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# EVALUATION OF CHEMICAL CONCENTRATIONS FOR LIQUID MEDICAL WASTE

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**Abstract**

Health waste is defined as infectious or hazardous medical or biological waste that, due to its properties, leads to or contributes significantly to an increase in mortality or serious diseases that are permanent or disabled. They also pose a potential risk to human health or the environment when improperly treated, stored, transported, disposed of or managed. Therefore, the research dealt with important chemical analyzes of liquid medical waste for a public health center and a specialized dental center over a period of six months of the year to fully identify how to treat this waste and the efficiency of treatment units. The results showed that the concentrations of chemical analyzes for the health center are higher than the concentrations recorded for the dental center. The acidity function and the phosphate ion are somewhat acceptable during the specified months. Sulfate and electrical conductivity were high in the sixth month of the year. A significant increase in the concentrations of biological requirement on oxygen (BOD), which represents the amount of oxygen needed by microorganisms to break down organic matter, as well as a significant increase in the chemical requirement for oxygen (COD), which represents the concentration of organic matter indirectly. This indicates the presence of high bacterial contamination that needs to be treated and followed

**Keywords**: Acidity Function, BOD, COD, Phosphate ion, Sulfation.

## Introduction

One of the important environmental issues is the medical waste of hospitals due to the environmental and health hazards that threaten individuals, society in general and hospital workers in particular, due to the rapidly spreading diseases and epidemics it contains[1]. Medical waste has taken the following definition as all solid, liquid or gaseous waste resulting from various medical care institutions, medical laboratories, medical research centers, factories and warehouses of human and veterinary medicines, veterinary clinics and home nursing institutions[2].Medical waste (hazardous), which is that part of medical waste that can cause health risks, and is classified into infectious waste, which is waste that contains infectious pathogens (bacteria, viruses, parasites, and fungi)[3], and includes media and materials used for infectious disease analyzes in laboratories, waste from patients isolated in the infectious diseases unit, dialysis unit waste from devices, filters, gloves, covers, shoes, single-use bibs, contaminated cotton and gauze garbage, swabs, and other waste contaminated with patient secretions..



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Anatomical waste that has to do with the patient's body or its components of tissues[4], amputated parts or embryos, as well as sharp waste and represent tools that may cause cutting or tingling in the human body such as syringes, needles, glass ampoules and scalpels used in surgeries and pieces of broken glass[5].There are also chemical wastes and include solid, liquid or gaseous waste resulting from personal, therapeutic or experimental work, cleaning, disinfection or management, and is characterized by being toxic, causing corrosion of surfaces and tools, fast Flammable and fast reaction[6].. Finally, pharmaceutical waste, which are raw materials, medicines and pharmaceuticals that are expired or non-conforming to specifications or that no longer have a use for one reason or another, as well as some solid and semi-solid, liquid and gaseous pharmaceutical industry waste. Large variety and different from disease microbes[7]. Chemical and pharmaceutical waste used in health institutions is among the sources of harm to workers and the surrounding environment, some of which are toxic chemicals and cancer-inducing substances and mutations in the human cell and wildlife, in addition to the presence of other chemicals that are incendiary and quickly flammable and explosive[8]. Or by inhalation or swallowing . The process of discharging chemical residues into the public sewage network (sewage) may lead to vital environmental damage due to the inability of sewage treatment plants to eliminate and dispose of these materials compared to the ease of disposal of microbes[9]. As for pharmaceutical waste, it has destructive effects on natural ecosystems, such as drug residues from antibiotics and drugs used to treat cancer diseases, which have the ability to kill existing microorganisms necessary for those systems[10]. As well as the possibility of mutations and deformations of the surrounding organisms.. The presence of large quantities of liquid medical waste[11] resulting from hospitals mixed with heavy metal residues such as mercury, phenolic compounds and its toxic derivatives and some products of sterilization and disinfection materials contributes to the destabilization of these systems[12]. Radiomedical effect of the two on the genetic content of cells. .Dealing with sources of active radioactive[13] substances in the diagnosis and treatment of certain diseases causes significant damage in the destruction of human tissues and cells. Less active radioactive waste damage contaminates the outer surfaces of the tools used, or due to poor storage of these materials[14].Garbage collectors are exposed to many problems such as injuries and wounds as a result of exposure to sharp objects such as syringe needles, razors, glass breakages mixed with patients' secretions or cotton and gauze contaminated with patients' blood, causing infections and serious diseases such as viral hepatitis[15]. And also infection with skin diseases such as eczema, blisters, suppurations and infections resulting from fungi[16].Medical effluents cause many diseases of the respiratory system and lungs due to inhalation of dust loaded with pathogens or chemical particles causing acute and chronic catarrh and asthma. Medical waste causes environmental hazards such as distortion of the landscape and the emission of unpleasant odors, as well as affecting the biological system in the area where waste[17]. accumulates by bringing in rodents and insects[18].. The gases emitted from landfills are mainly methane and carbon dioxide.These gases are considered greenhouse gases whose rise plays a role in global warming and raising the temperature of the planet in the long term[19].According to



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many sources and global studies, landfills can cause contamination of drinking water if not built in appropriate ways[20]. Improper incineration or incineration of inappropriate materials results in the release of pollutants into the air and ash residues[21]. The incineration of chlorine-containing substances generates dioxins and furans, which are cancer-causing substances in humans and have been linked to a wide range of harmful health diseases[22]. The incineration of heavy metals or materials containing heavy metals such as lead, mercury and cadmium leads to the spread of toxic metals into the environment. Therefore, materials containing chlorine or heavy metals should not be incinerated[23].the aim of this study Assessing the environmental reality of health centers in the city of Kirkuk as a model for the reality of health institutions operating in Iraq.Highlighting the environmental problems faced by these institutions, whether in terms of the treatment of liquid waste in terms of the availability or non-availability of treatment units for such waste.Knowing the efficiency of treatment plants in removing some heavy metals from waste water in health centers (health center, specialized dental center)Knowing the percentages of outgoing concentrations in rivers.The extent to which they conform to the environmental determinants of the offering in rivers[24].

## 3- Practical part

### 3-1- Sample Collection

Samples of (12) liquid medical waste were collected. (6) taken from a public health center and (6) from a specialized dental center over a period of (6) months of the year (October, November, December, January, February and March). As well as the effectiveness of pollutant treatment devices in medical institutions.

### 3-2- Chemical Analysis

#### 3-2-1 -PH Function

The pH Function was measured by a pH meter. in pH-meter are used stirr, thermometer, flask, distilled water. First wash the electrode with distilled water and then dry it completely. A quantity of a known pH solution is placed in a clean, dry Baker (50 ml). solutions with a pH (4,7,10) are usually used. The electrode of the device is placed in the solution (avoiding the contact of the electrode with the base of the baker). the electrical current connected to the device, then move the solution carefully to avoid breaking the electrode and then note the reading of the device.. Next, a quantity of the pH sample is taken by a clean and dry baker. The electrode is placed in the solution and reading of the device is recorded after the indicator stabilizes. Finally,,The electrode is lifted, washed with distilled water, dried and then placed in adistilled water [25].

