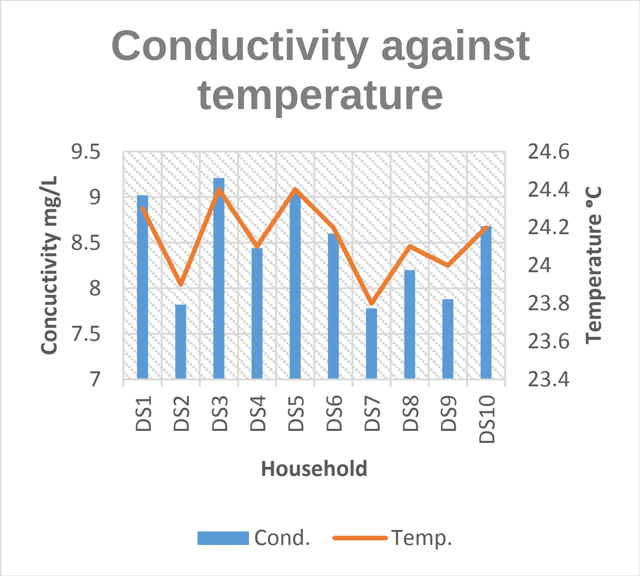

Figure 3: The effect of temperature change on conductivity

DISCUSSION

Ten rainwater samples were sampled from ten different households at Donaso for physicochemical analyses as well as some heavy metal concentrations determinations between the February and April. Table 2 indicates the mean physical parameters analyzed in the harvested rainwater at Danoso from the different households. The rainwater collected were all having some levels of physical and chemical containments. However the parameter found in these water samples were all within the permissible limits prescribe by WHO but quite below the upper limits. Exception is taken for pH which found to be outside the acceptable range of 6.5-8.5 set by WHO. Lowest average pH of 4.60 was recorded at DS9 and the highest of 5.48 was found in rainwater samples at DS1 (Table 2). The low pH figures recorded in all the samples at Donaso may due to the presence of nitrogen and Sulphur oxides which enter the atmosphere and converted to nitric acid and sulphuric acid respectively. These acids combined with hydrochloric acid arising from hydrogen chloride emissions, these acids cause acidic precipitation. Conductivity, TDS, and turbidity figures were very low compared to the international standards as shown in table 1 and 2. This may due to the fact that there were no major road or construction activities in the town and its environs during the time of research. This is in consonance with the assertion by WHO [15], that the primary sources for TDS in receiving waters include agricultural runoff, urban runoff, and industrial wastewater. Sewage, and natural sources such as leaves, silt, plankton, and rocks. The principal ions contributing to TDS are carbonates, chlorides, sulphates, nitrates, sodium, potassium, calcium, and magnesium. Total dissolved solids influence other qualities of drinking-water, such as taste, hardness, corrosion properties, and tendency to incrustation. It is a measure of the amount of material dissolved in water. Waters in areas of Palaeozoic and Mesozoic sedimentary rock have higher total dissolved solids (TDS) levels, ranging from as little as 195 to 1100 mg/litre [16]. According to Bruvold and Ongerth [17], palatability of drinking water has been related to its TDS. It is rated as excellent, less than 300 mg/L; good, between 300 and 600 mg/L; fair, between 600 and 900 mg/L; Poor, between 900 and 1200 mg/L; and unacceptable, greater than 1200 mg/L. Turbidity depends on the amount of particulate matter in the environment which may due natural or come from human activities. High turbidity may impact significantly on the number of ions in the harvested rainwater which eventually affects the conductivity of the water sample. Increase in solution temperature will cause a decrease in its viscosity and an increase in the mobility of the ions in solution. An increase in temperature may also cause an increase in the number of ions in solution due to dissociation of molecules. As conductivity of a solution depends on these factors then an increase in the solution's temperature will lead to an increase in its conductivity as shown in figure 3. The highest conductivity was found to be 9.21 µ/Sc with corresponding highest temperature of 24.4 which were recorded at DS3 as seen in figure 3. The trend ran through (figure 3). From table 2 the highest turbidity of 2.79 NTU was recorded at DS3 which invariably recorded the highest conductivity figure of 9.21 µs/cm and highest TDS of 3.21 mg/L. According to American Public Health Association [18], turbidity in water is caused by suspended matter such as clay, silt and organic matter as well as by plankton and other microscopic organism. This shows a linear correlation between conductivity and turbidity. This high turbidity levels in the harvested rainwater samples may be as a result of accumulation of dust on the roofing during the period of sample collection. In general, as the turbidity increases, the conductivity also goes up. The lowest turbidity of 1.26 NTU was recorded at DS2 with corresponding conductivity of 7.82 and TDS of 2.42 mg/L. The main source of natural alkalinity are rocks which contain CO_3^{2-}, HCO_3^- and OH^- compounds. As shown in table 1, the average conductivity figure per household was quite low in relation to the standard limit by WHO, 200 mg/L. The mean range during the period was 7.78-9.21µ/Sc. The minimum occurred at DS7 but the maximum occurred at DS3. The highest mean alkalinity of 17.20 mg/L was recorded at DS7 and the lowest was found at DS4, 14.20 mg/L. the rainwater samples were harvested from roof in plastic containers which have no contact with rocks that may impart ions in the rainwater. This explains why the mean alkalinity values were very low in all the water samples. Also it accounted for the low pH values. Because alkalinity is the ability or the capacity of water to resist changes in pH or to neutralize acid. Since the alkalinity was low in all the samples, it gave reason to understand that the ability of the harvested rain water which to neutralize the H^+ ions already in the rainwater is minimal. The relatively low alkalinity values mean that the water may have a low capacity to neutralize or "buffer" incoming acids and, therefore could be susceptible to acidic pollution since alkalinity is a measure of all the substances in water that can resist a change in pH when acid is added to the water. This reflects the very low pH values recorded in this study. The highest mean alkalinity of 17.20 mg/L with corresponding pH of 5.48 and the lowest was recorded as 14.20 mg/L and the corresponding pH 4.86 (table 1). The average concentration range over the entire period was 14.20 – 17.20 mg/L (See Table 4). The high average alkalinity value for DS7 is due is to its high total hardness and high pH values (See Tables 1 and 2). The total hardness of rainwater is due to the presence of ions such as carbonates, magnesium, bicarbonate and iron ions which cause both the temporarily and permanent hardness of water. It is most commonly expressed as milligrams of calcium carbonate equivalent per litre. Water containing calcium carbonate concentrations below 60 mg/L is generally considered as soft; 60-120 mg/L, moderately hard; and more than 180 mg/L, very hard. Hence all the harvested rainwater samples taken from the community can confidently be described as soft water. Generally the total hardness for all the samples was very low compared to the threshold limit recommended by the international bodies of 180 mg/L. The relatively low total hardness all the rainwater samples supports the existing notion that rainwater is soft and therefore, it does not contain high concentration of the ions which are responsible for permanent and temporarily hardness of water. From table 1 the maximum mean concentration of total hardness was 3.30 mg/L and the minimum was 2.42 mg/L. These low values may attribute to the fact that rainwater was harvested directly from roof tops into containers which have no sedimentary rocks that may impact calcium and magnesium ions in the rainwater. Essentially the principal source of hardness of water was completely absent. According to Exploring the Water Environment, a stream's hardness reflects the geology of the catchments area and sometimes provides a measure of the influence of human activity in watershed. Significant concentrations of all the three metals; zinc, iron and lead were found in all the water samples analyzed (table 3). This might have resulted from the dissolution of carbon dioxide, sulphur dioxide and nitrogen dioxide in the rainwater samples from that community. This led to the relatively high concentration of the metals analysed in the rainwater samples from the area as a results of the corrosion the roofing materials and rainwater collection tanks. Low pH values will lead to erosion of the aged metal roofing sheets into the water samples. The research showed considerable relationship between pH and metals concentrations.

