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Effect of Storage Conditions on Physicochemical Parameters of Stream Water

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Abstract
The aim of this study is to investigate the effect of storage conditions(time, containers and locations) on physicochemical parameters of stream water in Awka, Anambra State,Nigeria. Water sample were collected from Ezustream in Amansi, Awka. The water was stored in clay pots, white and blue plastics, plain and black metal, inside and outside laboratory for twenty-eight days, within which analysis were carried out at intervals of three days. Results of the analyses were compared with World Health Organization (WHO) and Nigerian Standard for drinking water quality guidelines to evaluate its suitability for potable and domestic purposes. Results indicated that all physicochemical parameters were within WHO standard except colour concentration. Statistically at 5% significant level, storage time affected all parameters except total alkalinity, chloride and total hardness (inside) and total hardness (outside).Storage containers were affected by chloride and colour (inside), total suspended solids, chloride and colour concentrations (outside). On locations, blue plastic and black metal containers parameters were mostly affected, which implies that they are not suitable or best for storing stream water. This study has shown that storage containers have effect on water quality. Consequently, it is recommended that stream water should be stored in clay pot, white plastic and plain metal containers(inside and outside) as time improves water quality.

Keywords: Stream water, Storage containers, Physicochemical parameters, Water quality

1.0 Introduction

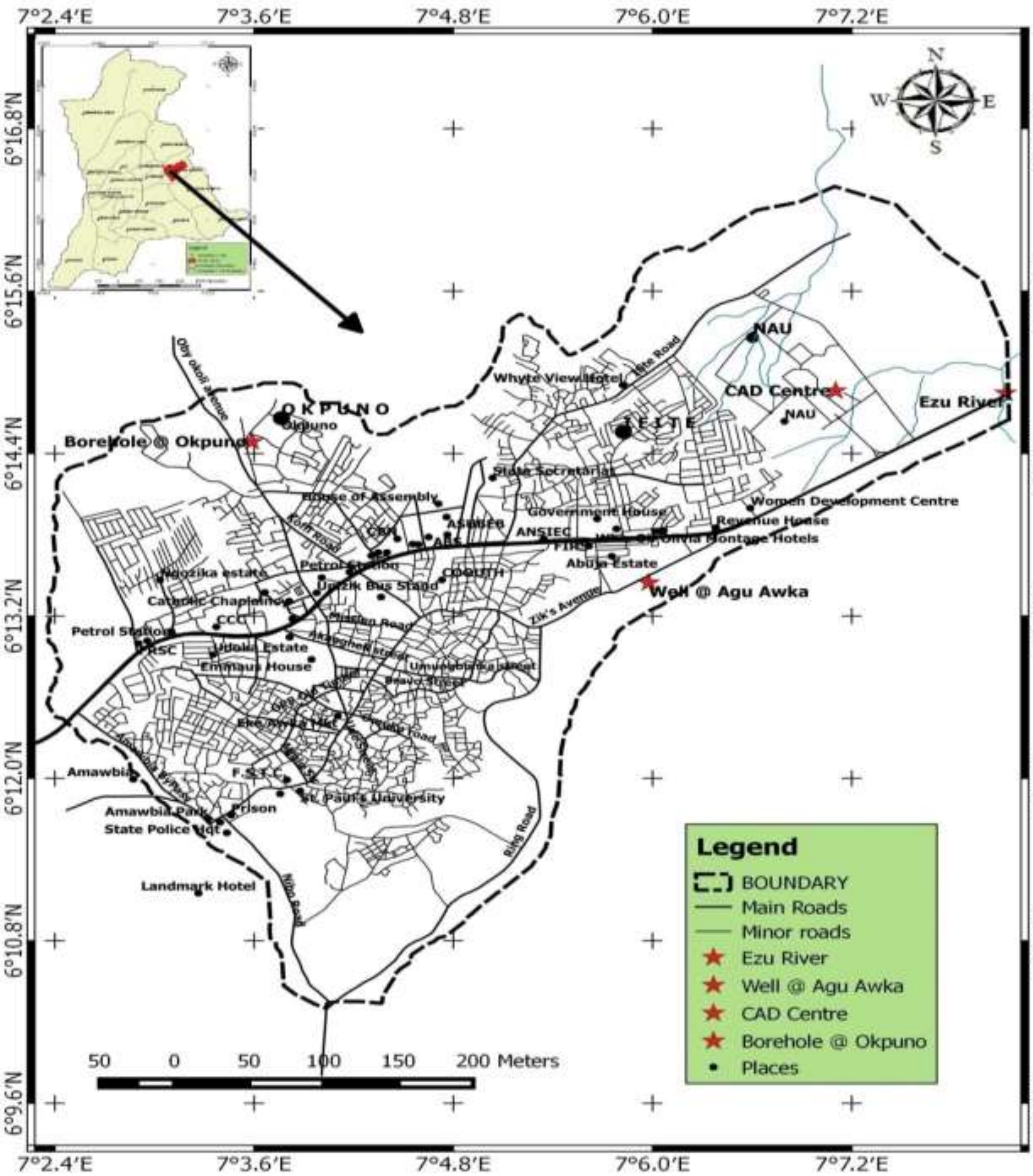
Water is one of the most essential commodities for survival of life (Ubuoh et al 2016). Human life to a large extent depends on water. It is used for cooking, bathing, drinking, irrigation and boating (Ubuoh et al 2016). The supply of water in terms of quality, quantity, and storage process continues to generate concerns (Eniola et al 2007). The provision of potable water is one of the major infrastructural problems in Nigeria as the people do not have access to water sources. Consequently, water storage becomes imperative to the populace for continuous availability or use(Osuji et al 2015; Adibeli et al 2019). However, during storage there is a great possibility of quality compromise (Adibeli et al 2019; Ogbozige 2015; Akubuenyi et al 2013; Maggy et al 2003; Agbede et al 1995; Adibeli et al 2021). Inappropriate water storage methods may introduce pathogens thereby compromising the quality (Andrew 2004; Trevett 2003; Duru et al 2013). Containers used for storing water may be made from various materials includingplastic, clay, concrete, steel, polyethylene and fibre glass. A good storage material or container should be able to maintain the water quality during storage (Ogbozige 2015). The water stored for hours or even days may increase the possibility of feacal contamination of otherwise good quality water inside the household (Valeric et al 2010; Subbaraman et al 2013). The aim of the present study is to investigate the effects of storage conditions on physicochemical qualities of stream water.

2.0 Materials and Methods

2.1 Description of Study Area

Awka, a capital city of Anambra State Nigeria, is the study area. The state lies between the co-ordinates of 6◦35' E to 7◦30'E and 5◦40'N to 6◦48N, with an approximate area of 199.1km (123.7m), by road. Awka is populated with the Igbos and located in South East Nigeria, with an average humidity of 80%, Mean Daily Temperature of 27°C and Mean Annual Rainfall of 200cm.

2.1.1 Map of Study Area



SOURCE: GIS & Cartography Lab, Department of Geography and Meteorology, Nnamdi Azikiwe University, Awka, Anambra State.

2.1.2 Method of Sampling and Collection of Water Samples

Stream water sample was collected from Ezu stream in Amansea - Awka Anambra State. It was analyzed and carried out in Civil Engineering Laboratory at Nnamdi Azikiwe Universitiy, Awka. Prior to storage, all the containers were rinsed with distilled water and later with the water sample to be stored. The stream water was stored in clay pots, white plastics, blue plastics, plain metals and black metal containers in the laboratory (indoor and outdoor). The water sample was stored for twenty-eight days. Analyses were carried out using the water stored in these containers at intervals of three days.