#### 3-2-2- Electrical conductivity

Examination is used using a Conductivity device. TUCK. C° meter) from this it turns out that it is a versatile device and is converted as needed for the type of examination. For example, for the purpose of finding the electrical conductivity of a particular model, the following is done: the indicator of the device is converted to the electrical conductivity indicator. The inspection device is calibrated by standard solutions with known electrical conductivity and is attached to the device and these solutions are read



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with a temperature set. Then the electrode of the device is inserted into the model and then the reading is recorded directly from the device, which represents the electrical conductivity of the model in units (μs), knowing that the electrode of the device is washed with distilled water after each inspection[26]

**3-2-3 -Determination of sulfate ion ($SO_4^{-2}$)**

The sulfate is deposited with barium chloride in an acidic medium to form a white precipitate of barium sulfate, and this precipitate is kept in a suspended form by adding the conditioned solution, so we have a turbid suspension whose turbidity is measured by the turbidity device, and the relationship between sulfate concentration and turbidity is a direct relationship[27]

**3-2-4 - Determination of phosphate ion concentration ($PO_4^{-3}$)**

Add one drop of phenolphthalein dye to 100 ml of the colorless and turbid form, if discolored, add a strong acid solution until the color disappears. 4 ml of aluminum molybdate solution and ten drops of tin chloride solution are added with shaking, where a blue color is formed, depending on the intensity of the phosphate concentration. After 10 minutes and not more than 12 minutes, the absorption is measured using a spectrophotometer at a wavelength of 690 nm and using distilled water as a plank for zeroing. The magnitude of light transmittance during the model solution is compared with the values of a standard graph drawn from the Curve Calibration[28]

**3-2-5- Determination of Nitrate ion Concentration $NO_3^-$**

Put a volume of 50 ml of the form (and add 1 ml of hydrochloric acid) to prevent the interference of the hydroxide ion and carbonate in the model to a concentration of 1000 mg/l in the form of calcium carbonate. Put a volume of 50 ml of distilled water, add 1 ml of hydrochloric acid and use as planck. Absorbance is measured at a wavelength of 220 nm. Absorbance is measured at a wavelength of 275 nm and subtracts from the pre-removal absorbance any interference of organic matter. The absorption value is compared with the values of the standard curve in force For this purpose. To make the standard curve, a set of standard solutions of 0-7 mg/L of nitrate is prepared by taking volumes of (0.2, 4, 6, 8) ml respectively from the original standard solution. Each standard solution is treated as a form and then diluted to 50 ml with distilled water. The absorbance of these standard solutions is measured at a wavelength of 220 nm and the standard curve between the concentration of these solutions and their absorption values is drawn Planck is used to read zero (and it is prepared from taking a quantity of distilled water instead of the standard solution and adding the same quantities of chemicals added to the model and treated as the model .The concentration is calculated by a device (spectrophotometer) [29].

**3-2-6 (Biochemical-Oxygen-Demand) (BOD)**

This important analysis was carried out at the Department of Environment and Water. The percentage of oxygen consumed in biological processes is very important and very low values of BOD indicate either that the water is clean, as the bacteria present do not



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consume the organic compounds present, or that the bacteria present are dead or they die that the value of the requirement or consumption of oxygen in the biological processes carried out by microorganisms in water, referred to as bioconsumption or biochemical requirement of oxygen (BOD). Biooxygen consumption is not itself a pollution factor but an indicator of the amount of oxygen consumed by microorganisms and bacteria involved in the process of organic disintegration .The first tests to determine biooxygen consumption are performed to determine oxygen in a stream by immersing two bottles, the amount of dissolved oxygen is determined in the first bottle while the other bottle remains in the stream for several days and then the amount of dissolved oxygen is determined in the second bottle. The difference in the level of dissolved oxygen determines the consumption of biooxygen, and Po expresses one concentration of mg of oxygen per liter of sample mg/L. This test has an important advantage as the water in the bottle is subject to the same environmental factors affecting the water in the stream, and therefore it is an accurate measure of the amount of dissolved oxygen use in the stream. It is impossible to compare the results of more than one stream due to the presence of three important non-constant variables: temperature, time and light. Temperature has a clear effect on oxygen absorption, due to which metabolic activity increases significantly at elevated temperatures. The test time is also important, as the amount of oxygen consumed increases with time .Light is also an important factor, as natural water contains algae and oxygen that can grow within the bottle if light is available. The difference in the amount of light will affect the final concentration of oxygen. The standard biooxygen consumption test requires that the measurement be carried out in the dark at 20°C for five days. The five-day consumption of biogen is the oxygen used by microorganisms in a sample of water during these first five days after sampling. Choosing five days is a compromise between doing a test for a period not long enough to get results, Or the test work for so long that anaerobic bacteria and mold in the bottles affect the consumption of biooxygen. Biooxygen consumption testing is usually performed within special standard bottles. The test is first carried out by measuring dissolved oxygen or saturating the sample with dissolved oxygen at the same temperature at which it will be stored, usually stored at 20°C. The dissolved oxygen in the samples is then measured every day for five days[30].

**3-2-7 (Chemical-Oxygen-Demand) (COD)**

It is the measurement of the concentration of organic matter in water and domestic and industrial waste water. It depends on the oxidation of the organic materials in the sample with strong oxidizing chemicals such as dachrome ammoniac ferrous sulfate, from which the concentration of organic matter in the sample is inferred. The method used in the measurement is (Open Reflex Method) A certain size of the sample and according to the concentration of organic matter in it are placed in the added heating flask. Vitreous containing boiling stone and mercury sulfate powder. Place in a glass heating flask as much distilled water as the size of the model with the same amount of mercury sulfate powder .



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Then quietly and with cooling to each of the two decans a part of concentrated sulfuric acid is added and then the specified amount of potassium dichromate solution is added. Both flasks are connected in a condenser with cooling water open through it. Complete the addition of the remaining part of the sulfuric acid through the upper condensate hole and then block this hole by placing a small glass baker on top of it. Both the sample solution and the plank are heated for two hours at a boiling point. Stop heating and leave both the sample solution and the plank bound to the condenser to cool to room temperature. Complete each to the required volume with distilled water and add three drops of ferron reagent dye. The excess amount of potassium dichromate in both sample and planck solutions is allowed with ammoniac ferrous sulfate solution until the color changes from greenish blue to reddish-brown[31]

**Results and Discussion:**

**4-1-The results of Chemical Analyzes of medical effluent (liquid) of the health center:**

Table (1) shows the values of chemical analyzes conducted on (6) samples of medical effluent taken from a public health center and for six months of the year (October, November, December, January, February, March) The results showed that there is an increase in concentration (EC COD, BOD, $SO_4^{-2}$, $PO_4^{-3}$) after comparison with the reference values and the reason may be due to the lack of good waste treatment, which led to its rise above the normal limit .We notice an increase in COD values, which is an indication of the presence of chemicals in high proportions offered by the center due to the use of detergents and chemicals. We observe a rise in BOD values, which is an indication of the presence of widespread organic pollution in the field of wastewater, and the absorbed biooxygen is usually formed due to foamed and dissolved organic matter, the amount of oxidized organic matter and the action of microorganisms. We also observe a rise in $PO_4^{-3}$values in the first months due to temperatures. We note that the values of $SO_4^{-2}$ have become high concentrations that exceeded the environmental determinant and this is due to the use of chemicals, dyes and ointments containing large amounts of sulfates. The value of electrical conductivity increased because sulfate ions are high in addition to the presence of iron and copper deposition .

