Determination of Copper and Lead and Study their Poisonous Effects in Drinking Water in Baghdad

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Abstract:

The objective of this study is to determine the concentration of copper and lead (mg/L) in drinking water by using absorption spectrophotometic and Atomic Absorption spectrophotometric method from different area in Baghdad and with different intervals , The results show that the concentration of copper and Lead (mg\L) in tap water which remains motionless in plumbing system for following periods one hours, 3 hours, 6 hours, 12 hours, 24 hours, 7 days and 14 days are (1 , 2.2 , 4 , 5.3 , 7.5 , 10 and 16 mg\L copper) & (0.3, 0.5 , 0.8 , 1 , 2.5 , 3 , 3.8 mg /L lead) respectively .from these results its clear that high levels of copper & Lead occur if tap water comes in contact with copper - lead plumbing and copper lead - containing fixtures in the water distribution system. If tap water remains motionless in the plumbing system for some time.

These amounts of copper and Lead are believed to give rise to the symptoms of chemical food poisoning precipitated by the ingestion of alcohol on an empty stomach (in presence of copper). Also children under one year of age are more sensitive to copper than adults. Long-term exposure (more than 14 days) to copper - lead in drinking water which is much higher than 1,000 ug/I has been found to cause kidney and liver damage in infants, In case of Lead it can effect a children physical development & ability to learn.

Key words: Lead determination, Spectrophotometry, 1-(2-pyridylazo)-2-napthol, copper determination.

Introduction:

Copper and its compounds are common in the environment. The body may be exposed to copper by breathing air, eating food, or drinking water containing copper. Also they can be exposed by skin contact with soil, water, or other copper-containing substances. [1-5] Levels of copper found naturally in ground water and surface water that are generally very low; about 4 micrograms of copper in one liter of water or less. However, drinking water may contain higher levels of a dissolved form of copper. [6].

High levels of copper occur if tap water comes in contact with copper plumbing and copper-containing fixtures in the water distribution system. If corrosive water remains motionless in the plumbing system for six hours or more, copper levels may exceed 1,000 ug/l[7]. The level of copper in drinking water increases with the corrosivity of the water and the length of time it remains in contact with the plumbing. Copper is necessary for good health. The body got about 1,000 micrograms (1,000 ug) of copper per day by eating and drinking.[8,9] Drinking water normally contributes approximately 150 ug/day. Immediate effects from drinking water which contains elevated levels of copper include vomiting, diarrhea, stomach cramps and nausea, The seriousness of

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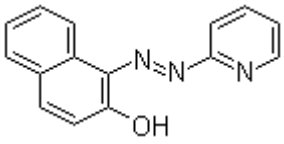
these effects can be expected to increase with increased copper levels or length of exposure.[10] Children under one year of age are more sensitive to copper than adults. Long-term exposure (more than 14 days) to copper in drinking water which is much higher than 1,000 mg/L has been found to cause kidney and liver damage in infants. Other persons who are highly susceptible to copper toxicity include people with liver damage or Wilson's disease because copper exhibits these harmful health effects, and because drinking water may be a significant route of exposure to copper,[11-15] it is important to determine the amount of copper in drinking water .

Lead, a metal found in natural deposits, is commonly used in household plumbing materials and water service lines. The greatest exposure to lead is swallowing or breathing in lead paint chips and dust. Lead is rarely found in source water, but enters tap water through corrosion of plumbing materials. Homes built before 1986 are more likely to have lead pipes, fixtures and solder. However, new homes are also at risk: even legally "lead-free" plumbing may contain up to 8 percent lead. The most common problem is with brass or chrome-plated.

Lead in drinking water can cause a variety of adverse health effects. In babies and children, exposure to lead in drinking water above the action level can result in delays in physical and mental development, along with slight deficits in attention span and learning abilities. In adults, it can cause increases in blood pressure. Adults who drink this water over many years could develop kidney problems or high blood pressure.

Atomic absorption spectrophotometric method has been used to determine the amount of the lead in drinking water using an ammonium tetramethylenedithiocarbamate extraction technigue as separating agent .

Spectrophotometric method has been used to determine the amount of the copper in drinking water in this work; Spectrophotometry is essentially a trace-analysis technique and is one of the most powerful tools in chemical analysis. 1-(2-pyridylazo)-2-naphthol (PAN) [16] has been used for the spectrophotometric determination of copper. This is a sensitive, highly specific spectrophotometric method for the trace determination of copper. The method is based on the reaction of non-absorbent (PAN) in a slightly acidic solution (0.02-0.4 mol L^{-1}) with copper (II) to produce a highly absorbent red chelate product followed by a direct measurement of the absorbance in an aqueous solution with suitable masking, the reaction can be made highly selective and the reagent blank solution do not show any absorbance.[17-20].



