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The Use of Electronic Equipment in Assessing Physicochemical Parameter of Some Sachet Water Samples in Akoko Land of Ondo State, Nigeria

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Abstract

Measurement of water parameters such as pH, turbidity, dissolve oxygen, conductivity and temperature were studied to prevent water pollution and reduce water related diseases. Traditional method of water monitoring requires collecting data from various sources manually and samples taken to laboratory for testing and analyzing. In order to save time and money wasted on traditional method, a low cost multi-parameters monitoring system based on wireless network was set up to achieve remote real-time monitoring of water quality of available sachet water in Akoko Local government of Ondo State, Nigeria. The equipment consists of two subsystems: data collection subsystem which consists of monitoring sensors and data management subsystem which accesses and receives data from sensors and displays on liquid crystal display (LCD) to the user. In the equipment solar cells and lithium cells were used for power supply. The dissolved oxygen sensor, pH sensor, temperature sensor, turbidity sensor and conductivity sensor were used to measure and monitor the water quality parameters. The experimental trials were carried out on some important sachet water samples in Akoko land. Various water parameters were assessed and successfully logged into the card. The following results from Physicochemical Parameters shows that all the samples have pH ranged from 6.4 - 7.2, dissolved oxygen ranged 6.4 - 6.8m/l, conductivity ranged from 43.3 - 24µS/cm, temperature ranged from 25.6 - 27.1℃ and turbidity ranged from 75 - 50 NTU. The results of pH, electric conductivity, temperature, turbidity and dissolved oxygen were conformed within the permissible limit recommended by World Health Organization (WHO), Nigeria Industrial Standard (NIS) and Standard Organization of Nigeria (SON) for human consumption and safe drinking water. Therefore, sachet drinking water in Akoko land is safe for consumption.

Introduction

According to Federal ministry of water Resources (FMWR), twenty million people in our country is still drinking contaminated water. The World health Organization (WHO) has also stated this crisis as "the largest mass poisoning of a population in history". Population growth, urbanization and industrialization have led to the decline of quality of surface waters globally (Martinez et al., 2011; Walakira and Okot-okumu, 2011; Owa, 2013). According to the Pan African Chemistry Network (PACN), Africa's population exceeded 1.1 billion in 2014 and continues to increase at a rate of 2.4 % annually (PACN, 2015). Of this population, more than 341 million lack accesses to clean drinking water and a further 589 million have no access to adequate sanitation, resulting in loss of productivity due to water-related illnesses (PACN, 2015). Water for human use requires sustaining an adequate water quality standards and changes in water quality threatens human health (Massoud, 2012).

Sachet packaged drinking water is very common in Nigeria. It is often found as a major source of water at food canteens and sold by many food vendors in the country (Abdullahi, et al., 2019). The non- availability of good quality drinking water has resulted in number of health challenges as water is known to be a primary causative agent of many contagious diseases (Abdullahi,et al., 2019). Contaminated water is one of the major causes of illnesses in the world. Since John Snow, the father of epidemiology, discovered disease-causing microorganisms in drinking water, scientists have been trying to either eradicate diseases caused by microorganisms or to monitor so as to ensure public safety and prevent disease outbreaks. Waterborne disease outbreaks (WBDOs) associated with drinking water contamination has caused epidemics throughout history. Most of the causes of these outbreaks are related to poor distribution water system infrastructure, water treatment, and monitoring. Most people rely on streams, hand dug wells, and other sources of water that may be available to them. The lack of safe water availability in the developing world transcends health issues, and is also a strong indicator of human poverty and a lack of economic resources. Failure to ensure drinking-water safety may expose the community to the risk of outbreaks of intestinal and other infectious diseases. Outbreaks of waterborne disease are particularly to be avoided because of their capacity to result in the simultaneous infection of a large number of persons and potentially a high proportion of the community. This gives chance to private individuals to invest in the production of packaged drinking water (Abdullahi, et al., 2019). Sachet water can be referred to as ready to drink packed and machine-sealed water. This water is referred to as "pure water" by many of the locals in Nigeria and other African neighboring countries like Ghana, Niger, Benin Togo etc (Adiotomre and Agbale, 2015). The five (5) major water quality parameters considered for the examination in this study are pH, Temperature, Turbidity, Dissolved oxygen (DO), conductivity. The objective of this study is to provide information on the physicochemical characteristics of some sachet water in Akoko land.

