Assessment of Dissolved Oxygen in Sewage Containing Camphor

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***Abstract*—Camphor is widely used for odor eradication in eateries and homes. The health of the sewage tank is paramount to the environmental engineer as bacteria aid in sewage degradation. This research is geared towards investigating the effects of camphor on aerobic and anaerobic sewage degradation due to its constant usage.**

Ten 4 liters clean containers having 2 liters sewage where prepared. To one set of four 4 liters containers which was not covered (Aerobic), crushed camphor weighing (7.38g, 14.25g, 21.91g, and 25.75g) were added and the other four 4 liters containers which was not covered (Anaerobic), camphor in solid form (2No., 4No., 6No., and 7No.) with the same weight as described above to check the effects of surface area and two control containers having sewage alone. The pH, Total Dissolved Solid (TDS), Dissolved oxygen (DO) and temperature was observed and compared with a control solution which had no camphor. From the research, dissolved oxygen level showed significant decrease as the weight and number of camphor increased. This could imply that the presence of camphor creates a film over sewage thereby reducing oxygen exchange rate as it was observed during the experimental process. This finding could emerge as one of the reasons for septic tank failures which may arise as a result of increased organic loadings over time. However, the physio-chemical properties which include pH, TDS and temperature obtained were within range and suitable for microbial growth.

Keywords—Sewage, Degradation, Camphor, Bacteria, Aerobic

INTRODUCTION

Any place where surface water advances into groundwater, organic chemicals and pathogens conceivably can enter [1]. Groundwater quality includes; the physical, chemical and biological characteristics [2]. Inorganic chemicals that occur naturally in soils, sediments and rocks – for instance; dissolve mineral matter can also degrade the quality of groundwater. Groundwater can be degraded by the entry of contaminants.Groundwater contamination is an undesirable change in groundwater quality resulting from anthropogenic activities [2]. Contaminants permeate the soil until they reach the groundwater. Contaminants can enter aquifers by several means which incorporates; infiltration of surface water through soil, direct flow through improperly built wells that become conduits for contamination, accidental spills, landfills, surface waste ponds, underground storage tanks, failed septic tanks, acid mine drainage, land application of waste and pesticides and injection wells [8][1][2]. A septic tank is a highly efficient, independent underground wastewater treatment system. A septic system is a sewage treatment, transfer and disposal system buried in the ground [3]. It comprises of two fundamental parts; a septic tank and a drain-field. The septic tank is a water-tight box, typically made of concrete with an inlet and outlet pipe. The drain-field is not of utmost importance to us during this research but it helps in the distribution of the wastewater to the soil, waste in form of solids and liquids flow from three layers inside the tank. The first layer (scum layer) consists of solids lighter than water and they float to the top while the second layer (sludge layer) which consists of solid sediments which are heavier than water, settle at the bottom of the tank [4]. Sludge is a layer composed of different sewage materials that are not homogenous [5]. The contaminants found in wastewater includes; phosphorus, nitrates, disease-causing bacteria and viruses, metals, and solvents [7][6][3]. The layers of sludge and scum are acted upon by micro-organisms (bacteria) which helps to break the solids down into smaller particles. Studies have shown that micro-organisms require oxygen to breakdown organic matter into smaller particles that would not be harmful to the environment. Improperly functioning and overloaded septic systems are major sources of pollution.However, with sufficient amount of oxygen, bacteria can be strengthened to break down this harmful pollutants. On the other hand, failing septic systems leak harmful pollutants like bacteria (micro-organisms), excess nutrients (Nitrates and Phosphorus) into the environment [3] as well as other contaminant found therein. The organisms and chemicals found in untreated septic waste can be dangerous and camphor may be one of them. Camphor is a volatile inorganic crystalline substance that is used in the production of explosives and pest deterrent [11].With a chemical formula of $C_{10}H_{16}O$, it is soluble in water, acetone, acetic acid, diethyl ether, chloroform and ethanol. These chemicals may migrate through water and affect the groundwater if failure occurs in the septic tank system as poor degradation may lead to shock loading [9][10][3]. Therefore, this research is carried out to ascertain camphor effect on depletion of dissolve oxygen (DO) as it is consistently used in toilets. This is essential as the availability of microbes could also be predicted.