Table (1): shows the values of chemical analyzes conducted on (6) samples of medical effluent taken from a public health center and for six months of the year (October, November, December, January, February, March).

| **Analysis** | | | | | | | **Months** | **sample** |
|---|---|---|---|---|---|---|---|---|
| $NO_3^{-1}$ mg/l | **$PO_4^{-3}$ mg/l** | **$SO_4^{-2}$ mg/l** | **BOD mg/l** | **COD mg/l** | **EC µm/cm** | **PH** | | |
| 22 | 4.8 | 266 | 73 | 115 | 950 | 6.0 | 1 | **Chemical Analysis of 6 Samples of Medical Effluent Taken from the Health Center** |
| 22.8 | 4.2 | 300 | 85 | 119 | 1000 | 6.8 | 2 | |
| 22 | 4 | 365 | 98 | 125 | 1248 | 7.1 | 3 | |
| 22.5 | 3.67 | 366 | 160 | 188 | 1650 | 7.3 | 4 | |
| 26 | 2.5 | 455 | 195 | 205 | 2430 | 7.8 | 5 | |
| 31 | 2 | 475 | 234 | 260 | 2584 | 8.2 | 6 | |
| 50 | 3 | 400 | 40 | Less then 100 | 2000 | 6-9.5 | 6-9.5 | **Reference values** |



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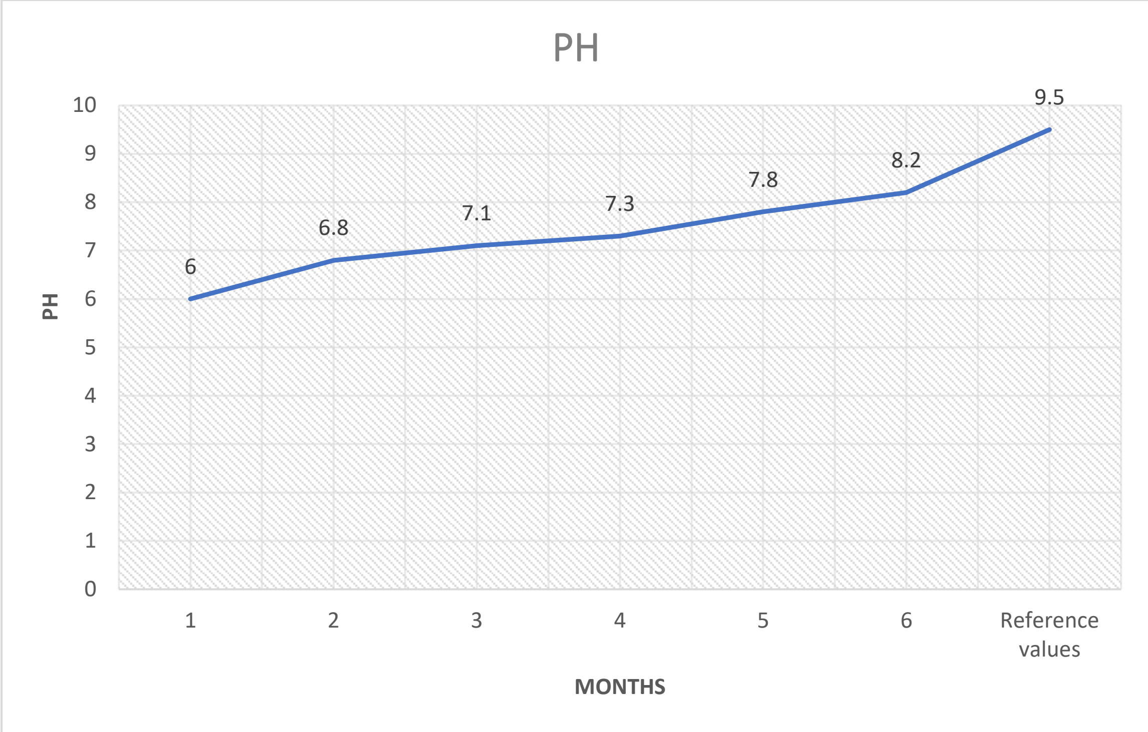


Figure 4-1: shows the laboratory results of the pH function of medical effluent over a period of six months of the year (for a health center).

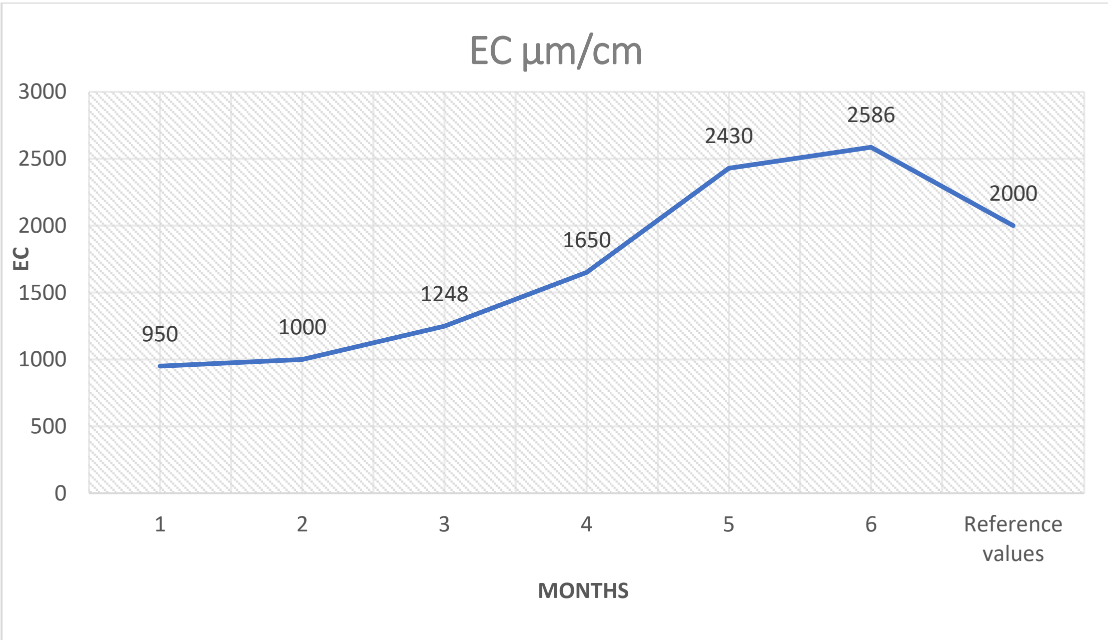


Figure 4-2: shows the EC laboratory results for medical effluents over a period of six months of the year (for a health center).