2.1.3 Physicochemical Parameters

The freshly collected stream water samples inside the containers were carefully transported for 30minutes to the laboratory. The temperature, Electrical conductivity, pH of each sample containers were recorded, followed by other parameters tested. Temperature and Electrical conductivity of the water samples was measured using H.M digital EC meter aqua pro water tester. It was achieved by switching "ON" and inserted into the water sample of 100mg/l collected from the storage containers, reading were taken immediately. pH: Electronic pH meter (JENWAY, 2015) was used. A buffer solution of pH4 and pH9 were prepared and was used to standardize the pH meter, the pH was inserted into the water sample (100mg/l), and the reading was taken immediately. Turbidity: This was determined with the use of turbidity meter made by Hanna. The device was standardized with respect 0.00NTU (Naphelometric Turbidity Unit). Next was the removal of the cuvette and rinsing it with distilled water and after which, 10ml of the water sample was poured into the cuvette and was covered with the cuvette cap. The cuvette was then inserted properly into the apparatus and readings were taken immediately. Total Suspended Solids: whatman paper 110mmØ rinsed in distilled water and dried in an oven at 105^0C for one hour and cooled in a desiccators. Its weight was determined using analytical weighing digital balance with a sensitivity of 0.000 degree. 100ml of water sample was filtered through the filter paper and dried at 105^0 for one hour.

The weight of the filter paper containing residue was recorded as described by Standard Analytical Procedures (1999). Total Dissolved Solids: The amount of Dissolved Solids of the water samples (100mg/l) filtered into the conical flask after oven drying at 105^0C was subtracted from the initial weight of the conical flask using gravimetric method as described by Standard Analytical Procedures (1999). Total Solids: Dry evaporating dish at 105^0C for 1 hour, cool and store in a desiccators. Weigh immediately before use. Stir sample with a magnetic stirrer. While stiring, pipette a 100mg/l into the pre-weighed evaporating dish using a wide bore pipette. The 100mg/l water sample was dried to residue. Evaporate to dryness in an over at 105^0C, allow it to cool in desiccators and weigh as described by Standard Analytical Procedures (1999). Total Alkalinity: Three drops of bromocrisol green indicator were added to100ml of the water samples in clean 25ml conical flask. The water samples were titrated with 0.02m H_2SO_4, until the colour changed from pale blue to pale yellow indicating the end point, the values were recorded. Total Hardness: Exactly 100ml of the water sample collected in a conical flask of 250ml; 2ml buffer solution was added to bring the pH of the water sample to 10.Three drops of Eriochrome black T indicator was also added. This was titrated with 0.01M EDTA from light purple to a tinge blue colour end point. Chloride: 100ml was measured into a conical flask. 1ml of standard potassium chromate (an indicator) was added and the solution was titrated with standard silver nitrate solution to a redish-brown colouration as end point. Phosphate: Exactly 100ml of the homogenized and filtered was pipette into a conical flask. The same volume of distilled water was also pipetted into another conical flask. 1ml of 18M H_2S0_4 and 0.89g of ammonium per sulphate were added to both conical flask and gently boiled for one and half hours, keeping the volume of 25-50cm^3 with distilled water.

It was then cooled, one drop of phenolpthelein indicator was added and after neutralized to faint pink colour with 2M HCL, and the solution made to 100ml with distilled water for the colorimetric analysis, 20ml of the sample was pipette into test tubes, 10ml of the combined reagent added, shaken and left to stand for 10mins before reading the absorbance at 690nm on a spectrophotometer. Sulphate: 100ml of the water sample was measured into conical flask and HCL was added to give a colourless solution. The solution was heated, stirred gently and barium chloride was added slowly until precipitation occurs. Cloudiness was formed and a precipitation of ($BaS0_4$) was formed beneath the solution. The solution precipitations completely, allowed cooling in desiccators and weigh the filter contents in the flask through an ash less filter paper and residue ($BaS0_4$) for 5mins in an oven. It was weighed to find out the final weight after drying. Colour: Dissolve 1.246g potassium chloroplatinate and 1.00g crystallized cobaltous chloride in distilled water with 100ml conc HCL and to 1000ml with distilled water. Pour water sample in a nessler tube up to 50ml mark. The three tubes were filled with colour standards which appear to correspond to the colour of the sample. The colour of the sample with that of the standards were compared by viewing vertical downward while the tubes were placed on a white surface. The water samples calculate colour units as: Colour Units =Ax50/B. where A=Estimated colour of diluted sample. B=ml sample in 50ml diluted sample as described by Standard Analytical Procedures (1999).

2.1.4 Statistical Analysis

All the data collected were analyzed statistically using analysis of variance (Two-factor without replication) Microsoft excel spread sheet 2007 version

3.0 Result and Discussion

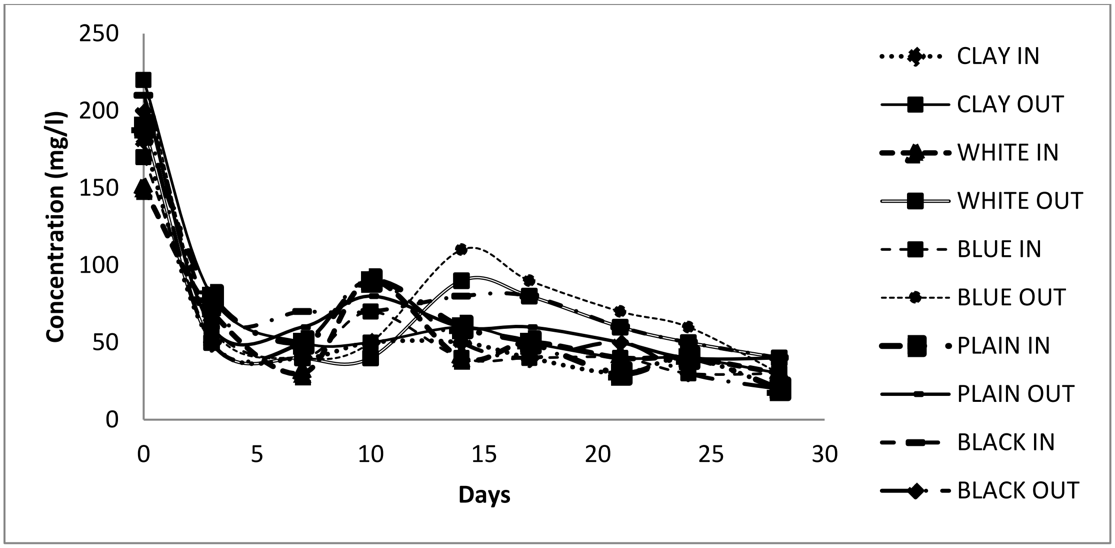


Figure 1 Total Suspended Solids concentrations for stream water stored inside and outside

The stream water used for this research work was carefully collected from Ezu stream. The results in Figure1 showed that there were improvements in Total Suspended Solids concentration with respect to time for stream water stored in each of the containers (inside and outside). The results also indicated that there were reductions in total suspended solids concentration with time irrespective of the colour of containers or locations. The stream water stored in all containers (inside) had a Total Suspended Solids concentration range of 20mg/l to 210mg/l and had a Total Suspended Solids concentration range of 20mg/l to 220mg/l (outside) as shown in Figure 1. This result obtained compare favourable with the findings of Ezeibe *et al* (2012) and Duru *et al* (2013). The reduction observed in Total Suspended Solids concentration each day of this study is due to the fact that, upon storage, big suspended or flocculated particles as well as other impurities settled down at the bottom of the storage containers thus reducing the Total Suspended Solids (Ogbozige 2015).