MATERIALS AND METHODS

A. Materials

Sewage for analysis was collected from Covenant University, Ota sewage treatment plant for laboratory analysis. Ten 4 liters containers having 2 liters sewage where prepared. To one set of Four liters containers which was not covered (Aerobic), crushed camphor weighing (7.38g, 14.25g, 21.91g and 25.75g) were added and the other Four 4 liters containers which was properly covered (Anaerobic), camphor in solid form (2No., 4No., 6No. and 7No.) with the same weight as described above to check the effects of surface area and two control containers having sewage alone. The sewage was collected using Two 25 liter containers and where properly shook and poured into the 4 liters containers. The following parameters were checked immediately the sample was poured into the containers and the camphor was added to it; pH, Temperature, Total dissolve solids (TDS) and Dissolve oxygen (DO).The analysis was done for 5 weeks (once a week). The ambient temperature was recorded for each day.

B. Method of Analysis

All the sewage samples collected for laboratory analysis were analyzed immediately they were brought into the laboratory. All the analysis were carried out using the Hanna Instrument Edge Multimeter.

C. Laboratory Determination

The pH, Temperature, Total dissolve solids (TDS) and Dissolve oxygen (DO) were determined using the Hanna Instrument Edge Multimeter.

Procedures

Temperature/pH

The sampling container was washed using a non-sulphate containing detergent (Ariel) and dried. The sewage samples were brought into the laboratory using a 25 litres container that was also washed using a non-sulphate containing detergent. The samples were properly shook in the container before pouring them into the 4 litres sampling container. The sampling containers were filled to the 2 litres mark. The pH/Temperature probe was properly cleaned and inserted into the Hanna instrument edge multimeter. The multimeter was switched on and allowed to boot. The probe was then calibrated using the standard buffer solution for pH (Solution 7.0). The sewage sample was stirred properly for homogeneity. The probe was then deep into the sewage sample and the readings for the pH at a particular temperature was recorded. The probe was cleaned after use.

Total Dissolve Solids (TDS)/Temperature

The sampling container was washed using a non-sulphate containing detergent (Ariel) and dried. The sewage samples were brought into the laboratory using a 25 litres container that was also washed using a non-sulphate containing detergent. The samples were properly shook in the container before pouring them into the 4 litres sampling container. The sampling containers were filled to the 2 litres mark. The total dissolve solids (TDS) probe was properly cleaned and inserted into the Hanna instrument edge multimeter. The multimeter was switched on and allowed to boot. The probe was then calibrated using the standard solution for total dissolve solids (HI7031 & HI8031). The sewage sample was stirred properly for homogeneity. The probe was then deep into the sewage sample and the readings for TDS at a particular temperature was recorded. The probe was cleaned after use. The unit for TDS is milligram per litre (mg/l).

Dissolve Oxygen (DO)/Temperature

The sampling container was washed using a non-sulphate containing detergent (Ariel) and dried. The sewage samples were brought into the laboratory using a 25 litres container that was also washed using a non-sulphate containing detergent. The samples were properly shook in the container before pouring them into the 4 litres sampling container. The sampling containers were filled to the 2 litres mark. The dissolve oxygen (DO) probe was properly cleaned and inserted into the Hanna instrument edge multimeter. The multimeter was switched on and allowed to boot. The probe was then calibrated using the standard solution for dissolve oxygen (HI7041 Electrolyte solution). The sewage sample was stirred properly for homogeneity. The probe was then deep into the sewage sample and the readings for DO at a particular temperature was recorded. The probe was cleaned after use. The unit for DO is parts per million (ppm).

RESULTS AND DISCUSSION

In Table 1 and Fig. 1, the results for the aerobic sample containing crushed camphor are reported for week 1. The results obtained for the pH, shows that there was a decrease in the pH value for the aerobic sewage sample as compared with that of control. Thus, the sewage sample is alkaline which is as a result of the camphor mixing with the sewage. The result also shows a varying temperature range of 26.9^{o}C to 27.7^{o}C. From previous studies, it has been observed that a good septic tank has to have a pH value of 6 to 7.5 which is the best range for microbial growth and a temperature value above 4.44^{o}C for the aerobic bacteria to perform properly. Now looking at the data obtained from the results, only the temperature values are within the stipulated scale. The results also shows the amount of total dissolved solids (TDS) present in the sewage samples to be on the increase (Sample 3 & 4) comparing it with the control which implies that the bacteria present is degrading the sewage. The result also shows a decrease in the level of dissolved oxygen (DO) present in the sewage sample comparing it with the control. This shows that the bacteria is using the oxygen present in the sewage to breakdown the organic matter.

