Quality Evaluation of Six Water Sources for Cattle at Point Of Entry into Nigeria Market through Ogun State, Nigeria

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ABSTRACT

Water samples were collected to evaluate the quality of water through the determination of physicochemical, microbiological and organoleptic properties of six water sources (Idi river, Iree river Afon river, Oke-agbede stream, Ileniku stream and Olodo borehole) enroute cattle market in Ogun State, Nigeria from neighbouring West African countries.The samples were collected at three different points from each water source and examine for pH, salinity, nitrates, nitrites, sulphates, chlorides, fluorides,bicarbonates, phosphates, total bacteria count, total coliform count, Escherichia Coli count, Blue green algae count, colour, odour and turbidity. Results showed that all the parameters measured differed significantly ($p<0.05$) among the six water sources. Afon river had the highest pH value (6.880) which compared favourably ($p>0.05$) with the value (6.817) recorded for Olodo bore hole but were both higher ($p<0.05$) than the values (6.553, 6.523, 6.453) recorded for Idi river, Iree river, Ileniku stream and Okeagbede stream which had the least pH value of 5.847, while the highest ($p<0.05$) salinity level (8.527) and concentrations (mg/L) of nitrates (1.440), nitrite (0.127), sulphate (24.853), chloride (841.633), fluoride (7.853), bicarbonate (714.000) and phosphate (20.467) were recorded for Ileniku steam, least concentrations of these parameters except fluoride were recorded for Olodo bore hole. Also Ileniku stream had the highest total bacteria count (22.80 x 105Cfu/100 ml), total coliform count (3.90 x 10^5Cfu/100 ml), Eshericia Coli count (2.60 x 105Cfu/100 ml) and Blue green algae count (0.40 x 10^5Cfu/100 ml) while the least ($p<0.05$) values of 0.20 x 105, 0.10 x 10^5, 0.00 x 10^5, and 0.0 x 10^5 in the listed parameters were recorded for Olodo bore hole. In addition, Ileniku stream had the highest ($p<0.05$) colour of 5.753TU while Olodo bore hole had the least ($p<0.05$) colour value of 1.107TU. Turbidity followed the same trend as colour which had its highest value for Ileniku stream and the least value for Olodo bore hole. The odour value of 1.000 recorded for Ileniku stream was significant and differ ($p<0.05$) from those recorded for the other water sources which values were similar ($p<0.05$).Only Ileniku stream showed the presence of odour and had a higher colour and turbidity than the recommended limits for cattle while Olodo borehole showed the least concentration of parameters across water sources. This research work therefore suggested that out of all the water sources analysed, borehole source seemed to be the fittest source of water for cattle consumption.

Keywords: Evaluation, physicochemical, microbiological, organoleptic, water sources.

{**Citation**: O.O Eniolorunda, H. A., Awojobi, A. J. Olubayode A. J., J. O. Fagbemi. Quality Evaluation of Six Water Sources for Cattle at Point Of Entry into Nigeria Market through Ogun State, Nigeria. American Journal of Research Communication, 2014, 2(4): 114-123} www.usa-journals.com, ISSN: 2325-4076.

INTRODUCTION

Water is the most abundant nutrient in the body and a critical nutrient for all classes of animal including cattle. Cattle needs access to adequate supplies of clean water at all times and should not have to travel long distances for water. Water is a critical nutrient required for a wide variety of body functions in cattle. It is needed for digestion and metabolism of nutrients, circulation of nutrients and metabolites to and from tissues, excretion of waste products (via urine, faeces, and respiration), maintenance of proper ion, fluid, and heat balance, and as a fluid and cushioning environment for the developing foetus (Murphy, 1992). Cattle obtained the water they need by drinking and consuming feed that contains water, as well as from metabolic water produced by the oxidation of organic nutrient. On the other hand water loss from the body occurs via urine, faeces, milk and sweat. Consuming water is more important than consuming feed because of water's vital importance to the animal's physiological function.