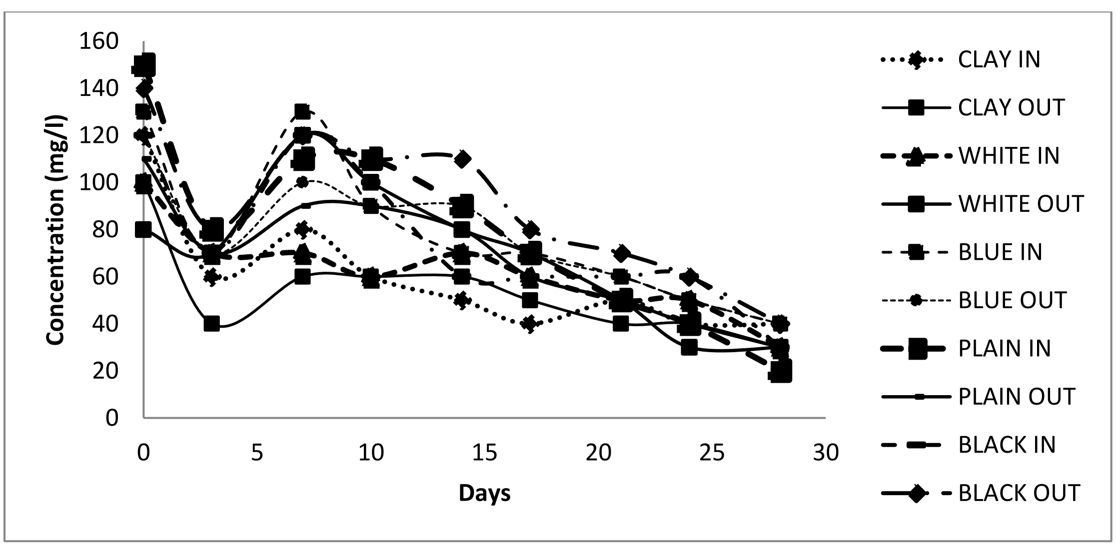


Figure 2 Total Dissolved Solids concentrations for stream water stored inside and outside.

The results shown in Figure 2 showed that there were improvements in Total Dissolved Solids concentration with respect to time for stream water stored (inside and outside) in each of the containers. The stream water stored in all containers (inside) had a Total Dissolved Solids concentration range of 30mg/l to 150mg/l and 30mg/l to 140mg/l (outside) as shown in Figure 2. The Total Dissolved Solids concentration for the stream water stored in all the containers inside and outside falls within WHO permissible limit of 600mg/l, which is in agreement with the early study of Ezeribe *et al* (2012). Moses *et al* (2016), opined that dissolved solids can settle and deposit at bottom of container upon storage thereby reducing the levels of impurities in water.

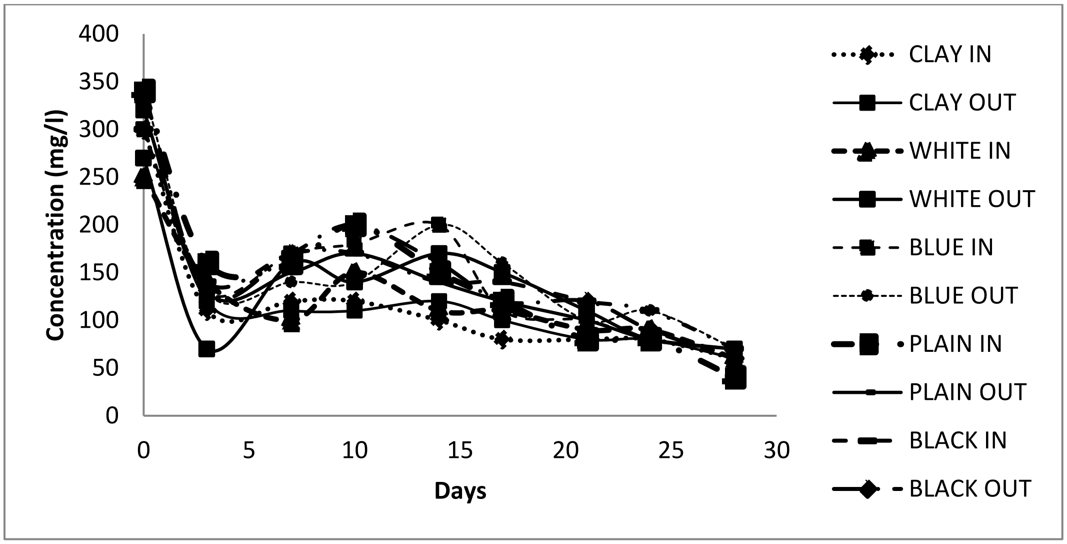


Figure 3 Total Solids concentrations for stream water stored inside and outside.

The results shown in Figure 3 show that there was improvement in Total Solids concentration with respect to time for stream water stored (inside and outside) in each of the containers. However, the stream water stored in all the containers inside had Total Solids concentration range of 40mg/l to 340mg/l (inside) and 60mg/l to 340mg/l (outside) as shown in Figure 3. The Total Solids concentration reduced each day of this study as a result of impurities that settled down at the bottom of the storage containers thus reducing the total solids (Ogbozige 2015).

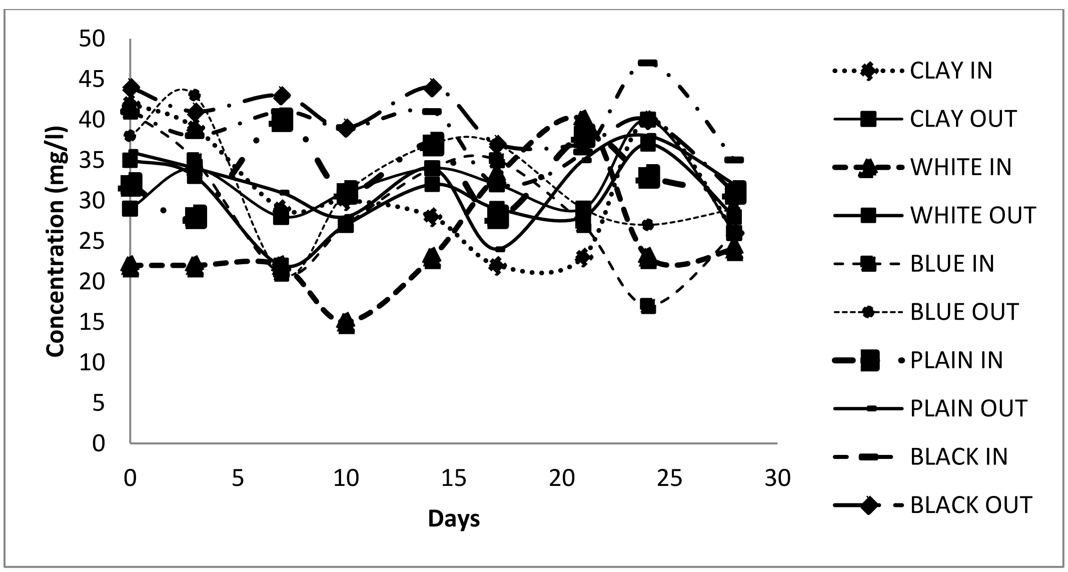


Figure 4 Total Alkalinity concentrations for stream water stored inside and outside

The stream water stored in clay pot, white plastic and blue plastic container had a Total Alkalinity concentration range of 15mg/l to 43mg/l (inside and outside) as shown in Figure 4, while the stream water stored in plain metal and black metal container had a Total Alkalinity concentration range of 24mg/l to 47mg/l (inside and outside) showing that the stream water has good buffering capacity (Ezekiel *et al* 2010). This result is in agreement with the similar study of Iloba (2017); Akubugwo*et al* (2013) and Luke *et al* (2012).