In Table 2 and Fig. 2, the results of the anaerobic sample containing camphor in solid form are reported for week 1. The results obtained for the pH, shows that there was an increase in the pH level for sample 1, 2 & 4 and a decrease in the pH level for sample 3 with respect to control. The pH results for the anaerobic sample falls under the neutral range which is the best range for microbial growth in the septic tank. The temperature is between 27.7^{o}C to 27.9^{o}C which is also good for the microbes found in the septic tank. The results also shows the amount of total dissolved solids (TDS) present in the sewage sample to be on the increase (Sample 4) comparing it with the control which implies that the bacteria present is degrading the sewage. The result also shows a decrease in the level of dissolved oxygen (DO) present in the sewage sample comparing it with the control. This shows that the anaerobic bacteria is using the available oxygen present in the sampling container to breakdown the organic matter.

In Table 3 and Fig. 3, the results for the aerobic sample containing crushed camphor are reported for week 2. The results obtained for the pH, shows that there was an increase (sample 1) and a decrease (sample 2, 3 & 4) in the pH value for the aerobic sewage sample as compared with that of control. Thus, the sewage sample was in the alkaline range (sample 1 & 2) and the neutral range (sample 3 & 4). The result also shows a varying temperature range of 27.1^{o}C to 28.1^{o}C. From previous studies, it has been observed that a good septic tank has to have a pH value of 6 to 7.5 which is the best range for microbial growth and a temperature value above 4.44^{o}C for the aerobic bacteria to perform properly. Now looking at the results in the table, only sample 3 & 4 are within the stipulated scale for pH and temperature. The results also shows the amount of total dissolved solids (TDS) present in the sewage sample to be on the increase (Sample 1) comparing it with the control which implies that the bacteria present is degrading the sewage. The result also shows a decrease in the level of dissolved oxygen (DO) present in the sewage sample comparing it with the control. This shows that the bacteria is using the oxygen present in the sewage to breakdown the organic matter.

In Table 4 and Fig. 4, the results of the anaerobic sample containing camphor in solid form are reported for week 2. The results obtained for the pH, shows that there was an increase in the pH level for sample 1 and a decrease in the pH level for sample 2, 3 & 4 with respect to control. The pH results for the anaerobic sample falls under the neutral range which is the best range for microbial growth in the septic tank (except sample 1). The temperature is between 26.8^{o}C to 27.1^{o}C which is also good for the microbes found in the septic tank. The results also shows the amount of total dissolved solids (TDS) present in the sewage sample to be the same with control (except sample 4). This implies that the bacteria present is degrading the sewage or is dying off. The result also shows a decrease in the level of dissolved oxygen present in the sewage sample comparing it with the control. This shows that the anaerobic bacteria is using the available oxygen present in the sampling container to breakdown the organic matter.

In Table 5 and Fig. 5, the results for the aerobic sample containing crushed camphor are reported for week 3. The results obtained for the pH, shows that there was an increase (sample 1) and a decrease (sample 2, 3 & 4) in the pH value for the aerobic sewage sample as compared with that of control. Thus, the sewage sample was in the alkaline range (sample 1 & 2)and the neutral range (sample 3 & 4). The result also shows a varying temperature range of 25.5^{o}C to 26.2^{o}C. From previous studies, it has been observed that a good septic tank has to have a pH value of 6 to 7.5 which is the best range for microbial growth and a temperature value above 4.44^{o}C for the aerobic bacteria to perform properly. Now looking at the results in the table, only sample 3 & 4 are within the stipulated scale for pH and temperature. The results also shows the amount of total dissolved solids (TDS) present in the sewage sample to be on the increase (Sample 1) comparing it with the control which implies that the bacteria present is degrading the sewage. The result also shows a decrease in the level of dissolved oxygen (DO) present in the sewage sample comparing it with the control. This shows that the bacteria is using the oxygen present in the sewage to breakdown the organic matter.

