المجلة العلمية لجامعة الإمام المهدي
E-ISSN: 1858-6449
Impact Factor: 2.635
العدد (١٨)

The Environmental Effect of Organic Constituents in Waste water from Kenana Sugar Factory

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Abstract

In recent periods observed that the intensity of population development of urban and rural areas and the establishing of many industries around urban cities , created different environment problems. This study was conducted during the period (October 2022 up to June 2023). The study aimed to determine the organic constituents of wastewater from Kenana sugar factory (Cliquees stream) and it is effect on the environment of the area. The results of the study were compared with reference values of reuse of waste water in the eastern Mediterranean Region the values between brackets below. The samples were analyzed as the following: biochemical oxygen demand (BOD) by Winkler trimetric chemical oxygen demand (COD) by $KMnO_4$ trimetric and Total Organic Carbon (TOC) by TOC – UV – 700 OR). 24 samples of wastewater were collected from two different locations around the Cliquees stream. The results obtained were follows : biochemical oxygen demand (BOD): 1301 mg/l to 2102 mg/l ؛ (770 mg/l)؛ COD : 1601mg /l to 2403 mg/l ؛(1830 mg/l) and TOC 253.36 mg/ l to 253 .64 (220 mg / l). The environment impact which was observed was impermissible range for most organic parameters. Conclusively the disposal of Kenana sugar factory effluents in (Cliquees stream) and cultivating soil directly caused significant environment impact and Eutrophication phenomena for some microorganisms and also plant roots burn and deformation of their fruits.

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Key words:Orgnic Constituents of wastewater (TOC,BOD and COD)

التأثير البيئي للمكونات العضوية لمياه الصرف الصناعي من مصنع سكر كنانة

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ملخص الدارسة

في الأوان الأخيرة يلاحظ ازدياد الكثافة السكانية وازدهار المدن والأرياف وقيام كثير من الصناعات حول المدن , مما أدى إلى الكثير من المشاكل البيئة المختلفة .

هذه الدارسة قامت في الفترة من (أكتوبر ٢٠٢٢م حتى يونيو ٢٠٢٣م) وتهدف هذه الدارسة لتحديد المكونات العضوية لمياه الصرف الصناعي من مصنع سكر كنانة (مجرى كلِكيس) وتأثيرها على بيئة المنطقة ومقارنة هذه النتائج مع القيم المرجعية المعاد استخدامها لمياه الصرف الصناعي لإقليم شرق المتوسط (القيم بين الأقواس أدناه) لقد تم تحليل العينات على النحو التالي :-

الأوكسجين المستهلك حيوياً بمعايرة وينكر ,الأوكسجين المستهلك المطلوب بمعايرة برمنجنات البوتاسيوم . إجمالي الكربون العضوي بجهاز إجمالي الكربون (OR -700-UV) . 24 عينة من مياه الصرف الصناعي تم جمعها من موقعين مختلفين حول مجرى كلِكيس نتائج المكونات العضوية المتحصل عليها على النحو الآتي:- الأوكسجين المستهلك حيوياً (BOD) 1301 مليجرام / لتر إلى 2102 مليجرام / لتر ؛ (770 مليجرام / لتر) الأوكسجين المستهلك المطلوب : 1601 مليجرام / لتر إلى 2403 مليجرام / لتر ؛ (1830 مليجرام/ لتر) , وإجمالي الكربون العضوي 253.36 ميلغرام/ لتر إلى 253.64 مليغرام/ لتر؛ (220 مليغرام / لتر)

يلاحظ أن التأثير البيئي لمعظم المتغيرات المشار إليها أنفا قد تجاوزت الحد المسموح به وبدرجة كبيرة وتوصلت الدارسة إلى إن التخلص من مخلفات مصنع سكر كنانة في مجرى كلِكيس والتربة الزراعية مباشرة يسبب تأثيراً بيئياً حاداً يؤدي إلى ظاهرة الافراط الغذائي لبعض الكائنات الحية وكذلك حرق جذور النباتات وتشوه ثمارها.