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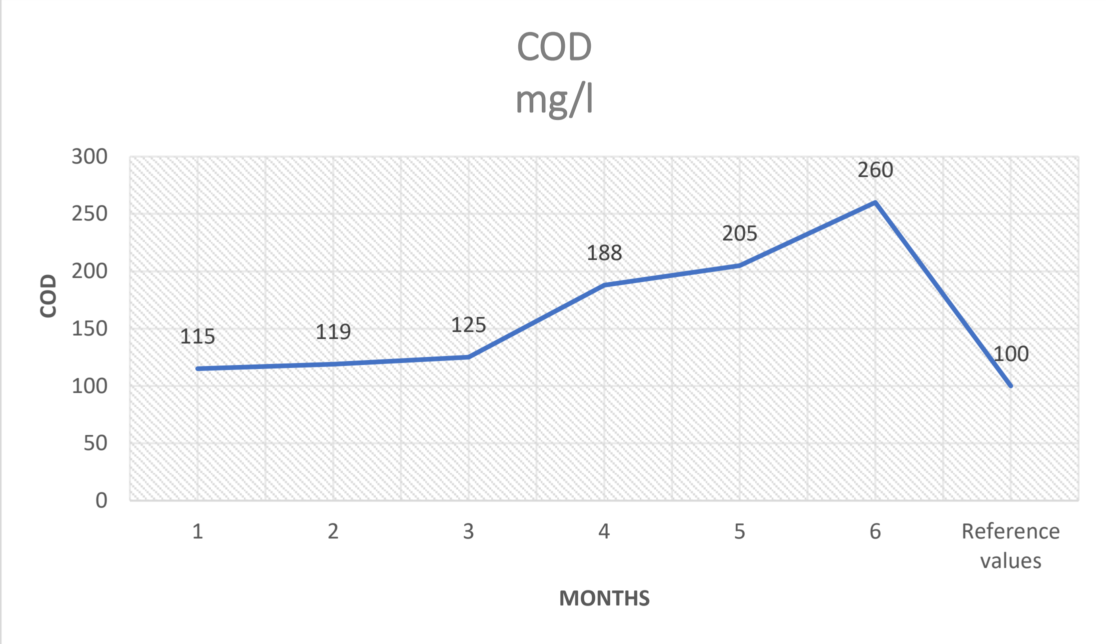


Figure 4:3shows the COD laboratory results for medical effluents over six months of the year (for a health centre).

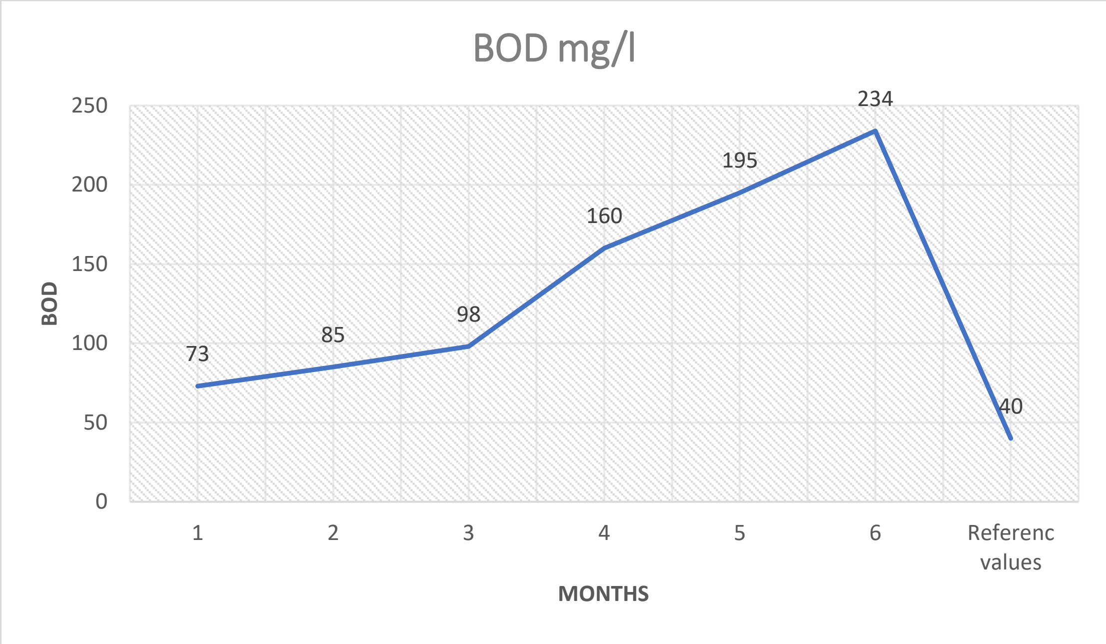


Figure 4-4 shows the laboratory results BOD for medical effluents over six months of the year (for a health center).



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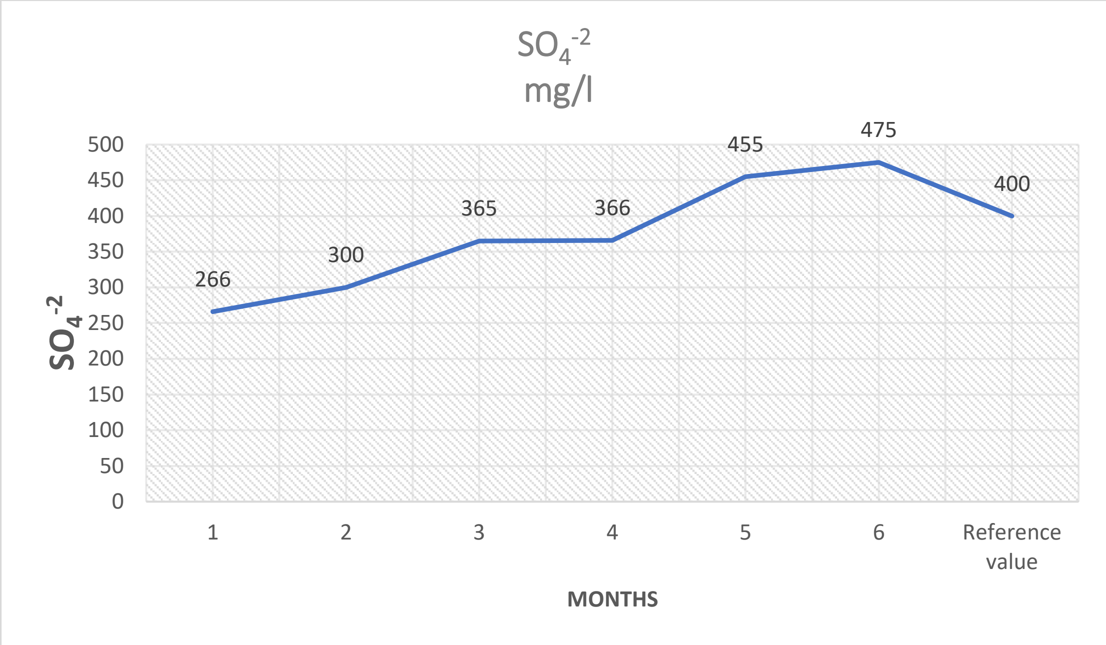


Figure 4-5: shows the laboratory results $SO_4^{-2}$for medical effluents over six months of the year (for a health center).