In Table 6 and Fig. 6, the results of the anaerobic sample containing camphor in solid form are reported for week 3. The results obtained for the pH, shows that there was an increase in the pH level for sample 1 and a decrease in the pH level for sample 2, 3 & 4 with respect to control. The pH results for the anaerobic sample falls under the neutral range which is the best range for microbial growth in the septic tank (except sample 1). The temperature is between 27.2^{o}C to 27.4^{o}C which is also good for the microbes found in the septic tank. The results also shows the amount of total dissolved solids (TDS) present in the sewage sample to be the same with control (except sample 4). This implies that the bacteria present is degrading the sewage or is dying off. The result also shows a decrease in the level of dissolved oxygen present in the sewage sample comparing it with the control. This shows that the anaerobic bacteria is using up the available oxygen present in the sampling container to breakdown the organic matter. Although, when the result is compared with the control, it is seen that camphor has an effect on dissolve oxygen.

In Table 7 and Fig. 7, the results for the aerobic sample containing crushed camphor are reported for week 4. The results obtained for the pH, shows that there was an increase in the pH value for the aerobic sewage sample as compared with that of control. Thus, the sewage sample was in the alkaline range. The result also shows a varying temperature range of 25.9^{o}C to 26.6^{o}C. From previous studies, it has been observed that a good septic tank has to have a pH value of 6 to 7.5 which is the best range for microbial growth and a temperature value above 4.44^{o}C for the aerobic bacteria to perform properly. Now looking at the results in the table, the pH requirements for the samples were not satisfied but the temperature requirements were satisfied. The results also shows the amount of total dissolved solids (TDS) present in the sewage sample to be on the increase with respect to the control which implies that the bacteria present is degrading the sewage. The result also shows a decrease in the level of dissolved oxygen (DO) present in the sewage sample comparing it with the control. Although, the control has a high value for dissolve oxygen which may imply that the bacteria is inactive therefore the increase in dissolve oxygen.

In Table 8 and Fig. 8, the results of the anaerobic sample containing camphor in solid form are reported for week 4. The results obtained for the pH, shows that there was an increase in the pH level for all the samples. The pH results for the anaerobic sample falls under the alkaline range which is not good for bacteria growth. The temperature remains constant for all the samples at 27.9^{o}C which is also good for the microbes found in the septic tank. The results also shows the amount of total dissolved solids (TDS) present in the sewage sample to beon the increase (sample 1, 3 & 4) with respect to control. This implies that the bacteria present is degrading the sewage. The result also shows a decrease in the level of dissolved oxygen present in the sewage sample comparing it with the control. This shows that the anaerobic bacteria is using up the available oxygen present in the sampling container to breakdown the organic matter. Although, when the result is compared with the control, it is seen that camphor has an effect on dissolve oxygen as the control has a very high DO value.

In Table 9 and Fig. 9, the results for the aerobic sample containing crushed camphor are reported for week 5. The results obtained for the pH, shows that there was an increase in the pH value for the aerobic sewage sample as compared with that of control. Thus, the sewage sample was in the alkaline range. The result also shows a varying temperature range of 25.5^{o}C to 25.9^{o}C. From previous studies, it has been observed that a good septic tank has to have a pH value of 6 to 7.5 which is the best range for microbial growth and a temperature value above 4.44^{o}C for the aerobic bacteria to perform properly. Now looking at the results in the table, the pH requirements for the samples were not satisfied but the temperature requirements were satisfied. The results also shows the amount of total dissolved solids (TDS) present in the sewage sample to be on the increase with respect to the control which implies that the bacteria present is degrading the sewage. The result also shows a decrease in the level of dissolved oxygen (DO) present in the sewage sample comparing it with the control. Although, the control has a high value for dissolve oxygen which may imply that the bacteria is inactive therefore the increase in dissolve oxygen.

In Table 10 and Fig. 10, the results of the anaerobic sample containing camphor in solid form are reported for week 5. The results obtained for the pH, shows that there was an increase in the pH level for all the samples. The pH results for the anaerobic sample falls under the neutral range (except sample 4) which is good for bacteria growth. The temperature ranges from 27.3^{o}C to 27.6^{o}C which is also good for the microbes found in the septic tank. The results also shows the amount of total dissolved solids (TDS) present in the sewage sample to beon the increase (sample 3 & 4) with respect to control. This implies that the bacteria present is degrading the sewage. The result also shows a decrease in the level of dissolved oxygen (DO) present in the sewage sample comparing it with the control. This shows that the anaerobic bacteria is using up the available oxygen present in the sampling container to breakdown the organic matter. Although, sample 1 has a high DO value as compared with other samples which implies that the micro-organisms are inactive likewise sample 5 (control). It can be deduced that camphor has an effect on dissolve oxygen as the control has a very high DO value.