However, the most common water quality problems affecting livestock production include high concentrations of minerals, sulphates, nitrates and nitrites, bacterial contamination, heavy growth of blue-green algae and chemical contamination associated with agricultural and industrial activities (Socha *et al*.,2001). Water quality is affected by its source and contamination from abiotic and biotic factors as a result of either dissolved nutrients or direct deposition of urine or faecal material containing nutrients and possibly parasites (Olson *et. al.*,1995). These contaminants can affect the appearance, odour, and taste of drinking water as well as its physical and chemical properties. Some contaminants may directly affect animal health by causing disease and infection, others have a more indirect effect which may cause livestock to decrease their overall water intake (Bagley 1997). Also limiting water availability to livestock will depress production rapidly and severely, and poor quality water is often a factor limiting intake.

Despite the importance of water to livestock including cattle, very little or no research has examined the variability of physicochemical, microbiological and organoleptic properties of water from rivers, streams and borehole found along the distal route to cattle market in Ogun State. This work was therefore designed to evaluate the quality of water through the determination of the availability and levels of some physicochemical, microbiological and organoleptic properties of six water sources enroute cattle market in Ogun State, Nigeria from neighbouring West African countries.

MATERIAL AND METHODS

Background information: Ogun State lies within latitude 6^0 North and 8^0 North and longitude 2.5^0 East and 5^0 East (Onakomaiya, *et. al.,* 1972). The author also noted that the state is situated within the tropics and cover about 16,400sq km, approximately 1.9 percent of the area in Nigeria. This state is composed of low lying forest areas, with an annual rainfall of between 1,250 and 1,800mm. The rainy season is slightly bimodal with peaks in June and October. Temperature ranges from 27^0C to 32^0C, while relative humidity averages 80-90 percent.

Sampling techniques: For the purpose of this study, water samples were collected from six different water sources for cattle from (Ketu and Iwoye point of entries) into Nigerian market (Olodo) through Ogun State. Random sampling techniques were used to collect samples at three different points from each water source. The 18 bottles (75cl) used during the experiment were washed thoroughly with a liquid detergent and well rinsed in warm water and then soaked in 14% HNO3 for 24h. The washing was completed with distilled water. All the bottles were later oven dried at 48^0C for 24hrs to make them completely clean from any chemical residue.

The water sources and their location are IDI RIVER (at Idofa Village, from Ketu point of entry), AFON RIVER (at Afon, Imeko Village), IREE RIVER (at, Iwoye Road), OKE AGBEDE STREAM (at Iwoye, Road), ILENIKU STREAM (at Olodo Road), BOREHOLE WATER (at the cattle market, Olodo).

Laboratory analysis

Organoleptic/physicochemical properties: All the chemicals used were laboratory grade reagents. All the working solutions were prepared by diluting the stock solution with freshly prepared distilled water. The analyses of the physicochemical parameters were carried out according to American Public Health Association (APHA standard methods, 1998). The organoleptic/physicochemical parameters analysed were pH, Colour, Temperature, Odour, Turbidity, Salinity, Nitrate/Nitrate and sulphate, bicarbonate and phosphate.

Microbiological properties: Total Coliform count was determined by weighing 55g of MaCConkey Agar into a 1 liter capacity of conical flask and brings to boil to dissolve the agar and was distributed into MacCartney bottles and autoclave as for Nutrient Agar. The total Bacterial was determination by weighing 28g of powdered commercially prepared nutrient agar on analytical meter balance into a clean dry 1 litter conical flask and 1000mls of distilled water was placed inside a water bath set about 90^0C, the agar was allowed to dissolve and was distributed into mac Cantney bottles. They were placed inside an autoclave which was set at 121^0C for 15 minutes. In the determination of Blue Green Algae count, 39g of PDA was weighed into a 1 litre capacity of conical flask and bring to boil and was distributed into Mac Cartney bottles and placed inside an autoclave as for nutrient agar.

Lastly the total *Escherichia coli* was determination by dissolving 52g of *Escherichia coli* agar in 1000 ml distilled water and it was bring to boil to dissolve the agar. It was not autoclaved.

Statistical analysis: All data obtained were subjected to analysis of variance (ANOVA) for a completely randomised design using (SAS, 2002) and significant different mean were further subjected to Duncan's Multiple Range Test (SAS, 2002).