Introduction

Although Sudan is the largest country in Africa and lies mostly in the arid region where water is scarce (Ginawi, 1994). Over 70% of its population and the majority of livestock live around the River Nile areas. The recent drought coupled with civil war have led to exodus migrations to urban centers resulting in over use of the available and limited urban facilities including water and sanitation system. The economy of the country is largely agro .Pastoral and hence provision of water for both human and livestock imposes the major constrain for all the developmental activities the available water resources comprise the Nile system rain water and ground water. The main Nile and its tributaries provide perennial fresh water (Total) dissolved salts>300ppm) of good chemical composition (Mukhtar, 1998).

The White Nile, though of homogeneous composition and steady levels has high colloidal matter. The Irrigation channels of Gezira, Rahad and new Halfa schemes are important water sources. They show sings of organic contamination and play an important role in the spreading of bilhaziasis, dysentery, and malaria.(abdelmonein *etal* 2010)

Early developments discharged wastewater(is any water that has been adversely affected by in quality, be anthropogenic influence. It comprises liquid waste discharged by domestic residences, commercial - properties, industry, and / or agriculture and can encompass a wide range of potential contaminants concentrations). (Deepthi,*etal* 2015). to cesspools which often had outlet pipes leading to ditches and creaks. Sewage is correctly the subset of wastewater that the contaminated with faeces or urine, but the often used to mean any wastewater. Sewage includes domestic, municipal, or industrial liquid waste products disposed of, usually via a pipe or sewer or similar structure, sometime in a cesspool emptier(Mukhtar, 1998). .The

physical infrastructure, including pipes, pumps, screen, channel, etc. Use to convey sewage from its origin to the point of eventual treatment or disposal is termed sewage.(Pradeep and Sahu,2017). In the most common usage, it refer to the municipal wastewater that contains a broad spectrum of contaminants resulting from mixing of wastewaters from different sources. (EIA ,2010)

The problem of the wastewater in White Nile State has not been a studies in details. The wastewater is one of the problematic situation in the state. Until now there was no practical trials involve solution of this problem in the White Nile State. According to the nature of the state, most of the biggest sugar factories were established since a long time ago, for example Kenana, Assalaya and White Nile sugar factories. Among those who are affected by the adverse influence of the wastewater are human, grazing animals and marine life (Fishes, Shells and small living organisms).There were no sufficient studies involving all these aspect in the White Nile State. As a result, there were newly developed disease such as asthma, diarrhea and some case of poisoning as a result of feeding on different vegetable and Fishes. Recently, test for diseased cases indicate a high presence of some diseases that have not been known before such as cancer, kidney failure, poisoning case…etc.

However there was no medical services to meet these kind of diseases were applied by the State Ministry of Health. Although the local environmental health factors were paramount importance in most residential town in the White Nile State, but there were not efforts undertaken to meet these factors. The available knowledge concerning the environmental health factors was insufficient to convince the arguments that raised from time to time in the White Nile State. The areas around

a big sugar factories in White Nile State suffering from acute environmental pollution such as organic constituents, heavy metals and so on, that come from sugar factories residues, Osman Taj (2016).

Material and method

Study area:

The study area included the one area divided into two sub area where the Kenana sugar factory is located (283km south Khartoum). The wastewater

sample collection from an area of approximately (1-2km) radius within each sub – area . Kenana sugar factory is located in Low rain fall Savanna which comprises 18,5% of the Sudan's area with mean annual rain fall ranging from 300 to 800 mm irrigated agriculture rain fed traditional and mechanized forming are practiced this zone. Kenana sugar factory is located between 13˚.06N - 32˚ .92E

Sample Collection:

24samples of wastewater collected from two different areas around factory and Cliquees Stream as following:

Sample from area A (wastewater location A) and sample from area B (wastewater location B).

Sample Technique:

each sample was taken to Pyrex bottle (500ml) for all parameters except (TOC) analyzer was taken into glass bottle(500ml) and all sample was kept in refiigerator (20°C) before use or after (24 – 48).

Determination of Chemical Oxygen Demand (COD)

$KMnO_4$ titrimetric method was used as described in standard method by (EEA, 2001).

Reagents

- Sulphuric acid (conc.)
- Copper Sulphate (1g)
- Potassium Permanganate (0.025N).
- Sodium Oxalate (0.025N).