Table 1. Results obtained from the Aerobic Sample Containing Crushed Camphor in Week 1

S/N	Wt. of crushed Camphor (in grams, g)	pH	Temp. (^{o}C)	TDS (mg/l)	DO (ppm)
S. 1	7.38	7.92	27.7	23.0	1.55
S. 2	14.25	7.91	27.0	23.0	1.33
S. 3	21.91	7.79	27.1	24.0	0.46
S. 4	25.75	7.78	26.9	24.0	0.40
S. 5	Control	7.91	27.2	23.0	1.70

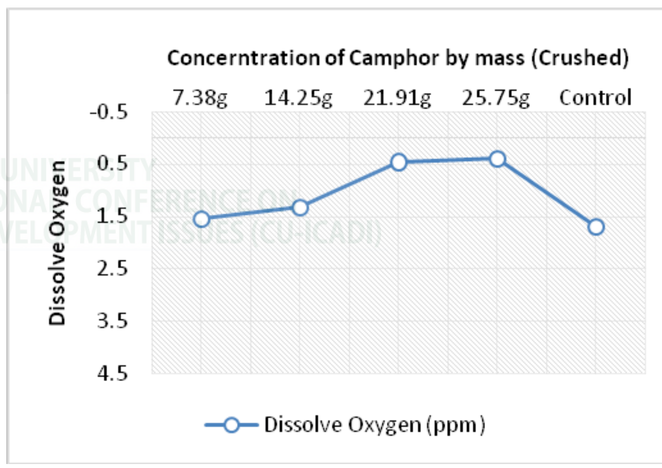

Fig. 1. Results of Dissolve Oxygen (ppm) against Concentration of Camphor for Aerobic sample in Week 1

Table 2. Results obtained from the Anaerobic Sample Containing Camphor in Solid form in Week 1

S/N	No. of Camphor (Solid form)	pH	Temp. (^{o}C)	TDS (mg/l)	DO (ppm)
S. 1	2	7.55	27.9	25.0	0.11
S. 2	4	7.49	27.8	24.0	0.14
S. 3	6	7.41	27.7	25.0	0.12
S. 4	7	7.51	27.9	27.0	0.08
S. 5	Control	7.48	28.0	25.0	0.20

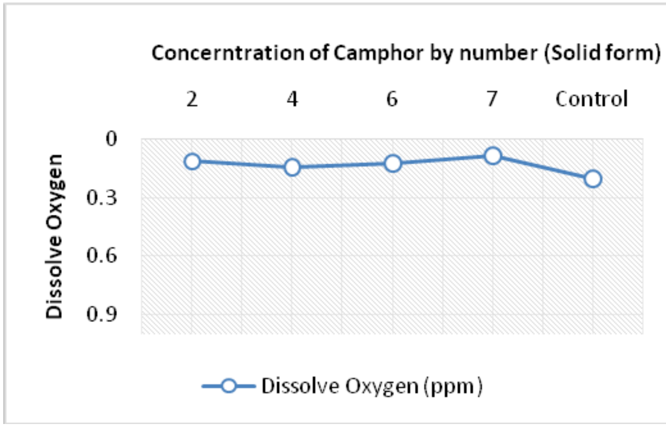

Fig. 2. Results of Dissolve Oxygen (ppm) against Concentration of Camphor for Anaerobic sample in Week 1

Table 3. Results obtained from the Aerobic Sample Containing Crushed Camphor in Week 2

S/N	Wt. of crushed Camphor (in grams, g)	pH	Temp. (^oC)	TDS (mg/l)	DO (ppm)
S. 1	7.38	7.77	28.1	22.0	0.58
S. 2	14.25	7.70	27.9	20.0	0.67
S. 3	21.91	7.60	27.2	21.0	0.71
S. 4	25.75	7.59	27.1	20.0	0.67
S. 5	Control	7.74	26.6	21.0	0.92