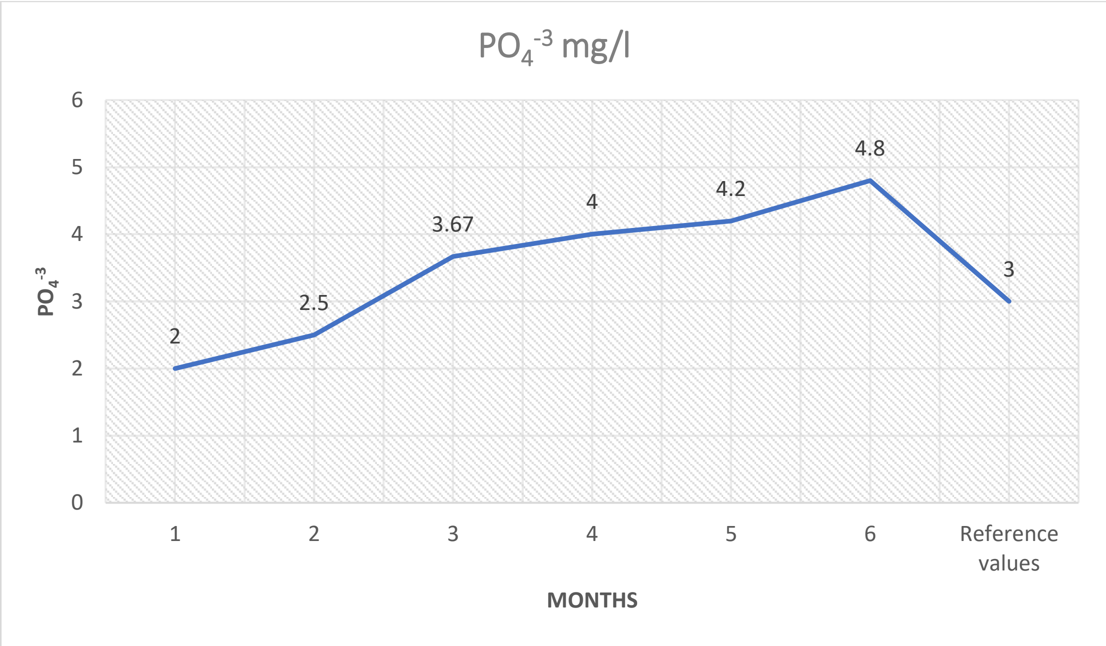


Figure 4-6 : shows the laboratory results $PO_4^{-3}$ for medical effluents over a period of six months of the year (for a health center).



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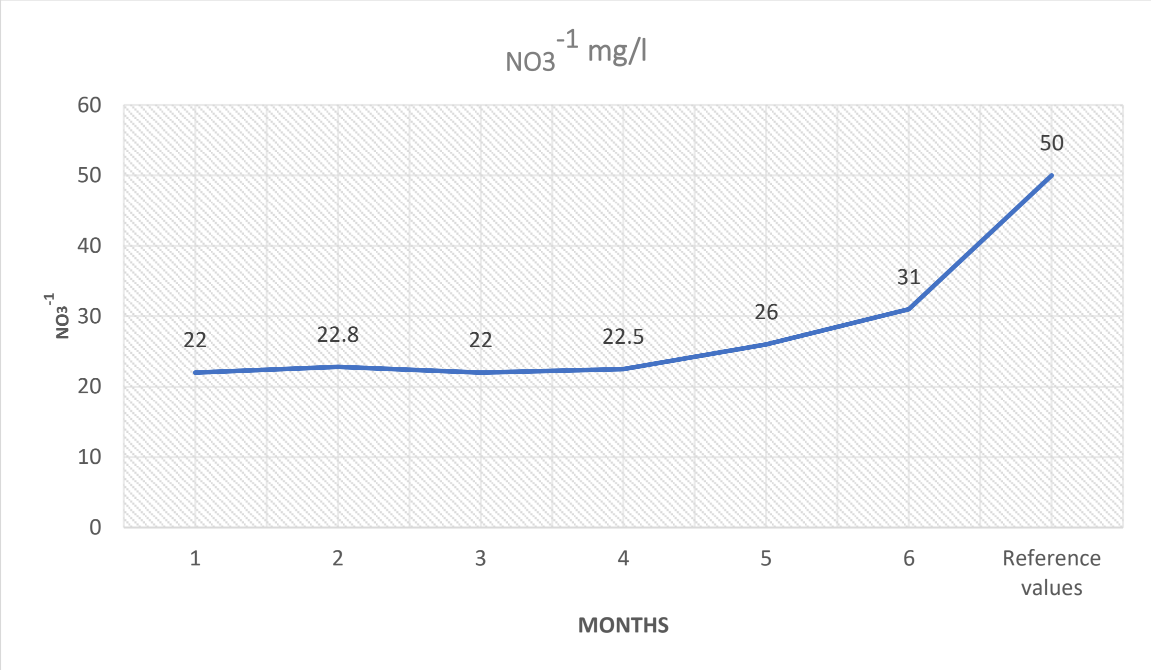


Figure 4-7 shows laboratory results for $NO_3^-$ medical effluents over six months of the year (for a health centre).

**4-2- Results of chemical analyzes of medical effluent(liquid) of the Specialized Dental Center**

Table (2) shows the values of chemical analyzes conducted on (6) samples of medical effluents taken from a public center and for six months of the year (October, November, December, January, February, March) The results showed that there is an increase in concentration (EC COD, BOD, $SO_4^{-2}$, $PO_4^{-3}$) after comparison with the reference values and the reason may be due to the lack of good treatment of waste, which led to its rise above the normal limit. We notice an increase in COD values, which is an indication of the presence of chemicals in high proportions offered by the center due to the use of detergents and chemicals. We observe a rise in BOD values, which is an indication of the presence of widespread organic pollution in the field of wastewater, and the absorbed biooxygen is usually formed due to foamed and dissolved organic matter, the amount of oxidized organic matter and the action of microorganisms. We also observe a rise in $PO_4^{-3}$ values in the first months due to temperatures. We note that the values of $SO_4^{-2}$ have become high concentrations that exceeded the environmental determinant and this is due to the use of chemicals, dyes and ointments containing large amounts of sulfates. The value of electrical conductivity increased because sulfate ions are high in addition to the presence of iron and copper deposition.