Study Area

The Akoko are a large Yoruba cultural sub-group in the Northeastern part of Yorubaland. The Akokos as a subgroup make up 20.3% of the population of Ondo State. Out of the present 18 Local

Government Councils it constitutes four; Akoko Northeast, Akoko Northwest, Akoko Southeast and Akoko Southwest. Akoko comprises about 45 small towns and villages, predominantly situated in rocky outcrop areas of northern Ondo state. The rocky terrain nevertheless, may have helped the region to become a melting pot of sorts with different cultures coming from the north, eastern and southern Yoruba towns and beyond. Akoko became one of the few Yoruba clans with no distinctive local dialect. Major Akoko settlements include; Ọkà, Ikare, Oba, Ikun, Arigidi, Ugbe, Ogbagi, Okeagbe, Ikaram, Ibaram, Iyani, Akungba, Erusu, Ajowa, Akunu, Gedegede, Isua, Auga, Ikakumo, Supare, Epinmi, Ipe, Ifira, Ise, Iboropa, Irun, Iye, Afin, Igashi, Sosan, Ipesi, Etioro, Ayegunle, Eriti and Oyin as shown in Figure 1. In addition to this group, there are several other autonomous communities of varying sizes.

The Akokos occupy a frontier zone of Yorubaland and are bound to the north by the Owé Okun Yorubas and the Ebira people, to the west by the Ekitis, to the south by the Owos and the Owan/Ora, and to the east by the Afemai groups. The climate at Akoko, which is 97.65 metres (320.37 feet) above sea level, is classified as tropical wet and dry or savanna (Aw). Akoko lies on the geographical coordinates of 5^0 5’ 0” N, 7^0 18’ 0” E. The district's average annual temperature is -0.69% lower than Nigeria's averages at 28.77oC (83.79oF). 233.37 millimetres (9.19 inches) of precipitation and 267.89 wet days (73.39% of the time) are Akoko's usual yearly precipitation totals.