RESULTS AND DISCUSSION

Table 1 shows the physiochemical properties of six water sources enroute cattle market in Ogun State. Result showed that significant difference ($P<0.05$) existed in pH concentration of the six water sources. River Afon had the highest pH of 6.880 which was found to be significantly different ($P<0.05$) and higher than levels from Idi river, Ire river, Okeagbede stream and Ileniku stream but comparable ($P>0.05$) to level in Olodo borehole. Okeagbede stream had the lowest pH of 5.847 which was more acidic and significantly different ($P<0.05$) to all other water sources. According to NRC (1980), drinking water with pH range between 6.5 and 8.5 was considered safe and acceptable for all classes of livestock including cattle. Also the author further reported that water with pH below 6.5 and above 8.5 could cause digestive upset in cattle resulting in rejection of water, depressed appetite and consequent loss in production. Therefore, water from all the water sources will not pose a threat to cattle except Oke agbede stream which had a lower pH level (5.847) than the recommended limit.

When the salinity level was compared, significant difference ($P<0.05$) was observed across water sources with Iree river and Oke agbede stream having comparable ($P>0.05$) salinity levels. Ileniku stream had the highest salinity level of 8.527mg/l ($P<0.05$) followed by Afon river with salinity level of 3.800mg/l which is higher and significantly different ($P<0.05$) to the level in Idi river. Olodo borehole on the other hand had the lowest salinity level of 1.217mg/l ($P<0.05$). Salinity levels found across water sources falls within the tolerance limit for cattle as reported by Bagley *et al* (1997) that values up to 1000mg/l of total dissolved salts are considered low and water could be offered to any animal species including cattle (Bagley, *et. al.*, 1997).

Significant difference ($P<0.05$) was also observed in the nitrate concentration of six water sources. Ileniku stream had the highest nitrate level of 1.440mg/l ($P<0.05$) while Olodo borehole had the lowest nitrate level of 0.110mg/l ($P<0.05$). Idi river and Afon river however, did not show significant difference ($P>0.05$) from each other but significant difference ($P<0.05$) existed in the nitrate level of Ire river and Oke agbede stream. The nitrate level found across water sources which ranged between 0.110mg/l and 1.440mg/l agreed with the tolerable level of drinking water standards for cattle which was put at less than 44mg/l

(NRCNRC, 2001). Therefore water from all water sources could be considered safe for drinking by cattle.

There was significant difference (P<0.05) in the nitrite concentration found across water sources. Ileniku stream had the highest nitrite level of 0.127mg/l which was found to be significantly different (P<0.05) to Ire river which had a comparable (P>0.05) and closer levels to Oke agbede stream. Similarly, Idi river and Afon river showed no significant difference (P>0.05) from each other. On the other hand, Olodo borehole had the lowest nitrite level of 0.006mg/l (P<0.05). The nitrite level found across water sources will not pose a threat to cattle since nitrate concentration found across water sources does not exceed the recommended maximum limit that may result in nitride toxicity. Thus, water from these sources will not cause problem for cattle.

Result in the present study showed that there was significant difference (P<0.05) in the sulphate level of six water sources. Ileniku stream had the highest (P<0.05) sulphate level of 24.853mg/l while Olodo had the lowest (P<0.05) sulphate level of 2.927mg/l. Afon and Idi rivers had comparable (P>0.05) sulphate levels of 8.553mg/l and 7.887 mg/l respectively. Also, Iree river and Okeagbede stream showed no significant difference (P>0.05) in sulphate levels with Iree river having a higher sulphate level between the two. According to CCME (2005) guideline, less than 1000mg/l sulphate concentration in drinking water is considered safe for cattle. Hence, water from the six water sources are safe for drinking by cattle because sulphate levels found across water sources did not exist in toxic levels. Additionally, water contain sulphate levels exceeding 1000mg/l can reduce water intake, dry matter intake, feed efficiency, and may induce sporadic cases of polioencephalomalacia (PEM) in cattle (Gould, *et. al.*, 2002)