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Table 2 :Chemical analysis of 6 medical effluent samples taken from a specialized dental center.

| Analysis | | | | | | | Months | sample |
|---|---|---|---|---|---|---|---|---|
| $NO_3^{-1}$ mg/l | $PO_4^{-3}$ mg/l | $SO_4^{-2}$ mg/l | BOD mg/l | COD mg/l | EC µm/cm | PH | | |
| 18.5 | 3.11 | 250 | 66 | 100 | 866 | 6.2 | 1 | Chemical Analysis of 6 Medical Effluent Samples Taken from a Specialized Dental Center |
| 15 | 3.5 | 284 | 68 | 122 | 970 | 6.1 | 2 | |
| 15 | 3 | 301 | 91 | 119 | 1200 | 6.5 | 3 | |
| 16.3 | 3.1 | 388 | 125 | 175 | 1697 | 7 | 4 | |
| 15.1 | 2.3 | 390 | 168 | 189 | 2100 | 7.6 | 5 | |
| 26 | 1.44 | 404 | 193 | 233 | 2430 | 7.9 | 6 | |
| 50 | 3 | 400 | 40 | Less then 100 | 2000 | 6-9.5 | 6-9.5 | Reference values |

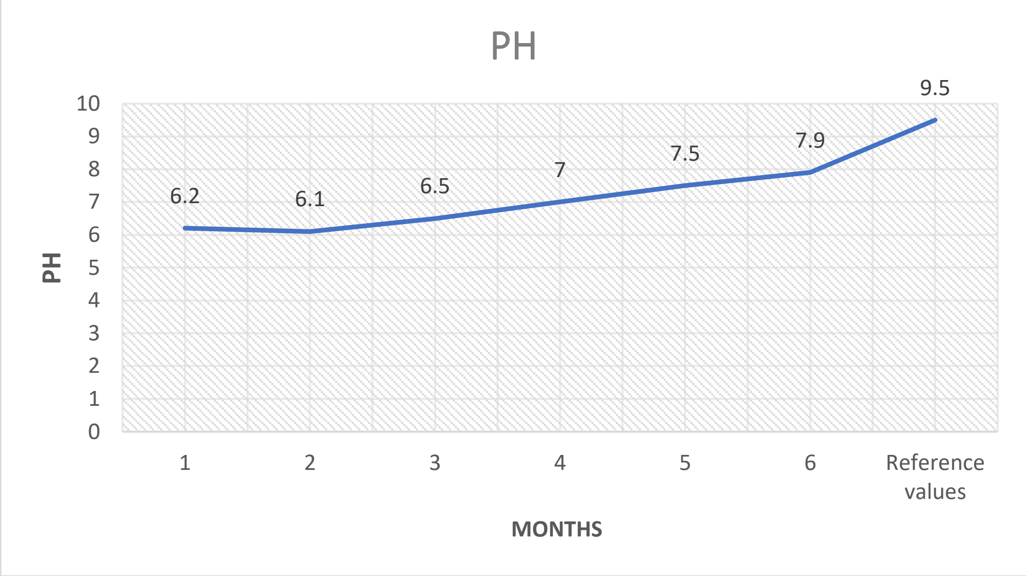


Figure 4-8 :shows the laboratory results of the pH function of medical effluent over a period of six months of the year (for a specialized dental center).

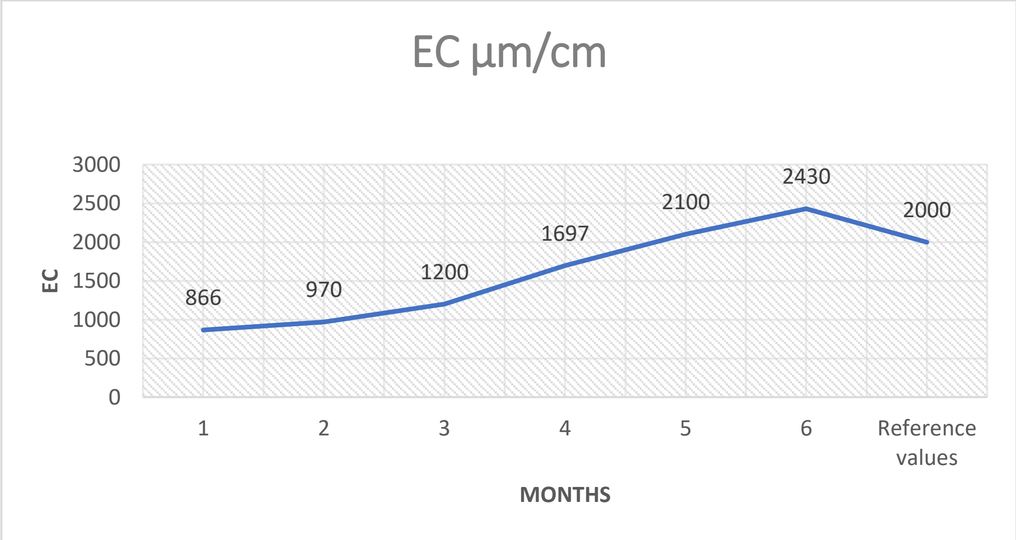


Figure 4-9: shows the EC laboratory results for medical effluents over a period of six months of the year (for a specialized dental center).



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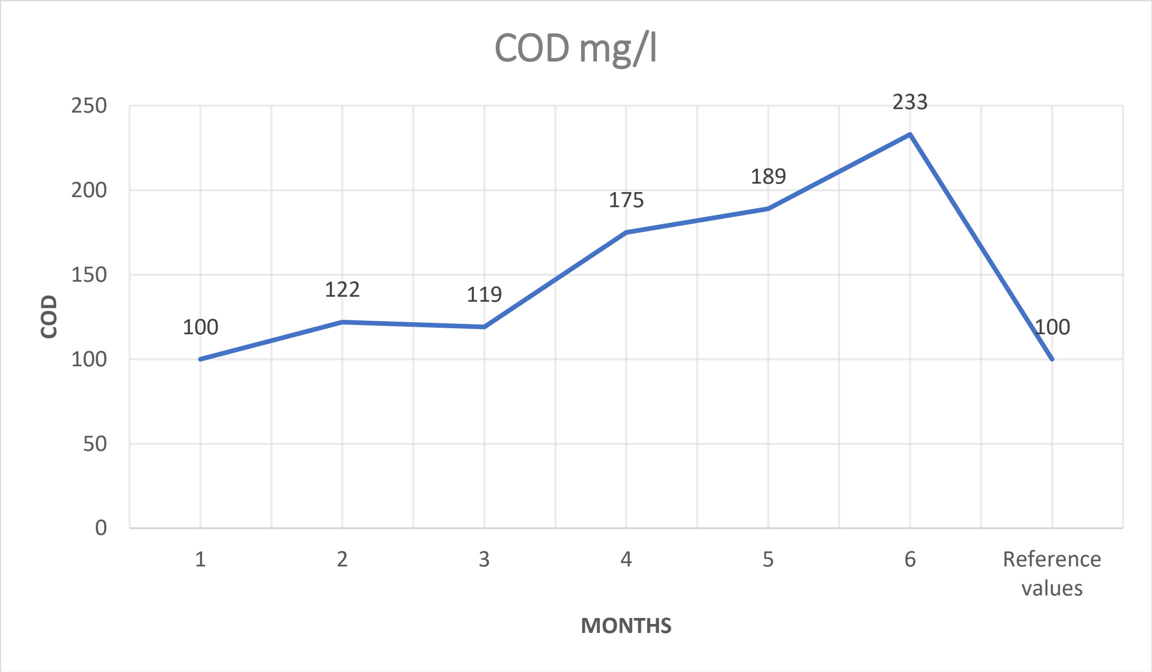


Figure 4-10:shows the laboratory results of COD for medical effluent over six months of the year (for the specialized dental center).