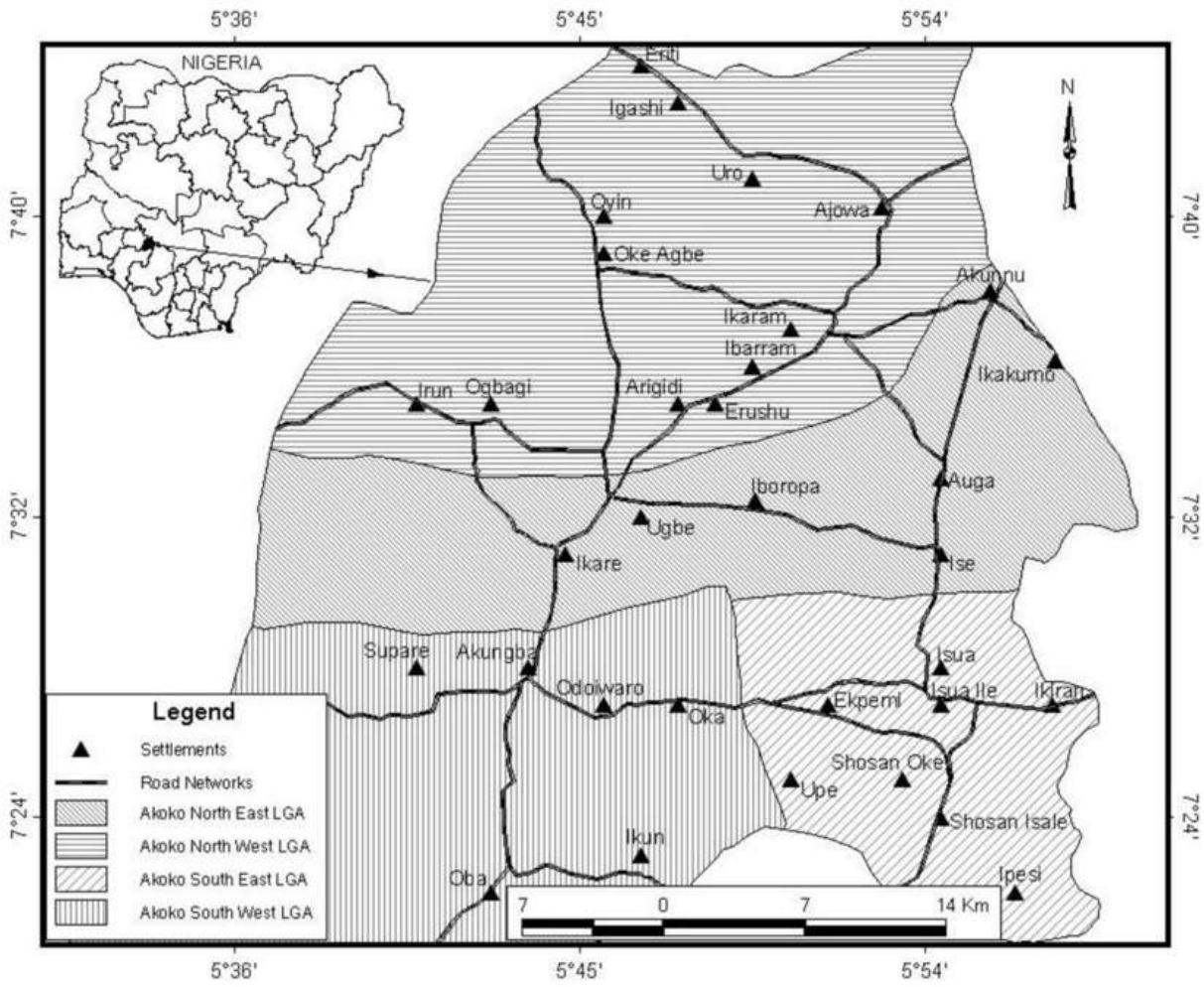

Figure 1: The map of Akoko land

System Design and Development

Figure 2 shows the general blocks diagram of water quality monitoring system. Three main subsystems identified include

1. Data collection subsystem which consists of multi-parameter sensors and optional wireless communication device to transmit the sensor information to the controller. A controller gathers the data, processes same.
2. Data management subsystem which accesses the data and displays same to the end user.
3. Data transmission subsystem consists of a wireless communication device which transmits the data from the controller to data storage.

The electronic materials used to develop the water quality monitoring system are, Sensors, Amplifiers, Analog-to-digital converters, AT89C52 Microcontroller, Transmitters, Receivers, Micro SD, shield +TF card, PC, Display unit and Timer. All these components will be connected together and appropriate embedded program using MickroC platform for decoding. Various

parameters of water quality will be automatically detected under the control of single chip microcontroller. The microcontroller will get signals from different sensors then process and analyze them as shown in block diagram in figure 1. The data will be instantaneously sent to monitoring center through GPRS (General Packet Radio Service) network. The system realizes the automation of water quality monitoring, intelligence of data analyzing, networking of information transfer and fast dissemination of information to relevant stakeholders for making timely decisions