Significant difference (P<0.05) was observed in chloride level found across water sources. Idi river and Iree river had comparable results (P>0.05) but significantly different (P<0.05) to Ileniku stream which had the highest (P<0.05) chloride level of 841.633mg/l while Olodo borehole on the other hand had the lowest level of 30.933mg/l which was significantly different (P<0.05) to Oke agbede and Afon river. CCME guideline (2005; Gould, et. al., 2002) cited that concentration above 250mg/l chloride may reduce water palatability which may result in lowered water intake. The chloride level found across water sources did not agree with the CCME guideline except for Olodo which had a chloride concentration of 30.933mg/l lower than 250mg/l thus making Olodo borehole the fittest for drinking by cattle. Earlier study of (Solomon *et. al.*, 1995; CCNRC, 2001) showed that saline water where chloride was a major component (580mg/l) negatively affected milk production.

There was a significant difference (P<0.05) in fluoride levels among water sources under study. Ileniku stream had the highest (P<0.05) fluoride level of 7.853mg/l followed by Olodo borehole with 6.407mg/l (P<0.05). On the other hand, Idi river had the lowest fluoride level of 3.580mg/l and significantly different (P<0.05). Afon river, Iree river and Okeagbede stream which had successively fluoride levels 4.207mg/l, 4.567mg/l and 4.840mg/

respectively. Each of the fluoride level found in the six water sources was higher than the recommended maximum limit as cited by CCME (2005) that fluoride levels greater than 2mg/l in drinking water may be hazardous to cattle health and may result in mottling of the teeth, this made water from these water sources unsafe for drinking by cattle. Also, NRC (2001) reported that excess fluoride concentration in water resulted in degeneration of the teeth.

Significant difference ($P<0.05$) was also observed in the bicarbonate level of all the water sources listed. Ileniku stream having the highest ($P<0.05$) bicarbonate level of 714.000mg/l while Olodo borehole had the lowest ($P<0.05$) level of 84.933mg/l. Iree River an Afon River however did not show significant difference ($P>0.05$) but Iree River had a higher level of bicarbonate. Also, Idi River and Oke agbede stream had a comparable ($P>0.05$) levels with Idi River having a higher level. Bicarbonate levels across the six water sources ranged between 84.933mg/l and 714.000mg/l. This did not exceed the recommended maximum limit in water which was put at 1000mg/l (NAS, 1980). Therefore, water from all the water sources are safe for drinking but Olodo borehole which had the least bicarbonate level might be considered the fittest for cattle consumption.

There was significant difference ($P<0.05$) in phosphate level across water sources. Ileniku stream had the highest ($P<0.05$) level of 20.467mg/l followed by Iree River (14.667mg/l) which was higher than Afon river (13.967mg/l) but similar ($P>0.05$) to Oke agbede stream (14.227mg/l). On the other hand, Olodo borehole had the lowest ($P<0.05$) phosphate level of 9.243mg/l. Phosphate level found across the six water sources which ranged between 9.243mg/l and 20.467mg/l was higher than the recommended limit which was put at 0.7mg/l (Socha, *et al.*, 2003). This therefore makes water from all the water sources not safe for drinking by cattle. The high phosphate levels found across water sources could come from fertilizers, pesticides, industrial wastes along the water sources. It could also come from natural sources such as phosphate-containing rocks and solid or liquid wastes.

The microbiological properties of six water sources enroute cattle market in Ogun State is presented in (table 2). Result showed that significant difference ($P<0.05$) existed in the Total Bacteria Count (TBC) and Total Coliform Count (TCC) across the six water sources with TBC and TCC having their highest values in Ileniku Stream and their lowest values in Olodo borehole. However, *Eshericia coli* Count which was also significantly different ($P<0.05$) across water sources had the highest count in Ileniku Stream with Olodo borehole having no count of *Eshericia coli.* Blue Green Algae also followed the same trend having its highest count in Ileniku stream with Olodo borehole having no count of Blue green algae.

