water and carotid artery atherosclerosis in adults [(20) Liu et al. (2014)]. In a recent study conducted by Irigoyen-Camacho, reports showed that increased morbidity and mortality rate could be correlated with nutritional deficiencies propagated by fluoride intake [(21) et al. (2016)]. In addition, However, this should also be placed in the context of water scarcity, population growth and access to clean water in the region of high concentrations fluoride in humans.

Due to raise in population and their daily needs, threats to groundwater have been increasing every day. The pressure on this resource has become enormous, overexploitation and improper management has also led to contamination of this resource. The degradation of groundwater may be due to natural like inherent geological or anthropogenic processes from wastewater. Usually people use groundwater for their daily live without any physical or chemical treatment, which led to number of health disorders.

IV. CONCLUSION

This review indicates the fluoride distribution and its contamination in groundwater at Aljfarah district with its assessed of human heath. It is very risky at high concentration for the skeletal system specially on toot fluorosis for adults and children. It can be concluding this study in followed points:

- Fluoride concentration is increase at south area of AlJfarah.
- Fluoride also increase since the depth of groundwater well increase.
- Excess of Fluoride ion in groundwater can lease to human diseases and harmful for animal and plants.
- study to clarify the causing of fluoride in the groundwater is important.
- People live at the high level of Fluoride in this region should treat the domestic water before their consumption.
- Finally; further deep study on fluoride ion should be carried out on this area specially geological task to indicate the main cause of fluoride on agriculture to find out the affection of fluoride on plants, veges and even on animals.

ACKNOWLEDGMENT

Thanks should be sent to the heath authority of Aljfarah district and to the laboratory of the Food and Drug Control for doing the water samples analysis.

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