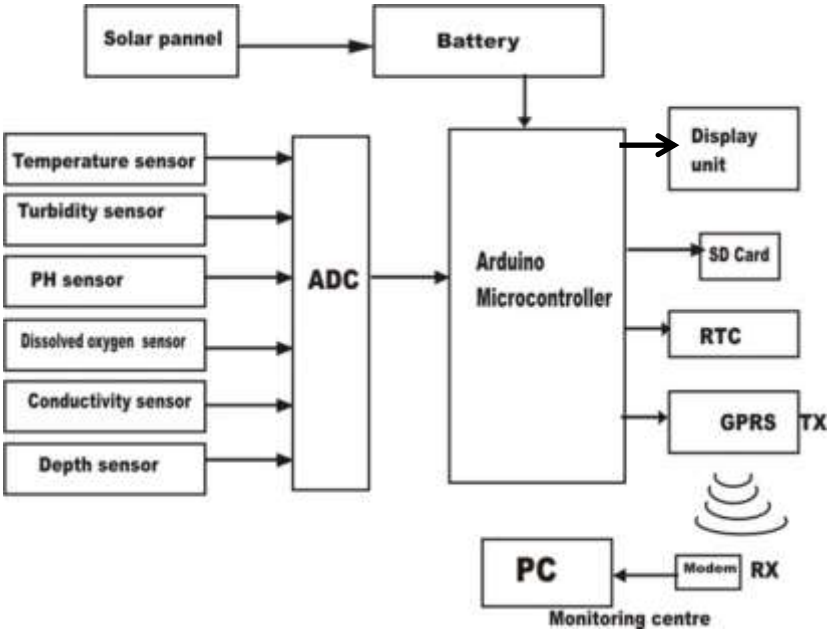

Figure 1: Block Diagram of multi-parameter water quality monitoring system

Samples collection

Samples

Sample A- Funmilayo Sachet and Table Water Company, Agbaluku Arigidi Akoko.
Sample B – AAUA Sachet and Table Water Company, AAUA Akungba Akoko.
Sample C – Divine Sachet and Table Water Company, Ikare Akoko.
Sample D - Kolatoks Sachet Water Company, Oka Akoko.
Sample E - Iyaniwura Sachet Water and Table water Company, Ogbagi Akoko.

Physical information about the water samples were observed and examined through the labels on sterile polypropylene sample containers. Information such as Producers name, Contact information, Batch number, Nutritional information, Expiration date (Best before date), Manufacturing date and NAFDAC registration number.

About five (5) pages of 20 pieces each from five different brands (Plate 1, 2 and 3) were purchase from the sellers as packaged by the manufacturers and emptied into five sample bowls for assessment.

Plate 1: Funmilayo Sachet water Water

Plate 2: Divine Sachet Water

Plate 3: AAUA Sachet

The Physicochemical Parameter such as pH, Temperature, Turbidity, Dissolved oxygen (DO), conductivity of all the water samples was determined using the developed Multiparameter equipment as shown in plate 4. These trials were conducted on June 18th, 2024, between 11:00 am and 11:40 am. The system was switched on to take the ambient temperature before deploying into the water. During the period of each experiment, pH, temperature, turbidity, dissolved oxygen and conductivity data were collected with a constant time interval.

Plate 4: Measurement of water quality parameters of water samples

Results and Discussions

The physico-chemical parameters are important for assessing the water quality. The main purpose of analyzing the physical, chemical characteristics of water is to determine its pollution status.

The result of physical examination of the entire sachet is shown in Table 1. The result revealed that none of the sachet water company had about 100% compliance in term of the Producers name, Contact information, Batch number, Nutritional information, Expiration date (Best before date), Manufacturing date and NAFDAC registration number. The National Agency for Food, Drug Administration and Control (NAFDAC) requires that all the labelling of food and drugs must be informative and accurate. These information are however essential as it tells the consumer whether the water sample is still within its shelf life or not (Abdullahi, et al., 2019). All the sachet water examined does not have Manufacturing date, Batch number and Mineral composition on their labeling. In the case of Expiration date, only Sample C (Divine Sachet and Table Water Company, Ikare Akoko) had Best before date on the sachet labeling. Batch number is essential for any product especially when there is need to recall a product from the market in the event of discovery of any abnormality with the product (Abdullahi, et al., 2019). The act of non-compliance by sachet water production companies as we truly observed in this research work post a great concern as the

packaged water sold to the entire public are liable to cause health risk when consumed. It has been reported that significant number of packaged water vendor that resist compliance to best practices laid down by the authorities do not have the license to operate (Ndinwu *et al*., 2008; Olaoye and Onilude, 2009).