Total Coliform count found in water sources ranged between 0.1x105cfu/100ml and 3.9x105cfu/100ml. According to (Bergsrud, *et. al.*, 1990), total coliform count exceeding 0.1x105cfu/100ml is not considered acceptable for cattle. Therefore, only Olodo borehole which falls within the acceptable range can be considered safe for drinking by cattle (Bergrud, *et al.*, 1990). *E. coli* count found in water sources ranged between

0.0x105cfu/100ml and 2.6x105cfu/100ml. It is generally recommended that drinking water for cattle should not contain *E coli* count exceeding 1.0x105cfu/100ml (Australian and New Zealand Environment and Conservation Council Water Quality Guideline, 2000). Therefore, water from Iree river, Afon river and Ileniku Stream having *E. coli* count exceeding the recommended limit should be avoided by cattle while water from Idi river, Oke agbede stream and Olodo borehole which fall within the recommended limit are considered fit for drinking but Olodo borehole which shows no count of *E. coli* remains the fittest for drinking by cattle.

Total bacteria count found across all water sources ranged between 0.2x105cfu/100ml and 22.8x105cfu/100ml. This did not agree with desired range of TBC in drinking water for cattle except for Olodo borehole which falls within the desired limit put at below 2.0 x105cfu/100ml (AWMFH, 1992) thus making Olodo borehole the only safe point for drinking.
Blue green algae count range from 0.0x105cfu/100ml and.0 4x105cfu/100ml. According to ANZECC (2000), a cyanobacteria count exceeding 0.1x105cfu/100ml could be a concern to cattle health and performance. Therefore, water from Idi River, Afon River and Ileniku stream which had higher cyanobacteria count are not considered safe for drinking by cattle while water from Iree river, Oke Agbede stream and Olodo borehole which falls within the recommended limit will not pose a threat to cattle, though Olodo borehole can be considered the fittest for drinking since it has no count of blue green algae.

Also, results showed that significant difference ($P<0.05$) existed in organoleptic properties across the six water sources (Table 3). Ileniku Stream had the highest colour of 5.753TU ($P<0.05$) while Olodo borehole had the least colour of 1.107TU ($P<0.05$). Turbidity followed the same trend having its highest in Ileniku stream and lowest in Olodo borehole. On the other hand, there was no significant difference ($P>0.05$) in odour of five water sources except that of Ileniku Stream which showed significant difference ($P<0.05$) from other water sources.

Colour found across water sources will not pose a threat in cattle drinking water except Ileniku Stream which had a higher colour than the recommended maximum limit put at 5TCU (Ontairo Drinking Water Standards, 2003) and the high colour level found in Ileniku stream could be due to the contribution of excess iron and manganese compounds produced by processes occurring in natural sediments.

Across the six water sources, only Ileniku stream showed the presence of odour and if water source smells or contains odour, cows may not drink enough to meet production needs or may completely refuse such water therefore Ileniku stream is not considered safe for drinking by cattle. According to Mantey, (1994) most causes of odour are as a result of physiochemical properties, substances present in excess and presence of bacteria and their metabolic products.

Turbidity level across water sources ranged between 0.193NTU and 12.613 NTU. The turbidity levels found in Idi river, Iree river, Afon river, Oke Agbede stream and Olodo borehole will not have any negative effect in cattle water since they existed within the recommended turbidity level put at 5NTU (Ontairo Drinking Water Standards, 2003). Whereas, Ileniku stream which showed a turbidity level (12.613 NTU) higher than 5NTU should be avoided by cattle because this will provide a medium for microbial growth and it also indicated the presence of organisms such as bacteria, viruses and parasites that could cause symptoms like diarrhoea, cramps etc in cattle (USEPA, 2003).

Table 1: Physiochemical Properties of Six Water source enroute cattle market in Ogun State

Parameters (Mg/L)	Idi River	Iree Rivers	Afon River	Oke Agbede	Ileniku Stream	Olodo bore Hole	SEM
pH	6.533^{b}	6.523^{b}	6.880^{a}	5.847^{c}	6.453^{b}	6.817^{a}	**0.082**
Salinity	2.173^{c}	2.467^{c}	3.830^{b}	2.487^{c}	8.527^{a}	1.217^{d}	**0.581**
Nitrates	0.124^{b}	0.131^{b}	0.123^{b}	0.116^{bc}	1.440^{a}	0.110^{c}	**0.012**
Nitrites	0.013^{c}	0.016^{b}	0.011^{cd}	0.015^{b}	0.127^{a}	0.010^{d}	**0.002**
Sulphate	7.887^{c}	8.067^{c}	8.553^{c}	18.267^{b}	24.853^{a}	2.927^{d}	**1.649**
Chloride	741.633^{b}	741.967^{b}	333.987^{c}	352.167^{c}	841.633^{a}	30.933^{d}	**70.212**
Fluoride	3.580^{c}	4.567^{c}	4.207^{d}	4.840^{c}	7.853^{a}	6.407^{b}	**0.352**
Bicarbonate	490.600^{c}	571.933^{b}	557.133^{b}	481.667^{c}	714.000^{a}	84.933^{d}	**47.034**
Phosphate	**12.707^{c}**	**144.667^{b}**	**13.967^{bc}**	**14.227^{bc}**	**20.467^{a}**	**9.243^{d}**	**1.813**