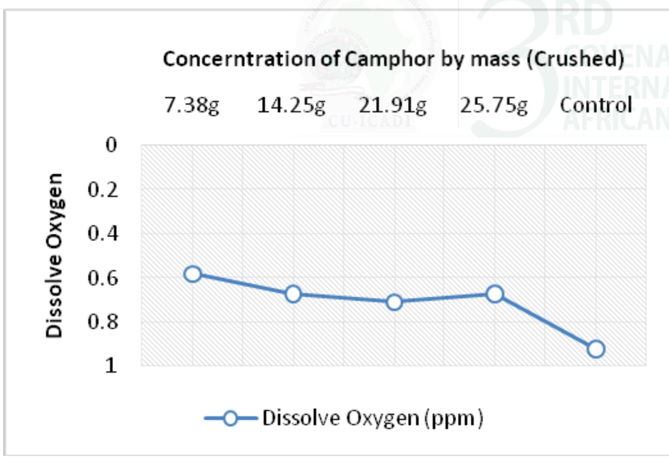

Fig. 3. Results of Dissolve Oxygen (ppm) against Concentration of Camphor for Aerobic sample in Week

Table 4. Results obtained from the Anaerobic Sample Containing Camphor in Solid form in Week 2

S/N	No. of Camphor (Solid form)	pH	Temp. (^oC)	TDS (mg/l)	DO (ppm)
S.1	2	7.84	27.1	25.0	0.27
S.2	4	7.60	26.8	25.0	0.56
S.3	6	7.55	26.9	25.0	0.69
S.4	7	7.54	27.0	24.0	0.55
S.5	Control	7.82	27.3	25.0	0.94

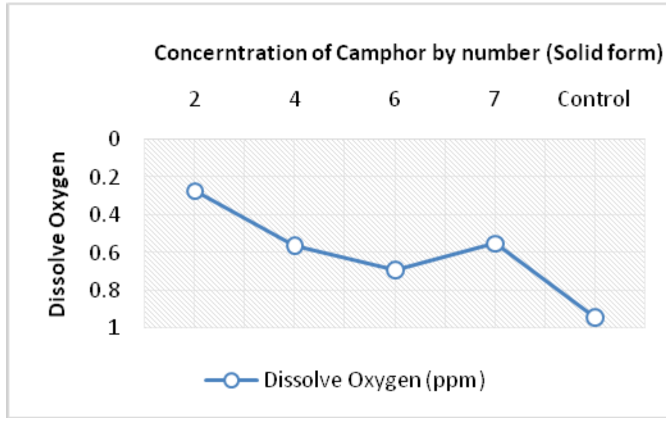

Fig. 4. Results of Dissolve Oxygen (ppm) against Concentration of Camphor for Anaerobic sample in Week 2

Table 5. Results obtained from the Aerobic Sample Containing Crushed Camphor in Week 3

S/N	Wt. of crushed Camphor (in grams, g)	pH	Temp. (^oC)	TDS (mg/l)	DO (ppm)
S. 1	7.38	7.77	25.5	22.0	0.22
S. 2	14.25	7.70	25.6	20.0	0.17
S. 3	21.91	7.60	25.9	21.0	0.16
S. 4	25.75	7.59	26.2	20.0	0.14
S. 5	Control	7.74	26.3	21.0	0.44

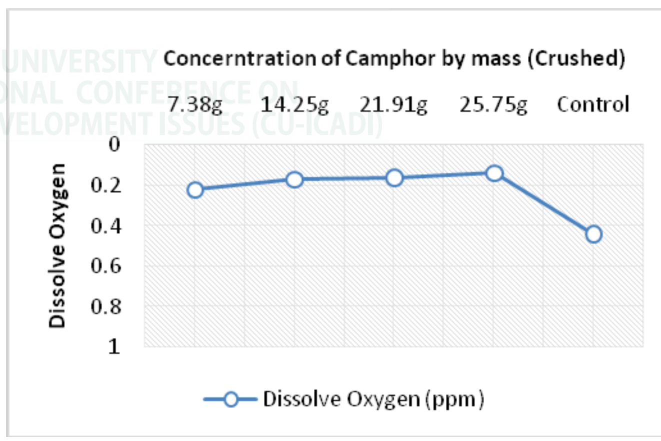

Fig. 5. Results of Dissolve Oxygen (ppm) against Concentration of Camphor for Aerobic samples in Week 3

Table 6. Results obtained from the Anaerobic Sample Containing Camphor in Solid form in Week 3

S/N	No. of Camphor (Solid form)	pH	Temp. (^oC)	TDS (mg/l)	DO (ppm)
S.1	2	7.84	27.2	25.0	0.68
S.2	4	7.60	27.2	25.0	0.65
S.3	6	7.55	27.3	25.0	0.64
S.4	7	7.54	27.4	24.0	0.56
S.5	Control	7.82	27.6	25.0	1.04