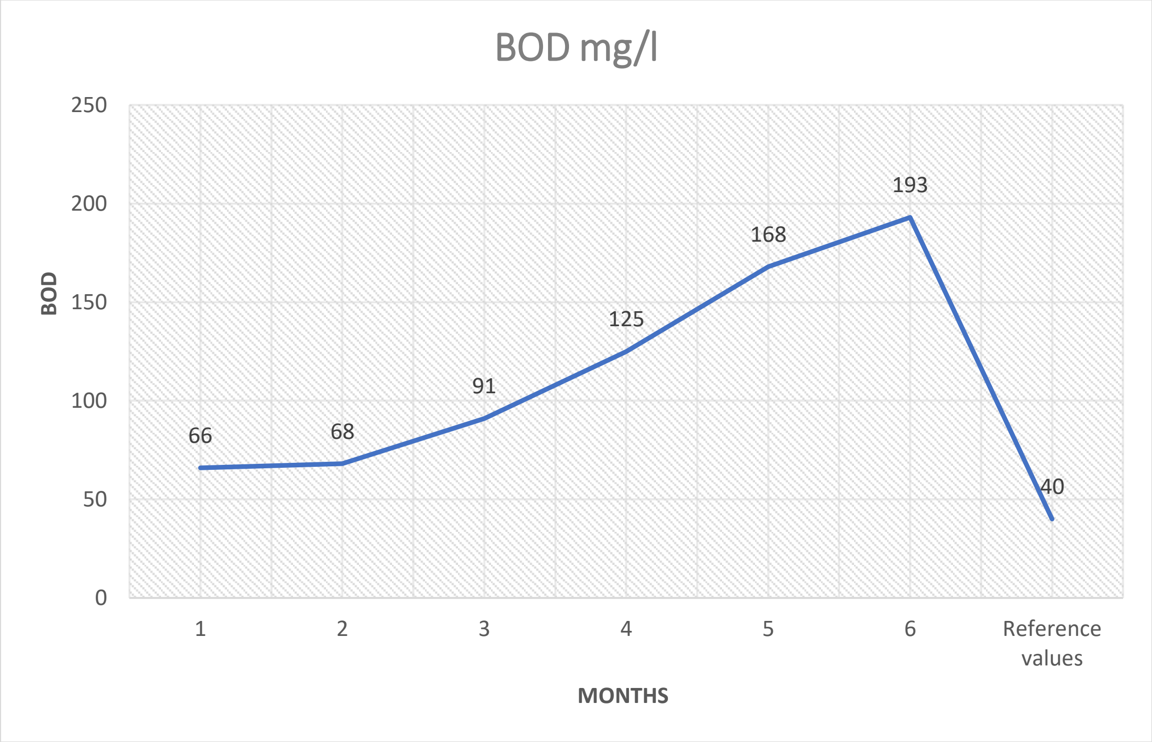


Figure 4-11 : shows the BOD laboratory results for medical effluents over a period of six months of the year (for a specialized dental center).



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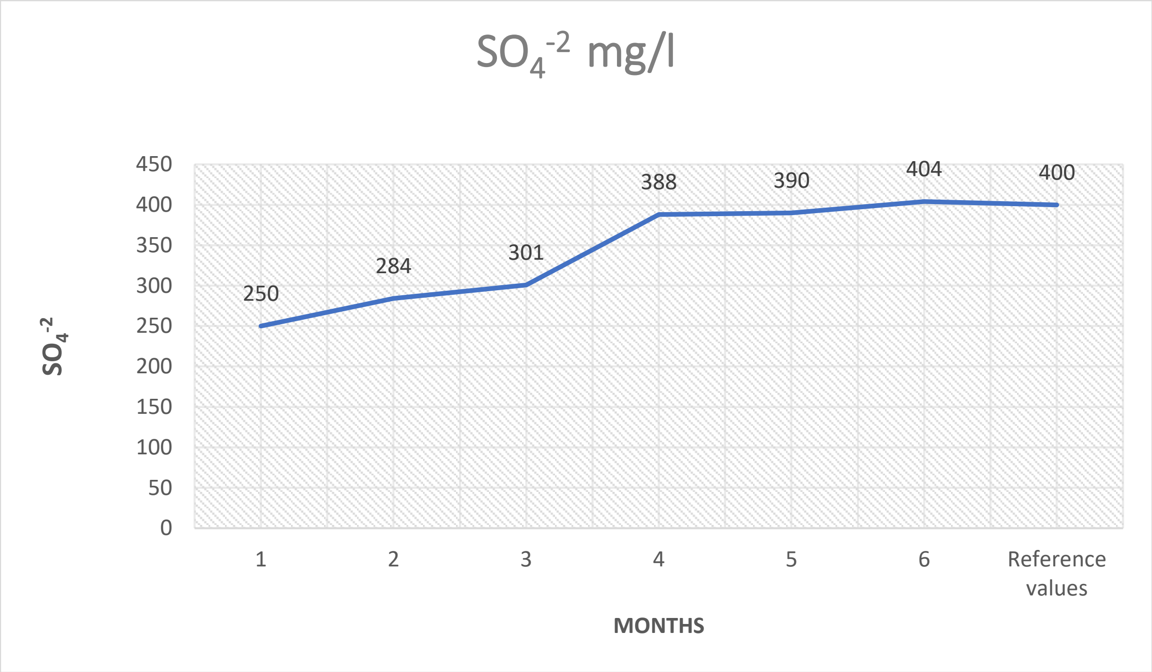


Figure4-12:shows the laboratory results SO4-2 for medical effluents and over a period of six months of the year (for a specialized dental center).

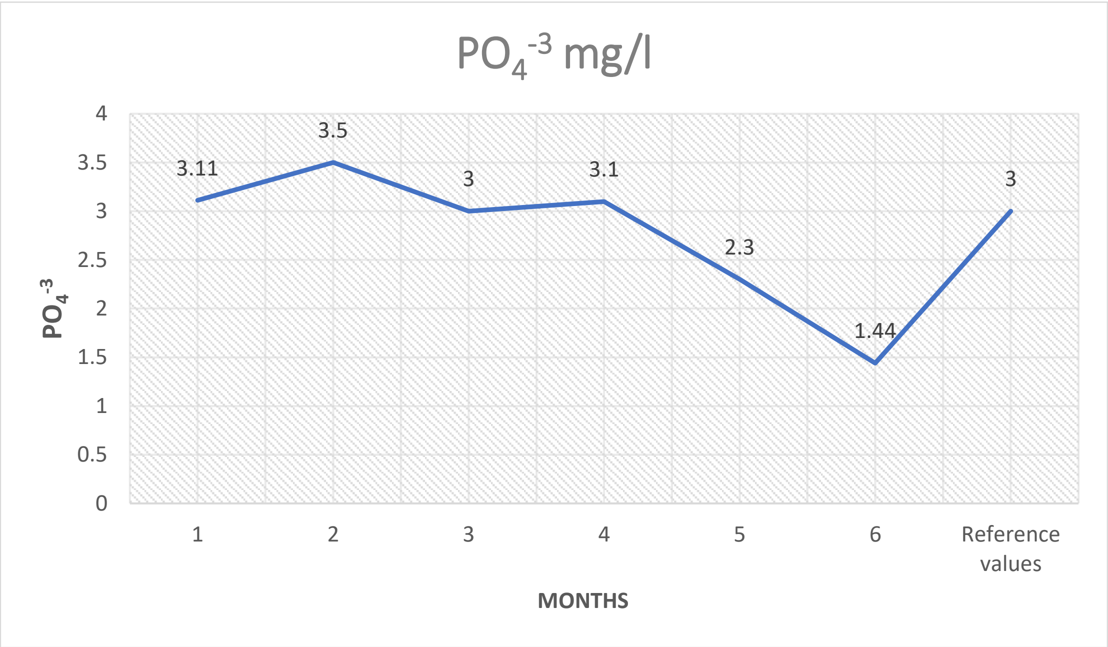


Figure 4-13:shows the laboratory results of PO4-3 for medical effluents over a period of six months of the year (for a specialized dental center).