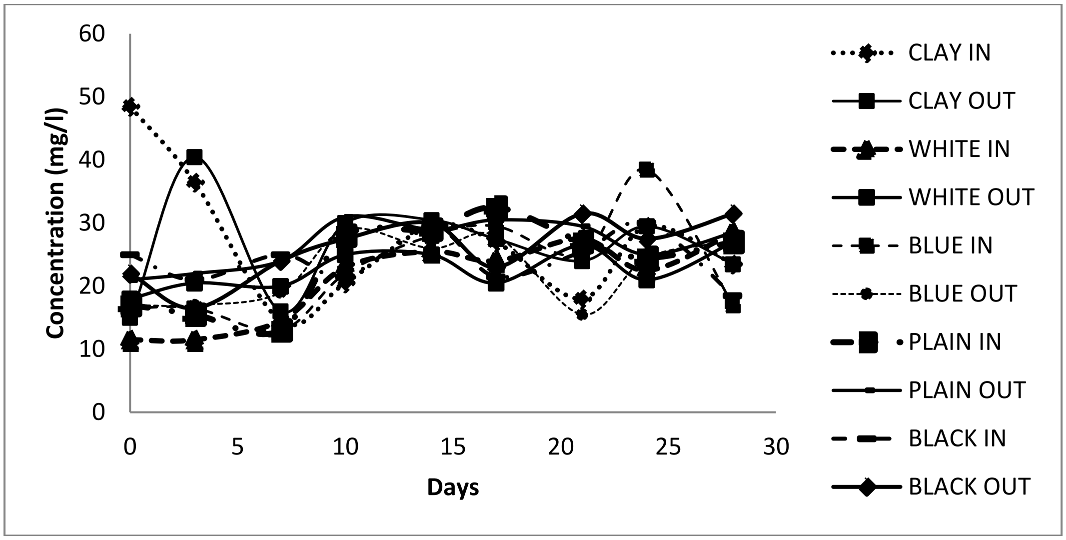


Figure 5 Chloride concentrations for stream water stored inside and outside.

The result presented in Figure 5 showed that the stream water stored in clay pot, white and blue plastic container had a chloride concentration range of 11.49mg/l to 48.48mg/l(inside and outside),while the stream water stored in plain metal and black metal container had a concentration range of 12.99mg/l to 32.48mg/l(inside and outside).This result also corroborates Ezeribe *et al* (2012) and Raymond *et al* (2013).The concentration of chloride for the stream water stored in all the containers analyzed falls within WHO permissible limit of 300mg/l.

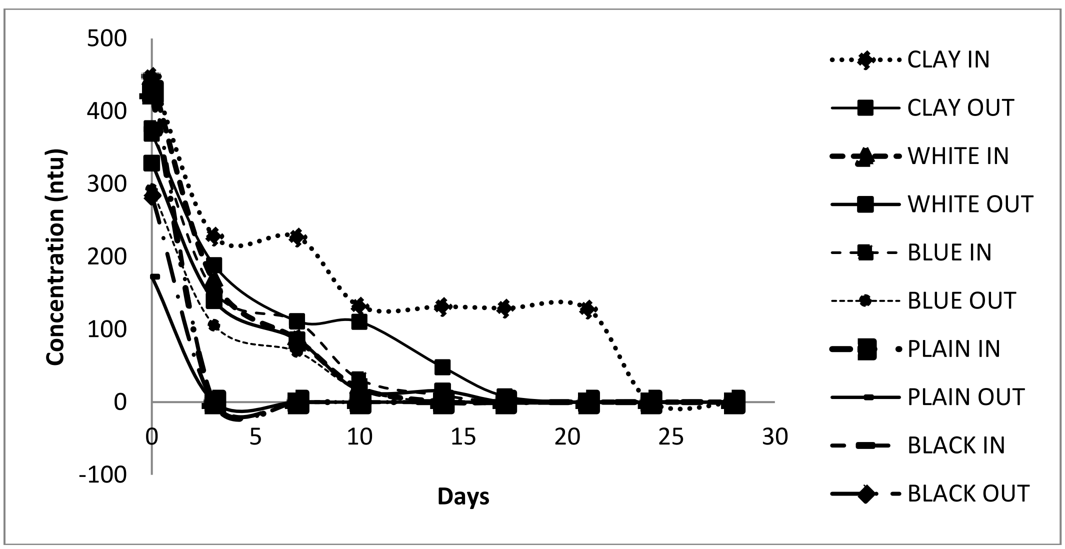


Figure 6 Turbidity concentrations for stream water stored inside and outside

The result in Figure 6 showed that there is improvement/reduction in the stream water samples stored in all containers (inside and outside). Turbidity concentration for the stream water stored in clay pot, white plastic, blue plastic, plain and black metal containers had a range 0NTU to 447.6NTU (inside and outside), but reduced after twenty-one days of storage and falls within WHO permissible limit of 5NTU. The reduction observed is as a result of the cloudiness or flocculated particles settle down in the container (Ogbozige 2015; Raymond *et al* 2013).

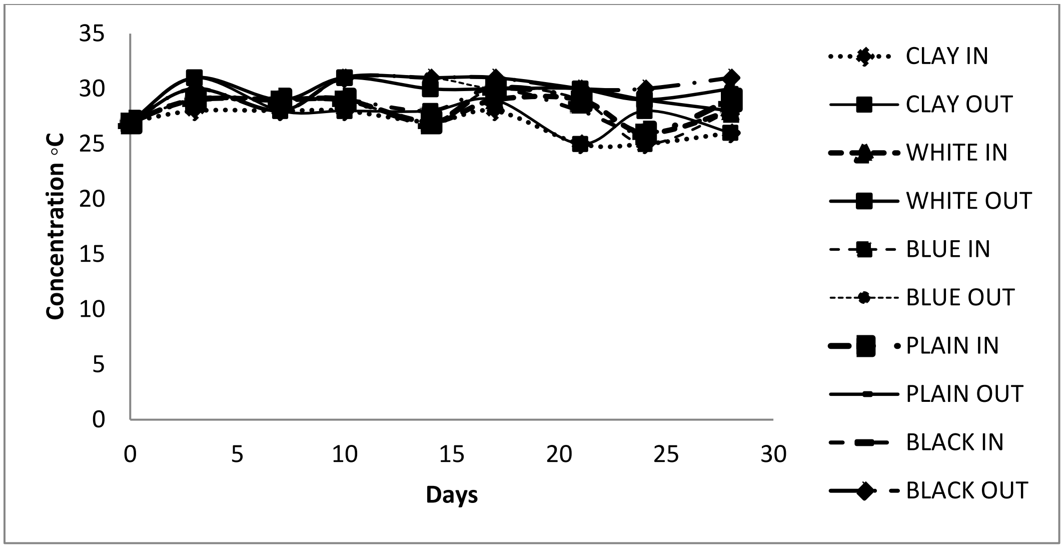


Figure 7 Temperature concentrations for stream water stored inside and outside

The Temperature measurements were taken between 10am to 12noon each day of this study. The stream water stored in all containers (inside and outside), had a Temperature concentration range of 25° C to 31ºC, falling with the recommended permissible limit of WHO as shown in Figure 7.Ehimeh*et al*.,(2011) reports similar result for river in Achlo and Niger in Idah, Kogi state, while (Manilla & Frank 2009) and (Clarke *et al* 2004) reports similar result which is in agreement with the result in this study. However, as temperature varies across different regions of the world, high temperature negatively impact water quality by enhancing the growth of micro organisms which may increase taste, odour, colour and corrosion problem (Adeyemo 2020)