Table 1: Results of Physical Examination of Sachet Waters

Samples	Name of the Product	Address of the Manufacturer	Manufacturing Date	Batch Number	Expiry Date of the Product	NAFDAC Number	Mineral Composition
Funmilayo	✓	✓	×	×	×	✓	×
AAUA	✓	✓	×	×	×	✓	×
Divine	✓	✓	×	×	✓	✓	×
Kolatoks	✓	✓	×	×	×	✓	×
Iyaniwura	✓	✓	×	×	×	✓	×

Table 2: Water Quality Parameters of Sachet waters

Parameters	Funmilayo	AAUA	Divine	Kolatoks	Iyaniwura	WHO	SON
Temperature (°C)	25.60	25.10	26.40	26.20	25.90	ND	ND
Turbidity (NTU)	0.10	0.20	0.40	0.30	0.22	1 – 5	1 - 5
PH	6.8	7.8	6.8	7.40	6.5	6.5 – 8.5	6.5 - 8 .5
Dissolved Oxygen (mg/L)	7.2	7.8	7.6	6.9	7.4	5 - 9	5 – 15
Conductivity (µSiemen/cm)	105	153	85	77	122	1000	1000

Table 2 shows the results of physico-chemical parameters of all the sachet water samples. In this study, the temperature of the sachet water samples was within the range of 25.10 to 25.90^{0}C.

Temperature is also very important in the determination of various other parameters such as pH, conductivity, saturation level of gases and various forms of alkalinity, etc. The air temperature of ranged between 29.05℃ to 29.25℃ during the measurement.

From Table 2, the pH of the water samples range from 6.5 to 7.8 which was within the allowable limit recommended by World Health Organization (WHO) and Standard Organization of Nigeria (SON) for safe drinking water. Funmilayo, Divine and Iyaniwura (Samples A, C and E) showed a slightly acidic nature while AAUA and Kolatoks (Samples B and D) showed an alkaline nature.

Electric conductivity of the sachet water samples range 77.0 to 153µscm-1. Conductivity of the water is a characteristic, which is mainly associated with the dissolved material or solute concentration present in the water. The electrical conductivity of all the sachet water samples are within the WHO and SON guide of 50 - 1000µscm-1.

Dissolved oxygen is a very important parameter of water quality and index of physical and biological process going on in water. In the present study, the level of DO of the water samples falls within the range of 6.9 to 7.8 m/l as shown in Table 2.

The results from Table 2 show that all the brands of sachet water were observed to have nearly zero
turbidity. Turbidity determinations the actual amount of suspended matter as the scattering of light is highly dependent upon the size, shape and refractive index of the particles. Turbidity makes the water unfit for domestic purposes, food and beverage industries, and many other industrial uses. A reduction in turbidity is associated with a reduction in suspended matter and microbial growth. In the present investigation, the maximum turbidity value recorded was 0.40 NTU. The results show that all sachets water conformed within the permissible limit recommended by World Health Organization (WHO), Nigeria Industrial Standard (NIS) and Standard Organization of Nigeria (SON) for safe drinking water.

Conclusion

The results of various physiochemical parameters like pH, electric conductivity, temperature and turbidity were assessed and analyzed using electronic equipment. All the parameters of the sachet water samples analyzed are within the allowable limit recommended by World Health Organization (WHO), Nigeria Industrial Standard (NIS) and Standard Organization of Nigeria (SON) for safe drinking water. However, none of the sachet water company complied with the National Agency for Food, Drug Administration and Control (NAFDAC) and Standard Organization of Nigeria (SON) requires indicating expiry date, batch number, manufacturing date and mineral composition on their packaged. From the results of physiochemical parameters, the entire water samples are safe for human consumption.

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