Procedure

10mls of the sample was taken in 100ml bottle then 5mls of conc.H_2SO_4 was added and about 1g of copper sulphate ($CuSO_4$) also added. Then 3mls of prepared (0.025N $KMnO_4$) solution was added and immersed the bottle in boiling water for 30min while keeping the surface of the boiling water at the higher level than the surface of the sample . Three mills were then prepared 0.025N Sodium Oxalate ($Na_2 C_2 O_4$) was added and immediately titrated with 0.025N Potassium Permanganate ($KMnO_4$) violet color appeared ,then repeated for the blank separately under the same condition using 10mls of distilled water instead of 10mls of samples.

Calculation

$$\text{COD as mg/L} = \frac{(sample\ of\ ml\ B\ )\ (A\ 8000\times 0.025)}{ml\ of\ sample}$$

Where as:

A= ml of $KMnO_4$ used for sample;

B= ml of $KMnO_4$ used for blank;

0.025(1/40) = Normality of $KMnO_4$

8000 = ml-equivalent weight of oxygen in 1000ml/l.

Determination of Biochemical Oxygen Demand (BOD)

Winkler titrimetric method was used as described by (EEA, 2001).

Reagents

- Sulphuric acid (H_2SO_4).
- Starch indicator.
- Iodide sodium.

Manganese sulphate.

Procedure

Two 100mls bottles were obtained with lid and cleaned well. Twentyfive mills sample was taken in each bottle and 75mls of the sample was added to each of the two bottles. Then the two bottles closed well. One bottle was kept in the incubator (06287 AKyurty) at (20-22C°) for 5days .Then 10mls of manganese sulphate solution and 2mls of alkali-iodide solution was added to the other bottle below the surface of the liquid by using a syringe. Then the bottle closed and mixed by inverting it several times.

When the precipitate settles leaving a clear supernatant above the precipitate, shaken again slowly by inverting the bottle and when the setting has produced at least 50mls supernatant 8mls of conc. H_2SO_4 was added. Then the bottle was closed and mixed by gentle inversion until dissolution was completed. One-hundred mills of the sample was titrated with 0.05M $Na_2S_2O_3$ solution until a pale yellow solution reached. Then 2mls of freshly prepared starch solution was added and titration was continued until a blue color appeared. The procedure was then repeated using 100mls distilled water (blank). Then, repeated for incubated sample after 5days.

Calculation

The BOD was calculated as follows:

BOD as mg/l = $16(V_1-V_2)$

Where as:-

V_1 = ml of $Na_2S_2O_3$ used for the sample before incubation.

V_2 = ml of $Na_2S_2O_3$ used for the sample after incubation.

Total Organic Carbon (TOC)

Total organic carbon .water analyze (model =TOC OR 700UV)

Procedure

To determine the analysis of TOC using TC (Total carbon), IC (inorganic carbon) NPOC (Non – purge able organic carbon Methods) two main stages were used oxidation and acidification (punmia*etal*, 1998)

Statistical Analysis

Data were analyzed using analysis of variance (ANOVA) was performed. Differences in mean values were accepted as being statistically significant if $P < 0.05$. A statistical test was used to determine the variance between F-value and the tabulated F-value.(Liamine and Bomi,2019).

RESULTS and DISCUSSION

RESULTS

The results of organic constituents in wastewater sample in location (A) are shown in table (1) and table (2) below. The concentration of bio oxygen demand in the samples were obtained in range 2100 mg/l to 2012 mg/l, the levels were not acceptable limits recommended by Eastern Mediterranean Region (EMR) value(770mg/l).

The concentration of chemical oxygen demand in the samples were obtained in the range of 2400 mg/l to 2403 mg/l, the levels were also not acceptable limits prescribed by the (EMR) value (1830 mg/l), and the results also indicate that the concentration of total organic carbon in the samples were obtained in the range 253.63 mg/l to 253.64 mg/l. The levels were also not acceptable limits recommended by (EMR) value (220 mg/l).