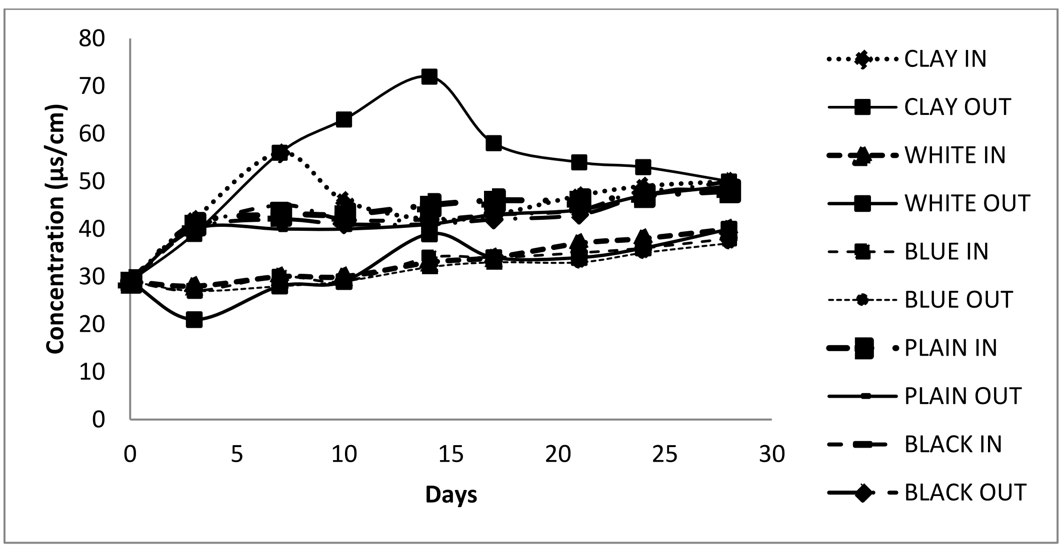


Figure 8 Electrical Conductivity concentrations for stream water stored inside and outside.

The stream water stored in all containers had Electrical Conductivity concentration range of 29µs/cm to 72µs/cm (inside and outside) as shown in Figure 8. The values of Electrical Conductivity fall within the recommended standard of WHO. The increase in Electrical Conductivity could be attributed to some electron fluctuation upon storage(Ravichandran *et al* 2016) or could be attributed to the geology of the well aquifer(Ogbozige 2015; Maxwell *et al* 2014).

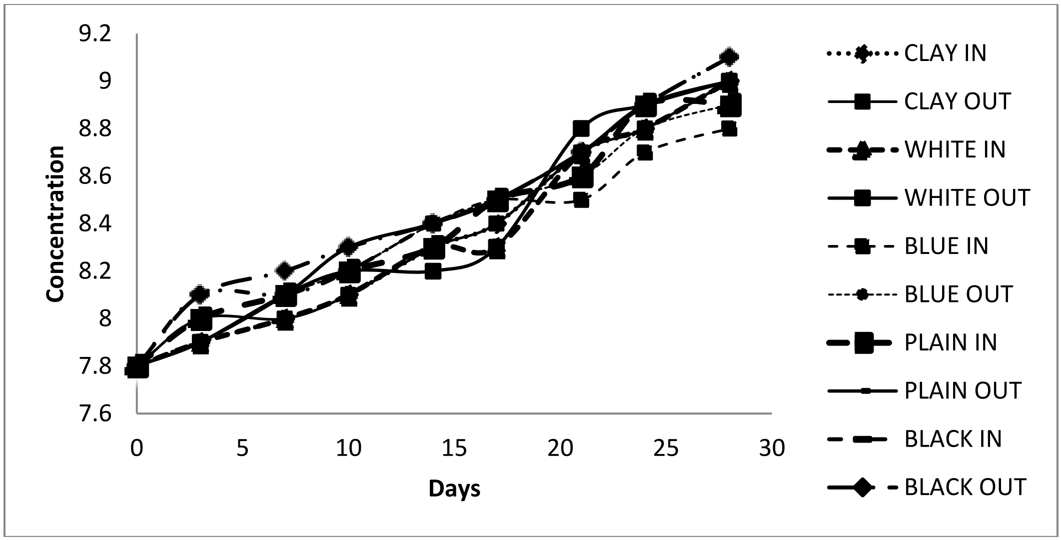


Figure 9 pH concentrations for stream water stored inside and outside

The result presented in Figure 9 showed that the stream water stored in clay pot, white plastic, blue plastic, plain metal and black metal containers had a pH concentration range of 7.8 to 9.1 (inside and outside), which is slightly above the recommended standard of drinking water. Water is said to be safe if the concentration of the substance do not exceed the level set by the regulatory bodies. A pH value above 8.0 would be disadvantageous in the treatment and disinfection of drinking water with chlorine (Adeyemo 2020). The slight increase in pH values might be due to some electron fluctuation upon storage (Ravichandran *et al* 2016). This result is in agreement with what was reported by other researchers in similar study Raji *et al* (2015) and Aremu *et al* (2011).

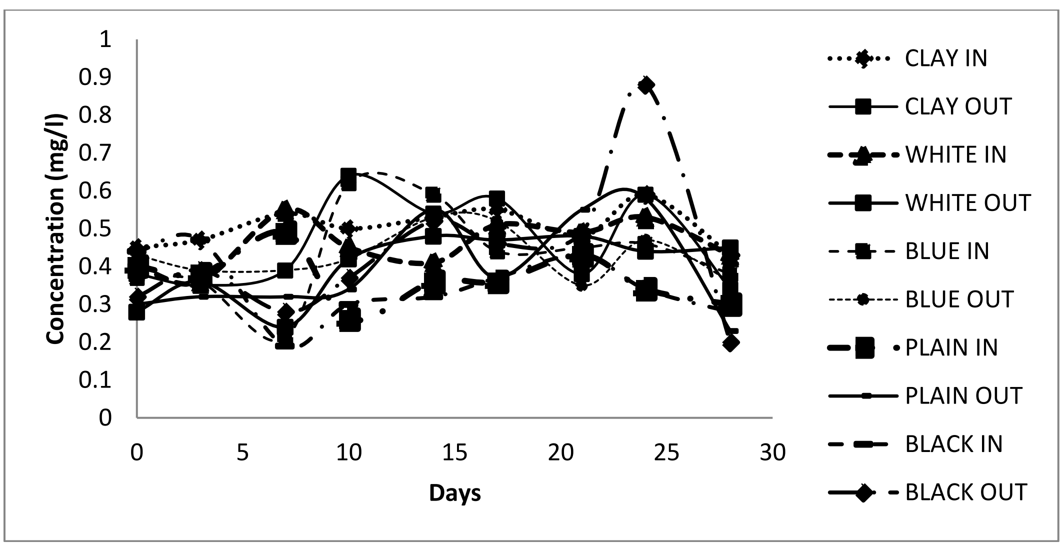


Figure 10 Total Hardness concentrations for stream water stored inside and outside

The results in table.10 suggest that storage of water in containers (inside and outside) does not guaranty the improvement or deterioration of its Total Hardness quality. This is because the variation (increase or decrease) in the concentration in each of the storage container during the storage period were not chronological (Ogbozige 2015). However, the stream water stored in clay pot, white plastic, blue plastic, plain metal and black metal container had a Total Hardness concentration range of 0.28mg/l to 0.64mg/l (inside and outside) as shown in Figure 10. This falls within WHO permissible limit 300mg/l.