^{abcd}, means on the same row followed by different superscript differ significantly (P<0.05)

Table 2: Microbiological Properties of Six Water Sources enroute cattle market in Ogun State

Parameters (Cfu/100ml)	Idi River	Iree Rivers	Afon River	Oke Agbede	Ileniku Stream	Olodo bore Hole	SEM
Total Bacteria Count	$11.5x10^{5c}$	$14.1x10^{5b}$	$12.3x10^{5c}$	$15.1x10^{5b}$	$22.8x10^{5a}$	$0.2x10^{5d}$	$1.6x10^{5}$
Total Coliform Count	$2.9x10^{5c}$	$3.4x10^{5b}$	$3.4x10^{5b}$	$1.6x10^{5d}$	$3.9x10^{5a}$	$0.1x10^{5c}$	$0.3x10^{5}$
Eshericia Coli Count	$1.0x10^{5c}$	$1.2x10^{5b}$	$1.3x10^{5b}$	$0.8x10^{5d}$	$2.6x10^{5a}$	$0.0x10^{5c}$	$0.1x10^{5}$
Blue Green Algae Count	$0.2x10^{5b}$	$0.1x10^{5c}$	$0.2x10^{5c}$	$0.1x10^{5a}$	$0.4x10^{5a}$	$0.0x10^{5d}$	$0.03x10^{5}$

^{abc}, means on the same row followed by different superscript significantly (P<0.05)

Table 3: Organoleptic properties of six water sources enroute cattle market in Ogun State

Parameters	Idi River	Iree Rivers	Afon River	Oke Agbede	Ileniku Stream	Olodo bore Hole	SEM
Colour (True Unit)	2.407^{bc}	1.840^{c}	2.323^{b}	2.813^{a}	5.753^{a}	1.107^{d}	**0.725**
Odour	$0.002c^{c}$	0.001^{c}	0.001^{c}	0.009^{b}	1.000^{a}	0.000^{c}	**0.005**
Turbidity (N.T.U)	3.507^{b}	2.410^{bc}	2.900^{b}	1.787^{c}	12.613^{a}	0.193^{d}	**1.106**
Blue Green Algae Count	$0.2x10^{5b}$	$0.1x10^{5c}$	$0.2x10^{5c}$	$0.1x10^{5a}$	$0.4x10^{5a}$	$0.0x10^{5d}$	**$0.03x10^{5}$**

^{abc}, means on the same row followed by different superscripts differ significantly ($P<0.05$)

CONCLUSION

Going through the analysis of various samples collected from different water sources, it was observed that most physicochemical, and organoleptic properties were within the recommended limits for cattle. Also, it was noted that most of the microbiological properties exceeded the recommended limits for cattle across the six water sources. In addition, it was noted that most of the parameters tested showed higher level than the recommended level in Ileniku stream making Ileniku stream unfit for drinking by cattle while Olodo borehole which showed the least concentrations of parameters seemed to be the fittest for drinking by cattle. Therefore, it can be concluded that out of the water sources analysed, borehole seemed to be the fittest and safest for cattle consumption.

RECOMMENDATION

Based on the findings in the present study, the following recommendations were made:

(a) Pastoralist or cattle producer should have the knowledge that water source like Ileniku stream containing excess minerals and microbes should be avoided as drinking points for their herds.

(b) Cattle producers and pastoralist should endeavour to seek boreholes or deep wells as water sources for their herds.

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