The results of organic constituents in wastewater sample in location (B) are shown in table (3) and table (4) below. The concentration of bio oxygen demand in the samples were obtained in range 1300 mg/l to 1302 mg/l, the levels were not acceptable limits

recommended by Eastern Mediterranean Region (EMR) value(770mg/l).
The concentration of chemical oxygen demand in the samples were obtained in the range of 1600 mg/l to 1603 mg/l, the levels were also not acceptable limits prescribed by the (EMR) value (1830 mg/l), and the results also indicate that the concentration of total organic carbon in the samples were obtained in the range 253.36 mg/l to 253.37 mg/l. The levels were also not acceptable limits recommended by (EMR) value (220 mg/l).

DISCUSSION

The result in location (A) tables (1) and (2) below showed the concentrations of each one of the organic constituents were highly significant at ($P < 0.01$). The results were also indicate the (BOD) was highly concentration (2102mg /L) which compared with the reference value (770mg/L). The overall results were indicate that the concentration of all organic constituents were highly significant at ($P < 0.01$) which compared with reference value level.

The result state that the concentration of total organic carbon (TOC mg/L) was highly significant because sugar manufacturing so it the usually organic hydrocarbon Materials which consist of carbon, hydrogen and oxygen. Examples of this group are glucose sugar, sucrose, starch and cellulose. It has been noticed from this study there were Organic change for this exhausted water consist of group of characters. These changes may be observed by the consumer where he can noticed its low hazard s such as: color, taste, odor and suspended materials. It the well-known that the drain water and industrial water were rich with organic material which lead to nutritive synthesis produced by algae coupled with the activation of bacteria that lead to increase of biological synthesis processes which in turn lead to decrease of dissolved oxygen ratio in the water . this process lead to high mortality of fishes and other aquatic living (marine life) however after that water tend to lead manage changes in its properties that means water could not use for any purpose this phenomenon known by the environmental sciences|(Eutrophication).

More over the concentration of the TOC was raised also by aerobic and in aerobic oxidation both of them done by bacteria Mohammed (2006).

The results state that the concentration of the (BOD mg /L) was highly significant due to there were many factors a raised the concentration of the BOD such as sugar and oil were came from machineries , nutrients

materials , a big equivalent number of microorganism suspended materials This discussion agree with Mohammed I (2006)

The results also state that the concentration of the (COD mg/L) was highly significant due to presence of organic constituents, quantity of organic constituents and types of organic constituents.

It has been noticed practically in this study, that chemical oxygen demand (COD) values divided by biochemical oxygen demand (BOD) values (COD / BOD) where values range between (1 to 3) that means usually organic materials were decomposed biologically. The values (1.14, 1.14, 1.14) respectively that. Whereas this value when equal or exceeding (5) then there are doubt on the availability of biological decomposition of the organic materials. In this case this organic material were difficult to decompose in biological ways and it may need a long time to be occurred or it may contain some components that inhibit the process of decomposition and may stop the process of biological oxidation. However vinas and filtrations mud both of them were contained of high organic constituents. This discussion agree with Mohammed I (2006)

The result in location (B) tables (3) and (4) showed the concentrations of each one of the organic constituents were highly significant at ($P < 0.01$). The results were also indicate the (COD) was highly concentration (1302mg /l) which compared with the reference value (770mg/l). The overall results were indicate that the concentration of all organic constituents were highly significant at ($P < 0.01$) which compared with reference value level.

The result state that the concentration of total organic carbon (TOC mg/l) was high significant because sugar manufacturing so it is usually organic hydrocarbon material which consist of carbon, hydrogen and oxygen. Example of this group are glucose sugar, sucrose, starch and cellulose. It has been noticed from this study there were organic change for this exhausted water consist of group of character. This change may be observed by the consumer where he can noticed its low hazards such as color, taste, odor and suspended materials. It is well known that the drain water and industrial water were rich with organic materials which lead to nutritive synthesis produced by algae coupled with the activational of bacteria that lead to increase of biological synthesis process which in turn lead to decrease of dissolved oxygen ratio in the water this process lead to