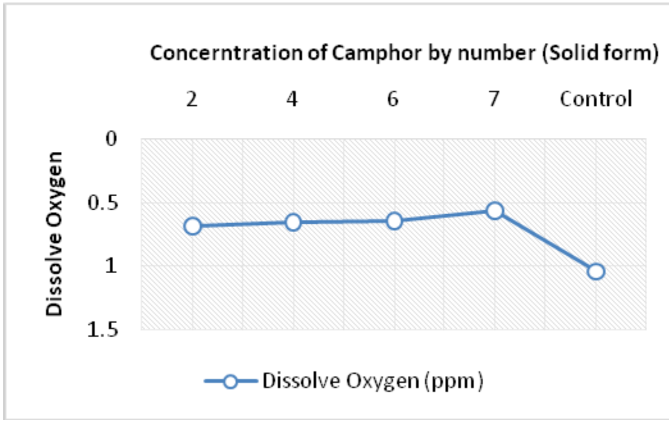

Fig. 6. Results of Dissolve Oxygen (ppm) against Concentration of Camphor for Anaerobic sample in Week 3

Table 7. Results obtained from the Aerobic Sample Containing Crushed Camphor in Week 4

S/N	Wt. of crushed Camphor (in grams, g)	pH	Temp. (^{o}C)	TDS (mg/l)	DO (ppm)
S.1	7.38	7.68	26.6	24.0	0.50
S.2	14.25	7.73	25.9	21.0	0.46
S.3	21.91	7.73	26.1	21.0	0.44
S.4	25.75	7.74	26.2	21.0	0.29
S.5	Control	7.35	26.3	18.0	4.45

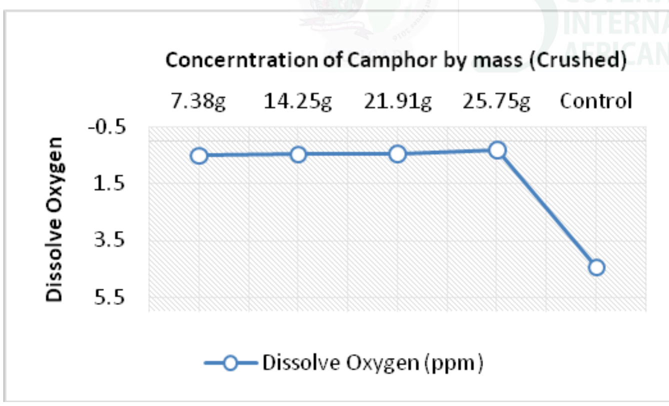

Fig. 7. Results of Dissolve Oxygen (ppm) against Concentration of Camphor for Aerobic samples in Week 4

Table 8. Results obtained from the Anaerobic Sample Containing Camphor in Solid form in Week 4

S/N	No. of Camphor (Solid form)	pH	Temp. (^{o}C)	TDS (mg/l)	DO (ppm)
S.1	2	7.32	27.9	19.0	0.80
S.2	4	7.12	27.9	18.0	0.77
S.3	6	7.36	27.9	21.0	0.62
S.4	7	7.70	27.9	23.0	0.54
S.5	Control	6.77	28.3	18.0	5.99

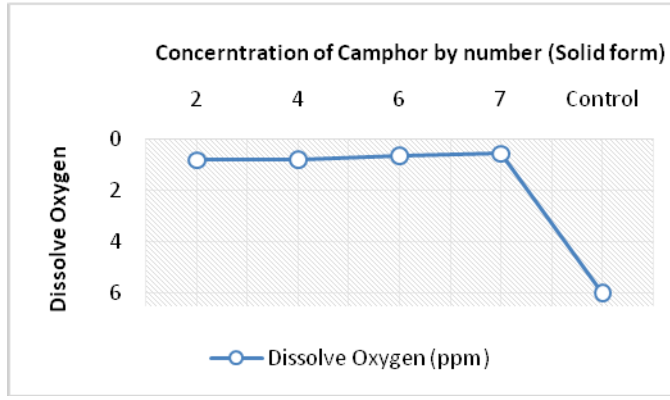

Fig. 8. Results of Dissolve Oxygen (ppm) against Concentration of Camphor for Anaerobic samples in Week 4

Table 9. Results obtained from the Aerobic Sample Containing Crushed Camphor in Week 5