The presence of iron and zinc in the water samples may due to the leaching of these metals from the roof surfaces. This is likely so because most of the roofs were old and rusty, and as the pH decreases the metal got eroded and found their way in the rainwater harvested.

CONCLUSION

In general, the physico-chemical quality of rainwater samples analysed in terms of total dissolved solids (TDS), total hardness and temperature, alkalinity, turbidity, and conductivity, met prescribed standards by World Health Organisation and other international bodies. However, the rainwater was found to be acidic in nature (pH < 7).

The levels of metals such as Zn, Pb and Fe, were reported present in all the samples analysed. They were also found to be below the threshold values recommended by World Health Organisation. With lead, the concentration of the metal, in all the samples was far below the permissible limit and might have arisen from the suspension of lead in the atmosphere due to previous vehicular activities and atmospheric pollutants adsorbed on the dust since no lead fittings were found on the roof of the houses were the rainwater samples were collected.

The aged nature of most of the roofing sheets and the type of collection systems might have contributed to the high levels of the remaining two metals; iron and zinc. In addition, the acidic nature of the rainwater samples analysed contributed to the high levels of metals such as Zn and Fe. On the other hand, the main problem with the quality of harvested rainwater in the studied area lies acidity. All the samples analyzed had pH below the acceptable range for good drinking water prescribed by WHO.

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Author Profile

AUTHOR 1
The author received the B.Sc. degree in Chemistry and M.Sc. degree in Analytical chemistry from Kwame Nkrumah University of Science and Technology in 2001 and 2010 respectively. After the first degree he stayed on in the Department of Chemistry as a teaching assistant between 2001 and 2002. He now with Kumasi Technical University as a lecturer.