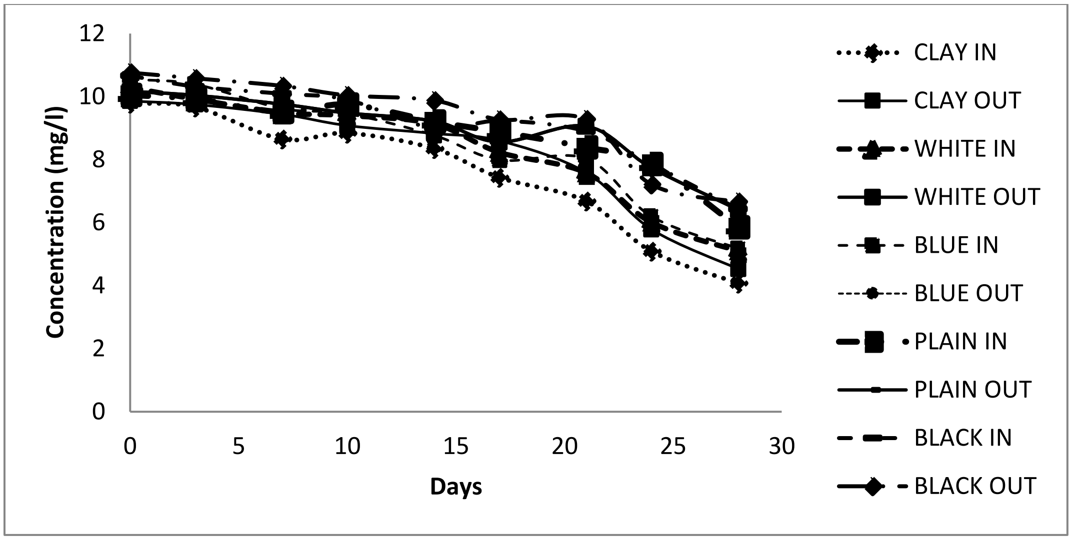


Figure 11 Sulphate concentration for stream water stored inside and outside

Sulphate had a concentration range of 4.08mg/l to 10.55mg/l (inside and outside) for the stream stored in clay pot, white and blue plastic containers, while the stream water stored in plain and black metal had a sulphate concentration range of 5.85mg/l to 10.66mg/l (inside and outside) falling within Nigerian Standard for drinking water quality (2007) as shown in Figure 11

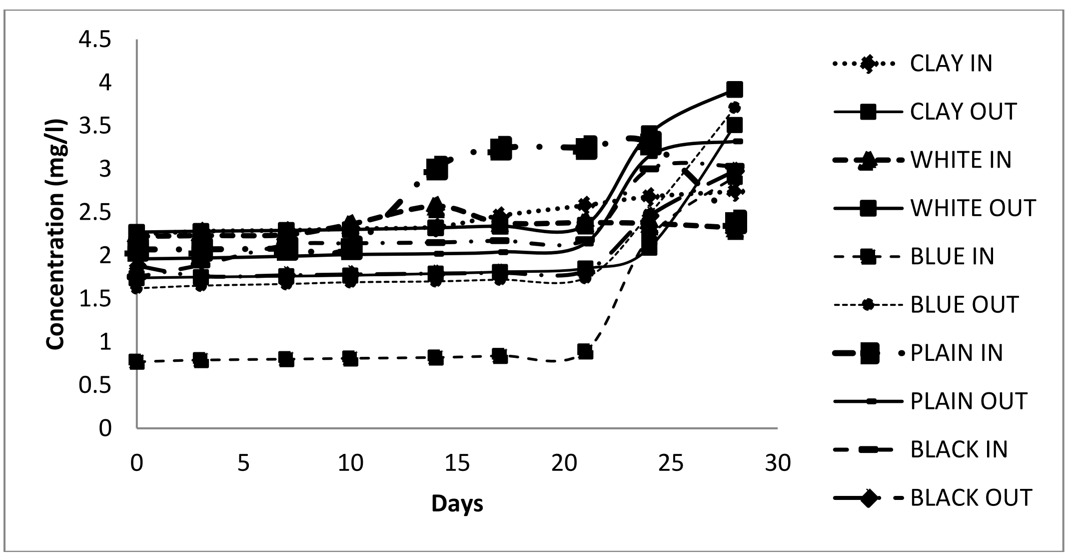


Figure 12 Phosphate concentrations for stream water stored inside and outside

The stream water stored in clay pot, white plastic, blue plastic, plain and black metal container had a Phosphate concentration range of 0.77mg/l to 3.92mg/l (inside and outside) as shown in Figure 12.

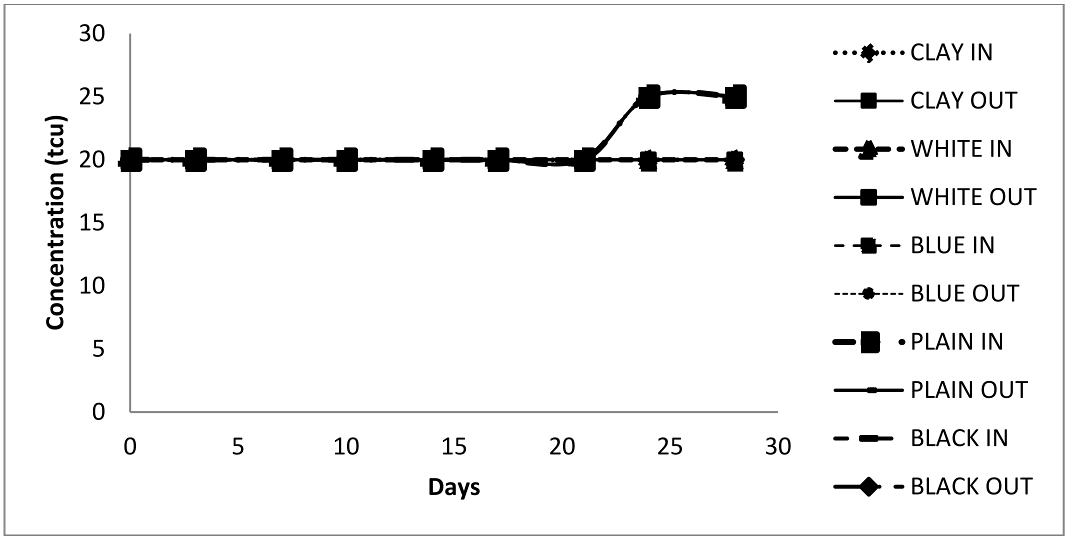


Figure 13 Colour concentrations for stream water stored inside and outside

The stream water stored in clay pot, white plastic and blue plastic containers had a colour concentration range of 20TCU (inside and outside) which does not falls within WHO permissible limit of 15TCU, while the stream water stored in plain and black metal containers had a colour concentration range of 10TCU to 25TCU (inside and outside) as shown in Figure 13. The increase in colour after twenty days in plain and black metal containers can be attributed to the rusting which might have resulted from reaction of iron in the stored water (Ogbozige 2015). The result of this study also corroborates with the findings of (Andrew *et al* 2017).

Table 1: Statistical evaluation of storage conditions on stream water physicochemical parameters at 5% significant level

Parameters	Source of variance	Type of storage container	F_Cal	F Critical	P_value
Total Suspended Solids (Mg/l)	Time	Clay pot	64.015	3.438	0.000
	Location		9.142	5.317	0.016
	Time	White plastic	7.195	3.438	0.005
	Location		1.186	5.317	0.306
	Time	Blue Plastic	10.679	3.438	0.001
	Location		5.444	5.317	0.047
	Time	Plain Metal	51.958	3.438	0.000
	Location		1.369	5.317	0.275
	Time	Black Metal	38.737	3.438	0.000
	Location		9.090	5.317	0.016
Total Dissolved Solids (Mg/l)	Time	Clay pot	13.666	3.438	0.000
	Location		2.666	5.317	0.141
	Time	White plastic	3.458	3.438	0.049
	Location		0.956	5.317	0.356
	Time	Blue Plastic	18.901	3.438	0.000
	Location		0.262	5.317	0.622
	Time	Plain Metal	20.894	3.438	0.000
	Location		5.263	5.317	0.050
	Time	Black Metal	16.365	3.438	0.000
	Location		8.243	5.317	0.020
Total Solids (Mg/l)	Time	Clay pot	143.909	3.438	0.000
	Location		1.818	5.317	0.214