Molecular structure of 1-(2-Pyridylazo)-2-naphol (PAN)

Material and Methods:

Instrumentation

AA-7000 Atomic Absorption Spectrophotometer (Shimadzu) ,wave lengh range 185-900 nm,Lamp type : Hallow – cathode and Deuterium , Lamp : 6 Lamps Turrent , Vaporization flame and \or grapgic furnace .

GBC (Australia) (Model: Cintral-6) double beam UV/VIS the recording spectrophotometer. Chem. Tech. Anal. (U.K.) (Model-ALPHA 4) atomic absorption spectrophotometer

equipped with a microcomputer controlled air-acetylene flame at 324.7nm was used for comparing the results. (Experimental conditions were: Slit width, 2 nm; lamp current, 3 mA; wavelength, 324.7; flow rate of carrier gases are- air, 6.5 L $min.^{-1}$; acetylene, 2 L $min.^{-1}$; sample volume, 10 µL.

All of the chemicals used were of analytical reagent grade or the highest purity available. Doubly distilled deionized water, which is non-absorbent under ultraviolet radiation, was used throughout.

ammonium tetramethylenedithiocarbamate .

PAN solution 1- (2-Pyridrylazo)-2-naphthol (Aldrich A.C.S) was prepared by dissolving the requisite amount of it in a known volume of distilled deionized water. More dilute solution of the reagent was prepared as required.

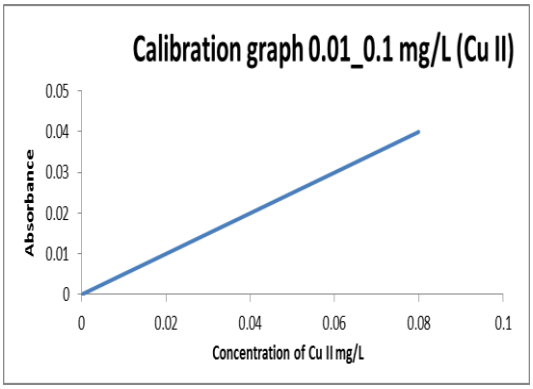
Copper (II) standard solution 1.57 × 10^{-2} mol L^{-1}

A 100-mL amount of stock solution (1 mg mL^{-1}) of Cu (II) was prepared by dissolving 392.9 mg of copper sulfate pentahydrate ($CuSO_4$. 5 H_2O) in doubly distilled deionized water. Aliquots of this solution were standardized by iodometric titration. Working standard solution was prepared by suitable dilutions of the stock solution.

Procedure

Drinking water samples were collected in polythene bottles from tap of plumbing system from different regions of Baghdad. After collection, HNO_3 (1 mL L^{-1}) was added as preservative.

A volume of 0.1-1.0-mL of neutral aqueous solution containing 0.1-70 µg of copper (II) in a 10-mL volumetric flask was mixed with a 1:5 to 1:100 fold molar excess of 1-(2-pyridylazo)-2-napthol (PAN) reagent solution (preferably 1-mL of 4 x 10^{-3} mol L^{-1}) followed by the addition of 0.1 – 2.0-mL of 0.2 mol L^{-1} sulfuric acid. The mixture was diluted to the mark with deionized water. After 1 min the absorbance was measured at 560 nm against a corresponding reagent blank. The copper content in an unknown sample (drinking water) was determined using a concurrently prepared calibration graph.(shown down)



Spectrophotometric analysis in a very dilute solution was derived from Beer's law. Set of solutions were prepared by dilution of stock solution (0.1 mg L^{-1}) to construct the calibration graph, The absorbance of the calibration and sample solutions were measured at wavelength 560nm , the absorbance to zero was setted with blank deionized water .The straight line equation of calibration graph is $y = mx + b$.

The determination of lead in drinking water has been achieved by using semi-micro technigue that chelate and separate the lead into an organic extract (an ammonium tetramethylenedithiocarbamate extraction technigue) prior to analysis, the extract is then injected directly into the atomizer without the need to separate in two phases .

Result and Discussion:

Table (1): The relationship between the concentration of copper and Lead (mg/L) in drinking water and the time remains motionless in plumbing system.

Tap water remains motionless in plumbing system for	Concentration of copper (mg\L) in drinking water	Concentration of Lead (mg\L) in drinking water
1 hour	1.0	0.3
3 hours	2.2	0.5
6 hours	4.0	0.8
12 hours	5.3	1.0
1 day	7.5	2.5
7 days	10.0	3.0
14 days	16.0	3.8

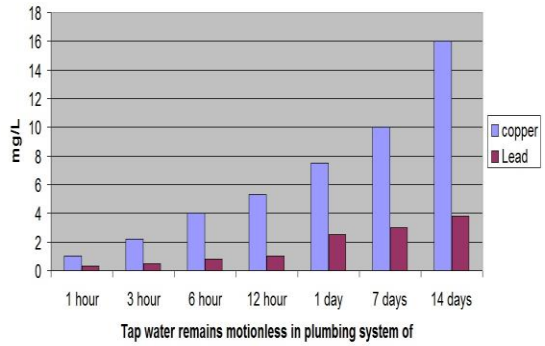


Fig. (1): Histogram between the concentration of copper and lead (mg/L) in drinking water and the time remains motionless in plumbing system

The determination of copper with 1-(2-Pyridylazo)-2-napho can be directly conducted in an aqueous solution without the need for any separations or clean up step. The reaction is instantaneous and the absorbance remains stable for over 72 h. and the useful concentration range (0.01-0.1 µg mL^{-1}) for Beer's low is widened. Finally, with suitable masking, the reaction can be made highly selective and reagent blank solutions do not show any absorbance.