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It has been noticed practically in this study, that chemical oxygen demand (COD) values divided by biochemical oxygen demand (BOD) values (COD/BOD) where values range between (1 to 3) that means usually organic materials were decomposed biologically the values (1, 23, 1, 23, 1, 23) respectively. Where a raised this values when equal or exceeded (5) then there are doubt on the availability of biological de composition of the organic materials. In this case this organic materials were difficult to de compose in biological ways and it may need a long time to be occurred or it may content some component that inhibit the process of decomposition and may stop the process of biological oxidation. However vinas and filtrates' mud both of them were contented of high organic constituents this discussion agree with Mohammed I (2006)

The table of Mean **(**1**)** in Location (A)

Replications	Treatments		
	BOD(mg/l)	COD(mg/l)	TOC(mg/l)
S_1	2100	2400	253.63
S_2	2102	2402	253.64
S_3	2101	2403	253.63
Total (T)	6303	7205	760.90
Mean (X^-)	2101	2401.67	
Reference value	770	1830	220

The ANOVA Table (2) in Location (A)

Source of variation	Degree of freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	Tabular f-value	
Treatment	2	٨١١٧٢١٧,١٨	4058608.59		5%	1%
Experimental error	٦	1536979.38	256163.23	15.84	4.46	8.65
Total	٨	9654196.56				

**highly significant at (1%) level significance.

The Table of Mean (3) in Location (B)

Replications	**Treatments**		
	BOD(mg/l)	COD(mg/l)	TOC(mg/l)
S_1	1300	1600	253.36
S_2	1302	1603	253.37
S_3	1301	1601	253.36
Total (T)	3903	4804	760.09
Mean (X^-)	1301	1601	253.36
Reference value	770	1830	220

The ANOVA Table (4) in Location (B)

Source of variation	Degree of freedom	Sum of Square (SS)	Mean of Square (MS)	F- value	Tabular f-value	
Treatment	2	3004772.5	1502386.25		5%	1%
Experimental error	6	64838.7	108026.43	13.90	4.46	8.65
Total	8	3069611.2				

**highly significant at (1%) level significance.

Conclusion:

The study showed that the flow of industrial and field irrigation wastewater are very palatial and give high concentration of organic constituents. The highly significant between calculate F- value and tabular F- value (in tables 2 and 4) indicate that the study area suffering from acute environmental pollution from organic constituents.

References

Abdel Moneim El hadi Suleiman, Abdelwahib, M, Y and Abdel moneiumM (2010). Chemical, physiochemical and physical properties of waste water from Sudanese Fermentation Industry (SFI). Fourteenth International Water Technology Gonference (IWTC), Cairo Egypt (305).

EuropeanEnvironmentAgency (**EEA**) (**Copenhagen**, **Denmark**). (**2001).** Indicator: Biochemical oxygen demand in rivers.

Deepthi, P.; Sarala, C. and Mukkanti, K. (2015). Application of natural adsorbents for wastewater treatment, International Journal of Research, Vol-7.

Ginawi, **M.M.H.** (**1994).**Water quality in household cisterns. M.Sc...Thesis, Institute of Environmental studies, university of Khartoum.

Layman. R (1993). An introduction to statistical Methods and data analysis, fourth Edt. Checking on the equal variance Assumption .pp.786-789.

Liamine fahta and Bomi latifa (2019). Analysis of variance and tests of variance from single variant. Dafatre ELMekhr. Magazine, V(14). Issue (01).

MohammedIsmail. (**2006).**Watertreatment. Scientific bookshop for Advertisement and Distribution. Cairo,Egyptian,Aabdean, 50 AlshakhRahmanStreet. www.sbheg.com

Mukhtar,A.R. **(1998).** Water supply provision in Sudan. Khartoum: In standard for drinking water, workshop 20-22februray 1999. (WHO and SSMO). Khartoum.

Osman Taj Eldeen (2016). The environmental pollution from sugar industries in White Nile State, Scientific journal of Imam Elmahdi University vol. 2016, Issue (7) pp 1-36

Pradeep,K.P and Sahu,O.P (2017). Quality and management of wastewater in sugar industry, Applied water science vol.7, pp461 – 468.

Punmia,**B.C,AshokJain, (1998).**Waste water Engineering. (2nd Edition). Arihant consultant, Bombay.

Technical EIA guidance manual for sugar industry, MOEF, August (2010).