	Time	White plastic	7.572	3.438	0.004
	Location		0.969	5.317	0.353
	Time	Blue Plastic	24.396	3.438	0.000
	Location		0.307	5.317	0.594
	Time	Plain Metal	60.662	3.438	0.000
	Location		0.649	5.317	0.443
	Time	Black Metal	43.900	3.438	0.000
	Location		0.210	5.317	0.658
Total Alkalinity(Mg/l)	Time	Clay pot	2.223	3.438	0.139
	Location		0.038	5.317	0.848
	Time	White plastic	0.851	3.438	0.587
	Location		3.060	5.317	0.118
	Time	Blue Plastic	12.751	3.438	0.000
	Location		6.149	5.317	0.038
	Time	Plain Metal	2.001	3.438	0.173
	Location		0.161	5.317	0.698
	Time	Black Metal	3.934	3.438	0.034
	Location		0.271	5.317	0.616
Chloride(Mg/l)	Time	Clay pot	1.145	3.438	0.426
	Location		0.085	5.317	0.085
	Time	White plastic	4.875	3.438	0.018
	Location		1.328	5.317	0.282
	Time	Blue Plastic	2.202	3.438	0.142
	Location		0.016	5.317	0.900
	Time	Plain Metal	7.122	3.438	0.005
	Location		5.408	5.317	0.048
	Time	Black Metal	1.561	3.438	0.271
	Location		0.904	5.317	0.369
Turbidity(Ntu)	Time	Clay pot	24.249	3.438	0.000
	Location		14.457	5.317	0.005
	Time	White plastic	43.361	3.438	0.000
	Location		1.201	5.317	0.304
	Time	Blue Plastic	56.284	3.438	0.000
	Location		4.874	5.317	0.058
	Time	Plain Metal	5.554	3.438	0.012
	Location		1.000	5.317	0.346
	Time	Black Metal	19.997	3.438	0.000
	Location		1.000	5.317	0.346
Temperature(°C)	Time	Clay pot	4.655	3.438	0.021
	Location		4.413	5.317	0.068
	Time	White plastic	3.185	3.438	0.060
	Location		10.666	5.317	0.011
	Time	Blue Plastic	2.244	3.438	0.136
	Location		10.000	5.317	0.013
	Time	Plain Metal	2.333	3.438	0.126
	Location		7.111	5.317	0.028
	Time	Black Metal	1.844	3.438	0.202
	Location		10.000	5.317	0.013
Electrical Conductivity (μs/cm)	Time	Clay pot	2.647	3.438	0.095
	Location		4.616	5.317	0.063
	Time	White plastic	8.385	3.438	0.003

	Location		0.765	5.317	0.406
	Time	Blue Plastic	67.814	3.438	0.000
	Location		12.000	5.317	0.000
	Time	Plain Metal	42.425	3.438	0.000
	Location		8.333	5.317	0.020
	Time	Black Metal	73.571	3.438	0.000
	Location		2.285	5.317	0.169
pH	Time	Clay pot	629.500	3.438	0.000
	Location		1.000	5.317	0.346
	Time	White plastic	147.888	3.438	0.000
	Location		2.000	5.317	0.195
	Time	Blue Plastic	212.777	3.438	0.000
	Location		4.000	5.317	0.080
	Time	Plain Metal	130.000	3.438	0.000
	Location		2.000	5.317	0.195
	Time	Black Metal	351.000	3.438	0.000
	Location		2.285	5.317	0.169
Total Hardness(Mg/l)	Time	Clay pot	3.055	3.438	0.067
	Location		1.627	5.317	0.237
	Time	White plastic	0.992	3.438	0.503
	Location		2.368	5.317	0.162
	Time	Blue Plastic	2.220	3.438	0.140
	Location		0.003	5.317	0.953
	Time	Plain Metal	1.191	3.438	0.405
	Location		0.329	5.317	0.581
	Time	Black Metal	1.335	3.438	0.346
	Location		1.659	5.317	0.233
Sulphate(Mg/l)	Time	Clay pot	101.958	3.438	0.000
	Location		18.386	5.317	0.002
	Time	White plastic	17.753	3.438	0.000
	Location		6.195	5.317	0.037
	Time	Blue Plastic	19.556	3.438	0.000
	Location		4.278	5.317	0.072
	Time	Plain Metal	54.844	3.438	0.000
	Location		0.996	5.317	0.347
	Time	Black Metal	48.146	3.438	0.000
	Location		1.876	5.317	0.207
Phosphate(Mg/l)	Time	Clay pot	2.527	3.438	0.105
	Location		7.929	5.317	0.022
	Time	White plastic	1.016	3.438	0.490
	Location		1.680	5.317	0.231
	Time	Blue Plastic	55.459	3.438	0.000
	Location		144.684	5.317	0.000
	Time	Plain Metal	1.725	3.438	0.228
	Location		2.052	5.317	0.189
	Time	Black Metal	16.918	3.438	0.000
	Location		14.871	5.317	0.004
Colour(Tcu)	Time	Clay pot	6553	3.438	0.000
	Location		6553	5.317	0.000
	Time	White plastic	6553	3.438	0.000
	Location		6553	5.317	0.000

	Time	Blue Plastic	1554	3.438	0.000
	Location		8.000	5.317	0.000
	Time	Plain Metal	1554	3.438	0.000
	Location		8.000	5.317	0.000
	Time	Black Metal	1554	3.438	0.000
	Location		8.000	5.317	0.000

The result presented in table 1 showed the statistical comparison of physiochemical parameters being affected by storage time and location. However, Total Suspended Solids concentration for the stream water stored in clay pot, blue plastic and black metal containers were significantly ($P<0.05$) affected by storage time and location, while the stream water stored in white plastic and plain metal container were significantly ($P<0.05$) affected by storage time but was not affected by storage location in terms of total suspended solids concentration as shown in table 1. The Total Dissolved Solids concentration for the stream water stored in clay pot, white and blue plastics containers were significantly ($P<0.05$) affected by storage time but were not significantly ($P>0.05$) affected by storage location, while the stream water stored in plain and black metal containers were significantly ($P<0.05$) affected by storage time and location as shown in table 1. The Total Solids concentration for the stream water stored in all the storage containers were significantly ($P<0.05$) affected by storage time but were not significantly ($P>0.05$) affected by storage location. Total Alkalinity concentration for the stream water stored in clay pot, white plastic and plain metal containers were not significantly ($P>0.05$) affected by storage time and location, while the water stored in blue plastic container was significantly ($P<0.05$) affected by storage time and location. The stream water stored in black metal container was significantly ($P<0.05$) affected by storage time but was not significantly ($P>0.05$) affected by storage location. Similarly, the concentration of Chloride for the stream water stored in clay pot, blue plastic and black metal containers were not significantly ($P>0.05$) affected by storage time and location, while the stream water stored in white plastic container was significantly ($P<0.05$) affected by storage time but was not significantly ($P>0.05$) affected by storage location as shown in table 1.

The stream water stored in plain metal container was significantly ($P<0.05$) affected by storage time and location. In the same vein, Turbidity concentration for the stream water stored in clay pot container was significantly ($P<0.05$) affected by storage time and location, while the stream water stored in white plastic, blue plastic, plain and black metal containers were significantly ($P<0.05$) affected by storage time but were not significantly ($P>0.05$) affected by storage location. Temperature of the stream water stored in clay pot was significantly ($P<0.05$) affected by storage time but was not significantly ($P>0.05$) affected by storage location, while the Temperature of the stream water stored in white plastic, blue plastic, plain and black metal containers were not significantly ($P>0.05$) affected by storage time but was significantly ($P<0.05$) affected by storage location. On the other hand, Electrical Conductivity concentration for the stream water stored in a clay pot container was not significantly ($P>0.05$) affected by storage time and location, while the Electrical Conductivity concentration for the stream water stored in white plastic and black metal containers were significantly ($P<0.05$) affected by storage time but were not significantly ($P>0.05$) affected by storage location. The Electrical Conductivity of the stream water stored in blue plastic, and plain metal containers was significantly ($P<0.05$) affected by storage time and location. The pH of the stream water stored in all the storage containers were significantly ($P<0.05$) affected by storage time but were not significantly ($P>0.05$) affected by storage location. The Total Hardness concentration of the stream water stored in all the storage containers were not significantly ($P>0.05$) affected by storage time and location.