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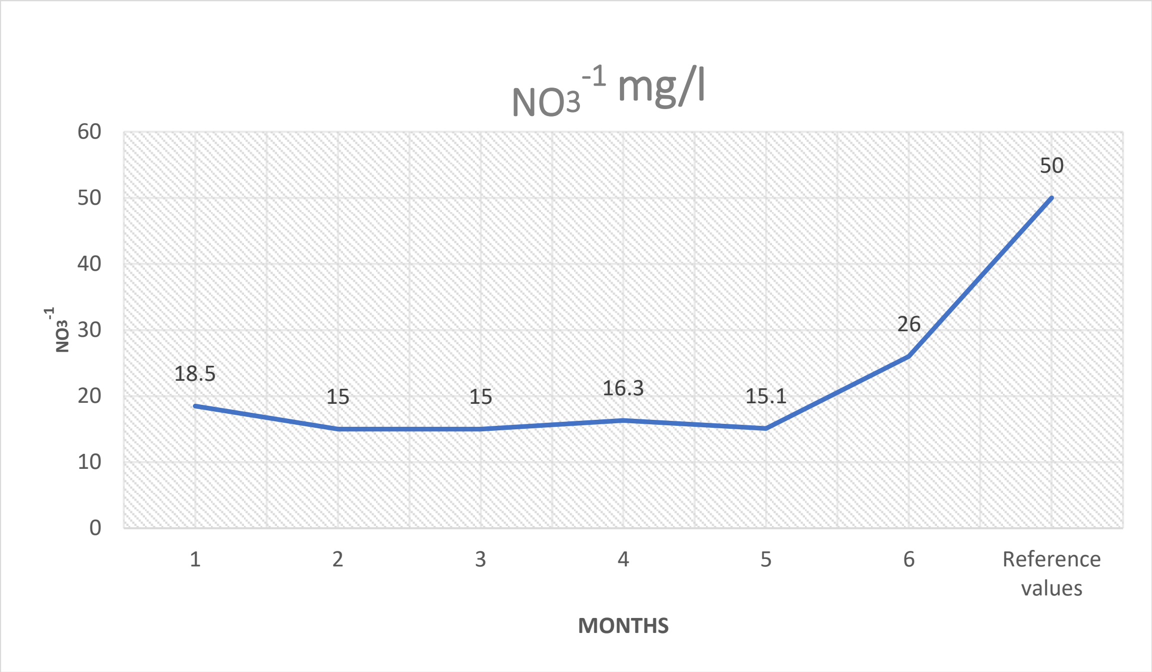


Figure 4-14 :shows laboratory results $NO_3^-$ for medical effluents over a period of six months of the year (for a specialized dental center).

**5-1-Conclusions**

1. It was found that the two studied centers dispose of their effluents in different ways, as they were discharged to public sewers, septic basins, or nearby rivers and trocars without treatment due to the failure of their treatment plants for several years.
2. Wrong handling of hazardous chemical waste and liquids resulting from the daily sterilization and cleaning of various surfaces, floors and equipment that are discharged to public sewers from analysis laboratories and pathological laboratories, as well as toxic drug residues and antibiotics for the treatment of tumors and liquid and radioactive waste that is discharged without treatment.
3. The characteristics of the liquid medical waste of the two centers compared to the city's wastewater were characterized by a high content of bacteria, germs and viruses causing many infectious diseases, various and dangerous chemicals, pharmaceutical waste, quantities of heavy metals, liquid and radioactive waste and other pollutants dangerous to the environment.
4. The study showed that the values of ($NO_3^{-1}$) in the effluents of the two centers fall within the normal limit while the values of (BOD, COD, $PO_4^{-3}$, $SO_4^{-2}$, EC) were higher than the environmental determinants.
5. The lack of use of any methods in the treatment of liquid waste of the two centers and discharge to the aquatic environment without treatment pollutes the environment and exposes living organisms to environmental and health risks.



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**5-2-Recommendations**

1-The need to develop a national strategy for the treatment of waste in general and medical waste in particular, with a comprehensive and integrated solution to manage the waste problem with the participation of all concerned parties.

2- Establishing an Iraqi commercial company to collect, transport, store and treat natural and medical waste.

3-Holding workshops and training courses for medicaland nursing staff on the dangers of medical waste and the need to adhere to occupational safety instructions.

4- Repairing idle incinerators or choosing suitable and safe incinerators for the environment and individuals in Iraqi hospitals.

5- Raising awareness of the dangers of waste and its damage to students in public and private schools.

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**الخلاصة**

تعرف النفايات الصحية بأنها نفايات طبية أو بيولوجية معدية أو خطرة تؤدي أو تساهم بشكل كبير، بسبب خصائصها، في زيادة معدل الوفيات أو الامراض الخطيرة الدائمة أو المسببة للعجز. كما تشكل خطرا محتملا على صحة الانسان أو البيئة عند معالجتها أو تخزينها أو نقلها أو التخلص منها أو إدارتها بطريقة غير صحيحة. لهذا تناول البحث التحاليل الكيميائية المهمة للنفايات الطبية السائلة لمركز صحي عام ومركز تخصصي للاسنان وعلى مدى سته اشهر من السنة للتعرف بشكل كامل على كيفية معالجة هذه النفايات ومدى كفاءة وحدات المعالجة .اظهرت النتائج ان تراكيز التحاليل الكيمياوية للمركز الصحي اعلى من التراكيز المسجلة لمركز الاسنان . ان الدالة الحامضية وايون الفوسفات مقبولة نوعا ما خلال الاشهر المحددة.اما الكبريتات والتوصيلية الكهربائية فكانت مرتفعة في الشهر السادس من السنة .وتم ملاحظة ارتفاع كبير في تراكيز المتطلب البيولوجي على الاوكسجين(BOD) والذي يمثل كمية الاوكسجين التي تحتاجهاالكائنات الحية الدقيقة لتحطيم المواد العضوية وكذلك هناك زيادة كبيرة في المتطلب الكيميائي للاوكسجين (COD) والذي يمثل تركيز المواد العضوية بطريقة غير مباشرة .وهذا يدل على وجود تلوث بكتيري عالي يحتاج الى معالجة ومتابعة.



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