S/N	Wt. of crushed Camphor (in grams, g)	pH	Temp. (^{o}C)	TDS (mg/l)	DO (ppm)
S.1	7.38	7.51	25.9	23.0	0.94
S.2	14.25	7.52	25.5	22.0	0.18
S.3	21.91	7.64	25.8	22.0	0.17
S.4	25.75	7.62	25.9	22.0	0.14
S.5	Control	7.46	26.0	20.0	3.78

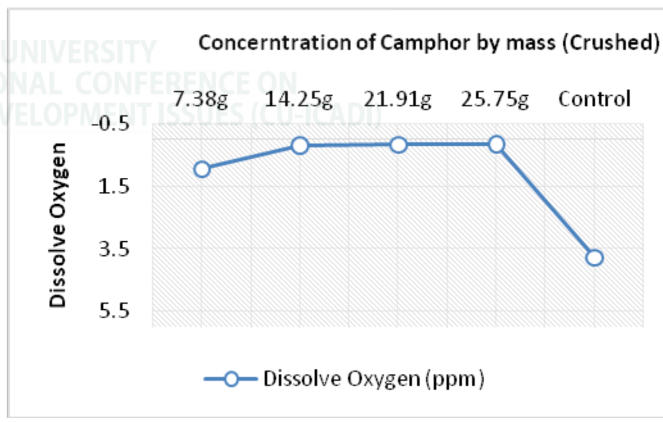

Fig. 9. Results of Dissolve Oxygen (ppm) against Concentration of Camphor for Aerobic samples in Week 5

Table 10. Results obtained from the Anaerobic Sample Containing Camphor in Solid form in Week 5

S/N	No. of Camphor (Solid form)	pH	Temp. (^{o}C)	TDS (mg/l)	DO (ppm)
S. 1	2	6.56	27.3	16.0	3.05
S. 2	4	7.22	27.3	16.0	0.86
S. 3	6	7.43	27.5	20.0	0.48
S. 4	7	7.51	27.6	23.0	0.25
S. 5	Control	6.51	28.0	19.0	4.35

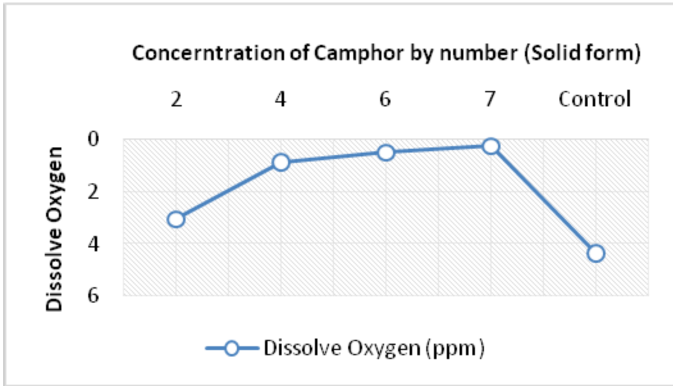

Fig. 10. Results of Dissolve Oxygen (ppm) against Concentration of Camphor for Anaerobic samples in Week 5

CONCLUSION

An assessment of the dissolved Oxygen (DO) and some relevant physio-chemical parameter in sewage further polluted with camphor under aerobic and anaerobic conditions have been studied. The results showed that dissolved oxygen for both aerobic and anaerobic sample decreased from 0.78 ppm to 0.31 ppm and 1.07 ppm to 0.34 ppm respectively. This reduction was as a result of thick films of black substance produced during interaction of sewage and camphor thereby preventing the adequate exchange of oxygen between the air and water interface. Although in a typical septic tank system, the bacteria activity requires minimum DO for septic tank operation. However, this study has shown that when such chemicals are present in large quantities, there is a propensity of gulping the little or needed DO for anaerobic digestion. Obviously, this is not good as it could possibly lead to the die-off of those bacteria thereby resulting in less organic matter being degraded and increase in shock loading in the septic tank system. And as such, this could lead to failures in septic tank. Therefore, constant flushing of toilet system to increase dilution in the septic tank chamber may not be a sustainable approach. Alternatively, it is suggested that people need to be enlightened of the possible effects of the use of camphor as odor repellent while unconsciously subjecting the septic tank to failures. Furthermore, manufacturers are advised to put the health of septic tank system into perspective while producing these chemicals by producing chemicals with little or no interference to sewage degradation.

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