Sulphate concentration for the stream water stored in clay pot and white plastic containers were significantly ($P<0.05$) affected by storage time and location, while the stream water stored in blue plastic, plain and black metal storage containers were significantly ($P<0.05$) affected by storage time but were not significantly ($P>0.05$) affected by storage location. The concentration of Phosphate for the stream water stored in clay pot was not significantly ($P>0.05$) affected by storage time but was significantly($P>0.05$) affected by storage location, while Phosphate concentration for the stream water stored in white plastic and plain metal containers were not significantly($P>0.05$) affected by storage time and location. The Phosphate concentration for stream water stored in blue plastic and black metal containers were significantly ($P<0.05$) affected by storage time and location. Furthermore, Colour concentration for the stream water stored in all containers were significantly ($P<0.05$) affected by storage time and location as shown in table 1.

Table 2: Statistical variation of storage time and container type for physicochemical parameters of stored stream water (inside) at 5% significant level

parameters	Source variation	F-Cal	F-critical	P-value
Total Suspended Solids (Mg/l)	Time	83.896	2.244	0.000
	Containers	7.870	2.668	0.000
Total Disolved Solids (Mg/l)	Time	24.520	2.244	0.000
	Containers	4.979	2.668	0.003
Total Solids (Mg/l)	Time	53.862	2.244	0.000
	Containers	5.623	2.668	0.001
Total Alkalinity(Mg/l)	Time	0.603	2.244	0.767
	Containers	5.370	2.668	0.002
Chloride(Mg/l)	Time	1.686	2.244	0.140
	Containers	1.042	2.668	0.400
Turbidity(Ntu)	Time	47.663	2.244	0.000
	Containers	9.526	2.668	0.000
Temperution(°C)	Time	19.082	2.244	0.000
	Containers	8.511	2.668	0.000
Electrical Conductivity (µs/cm)	Time	10.727	2.244	0.000
	Containers	29.935	2.668	0.000
pH	Time	171.818	2.244	0.000
	Containers	3.563	2.668	0.016
Total Hardness(Mg/l)	Time	0.612	2.244	0.760
	Containers	4.900	2.668	0.003
Sulphate(Mg/l)	Time	84.329	2.244	0.000
	Containers	18.705	2.668	0.000
Phosphate(Mg/l)	Time	3.647	2.244	0.004
	Containers	17.760	2.668	0.000
Colour(Tcu)	Time	2.666	2.244	0.022
	Containers	2.285	2.668	0.081

The result presented in table 2 showed the statistical comparison of physiochemical parameters being affected by storage time and container type inside. The Total Suspended Solids, Total Dissolved Solids and Total Solids concentration for the stream water stored in all the storage containers inside were significantly ($P<0.05$) affected by storage time and container type as shown in table 2. However, Total Alkalinity concentration for the stream water stored in all the containers inside were not significantly ($P>0.05$) affected by storage time but were significantly ($P<0.05$) affected by storage container type. The concentration of Chloride for the stream water stored in all the containers inside were not significantly ($P>0.05$) affected by storage time and container type as shown in table 2 above. Turbidity, Temperature, Electrical Conductivity, pH, Sulphate and Phosphate concentration were significantly ($P<0.05$) affected by storage time and container type. Additionally, the Total Hardness concentration for the stream water stored in all the storage containers inside were not significantly ($P>0.05$) affected by storage time but were significantly ($P< 0.05$) affected by storage container type. Furthermore, the Colour concentration for the stream water stored in all the storage containers inside were significantly ($P<0.05$) affected by storage time but were not significantly ($P>0.05$) affected by storage container type.

Table 3: Statistical variation of storage time and container type for physicochemical parameters of stored stream water (outside) at 5% significant level

Parameters	Source of Variance	F_Cal	F Critical	P_value
Total Suspended Solids (Mg/l)	Time	57.898	2.244	0.000
	Containers	1.435	2.668	0.245
Total Disolved Solids (Mg/l)	Time	30.378	2.244	0.000
	Containers	14.849	2.668	0.000
Total Solids (Mg/l)	Time	61.180	2.244	0.000
	Containers	3.850	2.668	0.011
Total Alkalinity(Mg/l)	Time	3.203	2.244	0.004
	Containers	7.256	2.668	0.000
Chloride(Mg/l)	Time	2.794	2.244	0.018
	Containers	1.854	2.668	0.140
Turbidity(Ntu)	Time	34.322	2.244	0.000
	Containers	5.872	2.668	0.001
Temperature(°C)	Time	7.313	2.244	0.000
	Containers	7.367	2.668	0.000
Electrical Conductivity (µs/cm)	Time	4.781	2.244	0.000
	Containers	21.654	2.668	0.000
pH	Time	171.818	2.244	0.000
	Containers	3.563	2.668	0.016
Total Hardness(Mg/l)	Time	0.612	2.244	0.760
	Containers	4.900	2.668	0.003
Sulphate(Mg/l)	Time	84.329	2.244	0.000
	Containers	18.705	2.668	0.000
Phosphate(Mg/l)	Time	3.647	2.244	0.004
	Containers	17.760	2.668	0.000
Colour(Tcu)	Time	2.666	2.244	0.022
	Containers	2.285	2.665	0.081

The result presented in table 3 showed the statistical comparison of physiochemical parameters being affected by storage time and container type outside. Total Suspended Solids concentration for the stream stored in all the storage containers outside were significantly($P< 0.05$) affected by storage time but were not significantly($P< 0.05$) affected by storage container type as shown in table 3. Total Solids and Total Alkalinity concentration for the stream water stored in all the storage containers outside were significantly ($P<0.05$) affected storage time and container type. Chloride and Colour concentration for the stream water stored in all the storage containers outside was significantly ($P<0.05$) affected by storage time and container type. Turbidity, Temperature, Electrical Conductivity, pH, Sulphate and Phosphate concentration for the stream water stored in all the storage were significantly ($P<0.05$) affected by storage time and container type as shown in table 3. Additionally, the Total Hardness concentration for the stream water stored in all the storage containers outside were not significantly ($P>0.05$) affected by storage time but were significantly ($P<0.05$) affected by storage container type as shown in table 3

4.0 Conclusion

This study focused on the effects of storage conditions on physicochemical parameters of stream water in Amansea - Awka, Anambra state, Nigeria. Storing of stream water was found desirable as it improved the water quality upon storage with respect to time. All physicochemical parameters were significantly affected by storage time (inside and outside), except Total Alkalinity, Chloride, Total Hardness (inside), and Total Hardness (outside). Chloride and Colour were significantly affected by storage containers (outside). Storage location had a significant effect on Total Suspended Solids (clay pot, blue plastic and black metal containers), Total Solids were significantly affected in all storage containers, Total Alkalinity (blue Plastic), Chloride (plain metal), Turbidity (clay pot), Temperature (white plastic, blue plastic, plain and black metal), Electrical Conductivity (blue plastic and plain metal) PH and Total Hardness in all the storage containers were not significantly affected by storage location. Sulphate (clay pot, white plastic) Phosphate (clay pot, blue plastic and black metal), Colour (clay pot, white plastic, blue plastic, plain and black metal).

5.0 Recommendation

Consequently, it is recommended that stream water should be stored in clay pot, white plastic and plain metal containers (inside and outside) as time improves water quality during storage

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Nomenclature

CLAY IN= Stream water stored in clay pot stored inside, CLAY OUT= Stream water stored in clay pot stored outside, WHITE IN= Stream water stored in white plastic inside, BLUE IN= Stream water stored in blue plastic inside, BLUE OUT= Stream water stored in blue plastic outside, PLAIN IN= Stream water stored in plain metal inside, PLAIN OUT= Stream water stored in plain metal stored outside, BLACK IN= Stream water stored in black metal inside, BLACK OUT= Stream water stored in black metal outside.

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