Table (1) and graph (1) show that the concentration of copper and lead (mg\L) in tap water which remains motionless in plumbing system for following periods (one hours, 3 hours, 6 hours, 12 hours, 24 hours, 7 days and 14 days) are (1 , 2.2 , 4 , 5.3 , 7.5 , 10 and 16 mg\L) & (0.3, 0.5 , 0.8 , 1 , 2.5 , 3 , 3.8 mg /L lead) respectively ,because the concentration of copper are high and do not give a accurate results to overcome this problem ,the solutions are diluted many times then multiple the results by the time of dilutions also the values of absorptions are converted to analytical concentrations by using the Beer-lambert law in case of lead .from these results it is clear that a high levels of copper occur if tap water comes in contact with copper-lead plumbing and copper lead-containing fixtures in the water distribution system. If tap water remains motionless in the plumbing system for some time, copper levels may exceed the normal level, the level of copper and lead in drinking water increases with the corrosivity of the water and the length of time it remains in contact with the plumbing.

These amounts of copper are believed according to World Health Organization (WHO) to have given rise to the symptoms of chemical food poisoning precipitated by the ingestion of alcohol on an empty stomach. Also children under one year of age are more sensitive to copper than adults[21]. Long-term exposure (more than 14 days) to copper in drinking water which is much higher than 1,000 ug/I has been found to cause kidney and liver damage in infants. generally the health-based guideline values for copper and lead in drinking water is the concentration of (1.0) mg\L and(0.05) mg\L respectively proposed by World Health Organization (WHO)

and the US Environmental Protection Agency (EPA) [22,23] , in addition to Iraqi standard No. (417) for drinking water.
The maxium acceptable level of lead in drinking water in Baghdad area has been established in this work.

Conclusions:

The present research indicates that the amount of the copper which was found in drinking water of plumbing system in Baghdad region are believed according to World Health Organization (WHO) to have given rise to the symptoms of chemical food poisoning precipitated by the ingestion of alcohol on an empty stomach . Also children under one year of age are more sensitive to copper than adults. Long-term exposure (more than 14 days) to copper in drinking water has been found to cause kidney and liver damage in infants. Amounts of lead in drinking water in Baghdad area in this work according to (WHO) is in anormal level .

Recommendation:

Avoiding drinking or cooking with water that has been in contact with house plumbing for more than six hours and using bottled water. Particularly if it will be used by young children as drinking water, or for making infant formula and finally using plastic tubes instead of steels alloys tubes which are used usually in plumbing system can be recommondated as a simple way for reducing exposure the drinking water to copper and lead .

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تعيين النحاس والرصاص ودراسة التأثير السمي لها في مياه الشرب في بغداد

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الخلاصة:

الهدف من هذه الدراسة هو قياس تركيز النحاس والرصاص (ملغم \لتر) في ماء الشرب بواسطة طريقة التحليل الطيفي باستخدام عامل مولد الصبغة بالنسبة للنحاس وجهاز الامتصاص الذري بالنسبة للرصاص، وقد تم اخذ عينات من ماء الشرب من مناطق مختلفة من بغداد من نظام الاسالة وتم قياس تركيز النحاس والرصاص بواسطة جهاز التحليل الطيفي والامتصاص الذري وبفترات زمنية مختلفة وهي (ساعة واحدة ، 3 ساعات ، 6 ساعات ، 12 ساعة ، 24 ساعة ، 7 أيام و 14 يوم) وبدون استخدام الماء لهذه الفترات وكانت نتائج التحليل هي (1 ، 2,2 ، 4 ، 5,3 ، 7,5 ، 10 و 16 ملغم| لتر نحاس) (3، 5، 8، 1 2،5 3 3،8 ملغم/لتر رصاص) وعلى التوالي ،ان سبب ارتفاع نسبة النحاس يعود الى تماس الماء مع انابيب نقل المياه التي تحتوي على النحاس في تركيبها وتتناسب هذه النسبة طرديا مع فترة التماس،ويعتقد ان هذه النسب قد تسبب اضرار جدية للاطفال حديثي الولادة وتلف الكلية والكبد للاجنة ، و قد تسبب هذه النسب ايضا تسمم اذا تناولت على معدة فارغة عند تناول الكحول بسبب ترسيب مركبات الكحول النحاسية طبقا لمنظمة الصحة العالمية وبطأ قابلية التعلم للاطفال بالنسبة للرصاص