Physicochemical Parameters and Water Quality for Livestock Consumption from selected Lakes in the Upper Benue Valley Area of Adamawa State, Northeastern Nigeria

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ABSTRACT

This experiment involves laboratory assessment of physicochemical properties and water quality for livestock consumption from selected lakes in the upper Benue valley area of Adamawa State, Nigeria has been carried out. The studied lakes were purposively selected on the bases of size and function as drinking points for livestock in the area. Water samples were collected and analyzed in dry and wet seasons of 2013 using standard procedures and results were evaluated using National Acedemy of Science (NAS) recommended drinking water standards for livestock. Values of Physicochemical and toxic parameters with the exception of cadmium for Lake Geriyo were found within permissible limits for livestock consumption. This confirms the lakes as good water sources for livestock in the area. However, there are the possibility of future accumulation of the parameters in the lakes observed. Therefore, proper management plans are required to protect the lakes from contaminants accumulation in order to sustain water quality in the study area.

Keywords: *Hydrology, physicochemical parameters, water quality, livestock, lakes, Upper Benue Valley.*

INTRODUCTION

In recent times, the scope of hydrology has shifted beyond its traditional bounds of placing sole emphasis on amount of water in a particular area. It now incorporates issues of water quality with equal importance as placed on quantity. Arguments qualifying the relevance of water quality in hydrology have been clarified (Davie, 2002). Therefore, the quality status of water in the hydrological storages of any region/area forms an integral part of the region's/area's hydrology and is of paramount importance to the types of uses the water bodies are subjected to. Herdsmen in the Upper Benue valley area of Adamawa State depend to a greater extent on lakes in the area as immediate sources of water for their livestock (mainly cattle, sheep and goats). After grazing on the greener pastures of the floodplain and feeding on hay from harvested farmlands, the lakes in most occasions serve as immediate drinking points for the livestock. Their dependence on the lakes is higher in dry seasons when most streams in the area get dry due to their ephemeral nature. Besides, the livestock's greater

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dependence on hay in dry seasons enhances much uptake of water from the lakes not minding the quality status. Water constitutes 60 to 70 percent of the body of livestock, such that its consumption is more important than that of food (Faries, Sweeten and Reagor, 1998). Dry cows require about 8 to 10 gallons of water daily; in their last 3 months of pregnancy, daily water consumption by the cows may rise to 15 gallons per day; those in milk need about five times as much water as the volume of milk they produce; while calves start drinking water at an early age and their performance can be highly dependent on it (Boyles, Wohlgemuth, Fisher, Lundstrom and Johnson, 1988). Therefore, as a critical component that meets the nutritional needs of livestock, the quality status of water consumed by the animals is a matter of great concern on their health and that of their consumers.

Ideally, water supplied to livestock should be safe against physical, chemical and biological contaminants. But in most situations where the livestock undergo free range grazing and taking water from sources such as lakes, the ideal condition aforementioned is hardly possible. Many such water sources are often potential contamination sites and reservoirs for various waterborne toxins and diseases. Hence, the evaluation of lake water quality for livestock consumption in the Upper Benue valley area of Adamawa State becomes imperative. Water quality assessment for livestock consumption is generally based on physical properties, physiochemical properties, excess nutrients, toxic compounds and microbial agents (Higgins, Carmen and Amando, 2008).

Among the parameters that determine drinking water quality for livestock are Sodium (Na^{+}), Magnesium (Mg^{2+}), Calcium (Ca^{2+}), Chloride (Cl^{-}), Sulfates (SO_4^{2-}), Nitrates (NO_3^{-}), Total dissolve solids (TDS), Toxic metals - Manganese (Mn), Cadium (Cd), Nikel (Ni), Zinc (Zn), Lead (Pb) and bacteria (Faries, Sweeten and Reagor, 1998; Pfost and Fulhage, 2001; Higgins, Carmen, and Amando 2008). Some of these parameters provide some levels of nutritional benefits when taken by livestock in required quantities but turn problematic when taken in excess (Fatoki, Lujizan and Ogunfowokan, 2002). The effects of excess physicochemical parameters on livestock have been discussed (Alberta Agriculture and Rural Development, 2000; Curran and Robson, 2007; UNEP, ERCE, UNESCO, 2008) and guidelines for required levels of these parameters have been provided (National Academic of Science (NAS), 1974; Pfost and Fulhage, 2001; Curran and Robson, 2007; Higgins, Carmen and Amando, 2008). Thus, this study examines the physical and chemical parameters of selected lakes for livestock consumption in the Benue valley area of Adamawa State.

MATERIALS AND METHOD

This study was conducted at selected lakes in the Upper Benue valley area of Adamawa State. The area covers the entire Yola North Local Government Area and parts of Fufore, Girei, and Yola South Local Government Areas of Adamawa State. The valley stretch is characterized by extensive floodplains on both sides of the River Benue which extends from Kocciel in Fufore to Koh in Girei Local Governments Area, having a length of about 76.250km. The selected lakes studied are Lake Gwakra (09°24’26"N, 12°23’38"E), Lake Geriyo (09°18’15"N, 12°25’34"E), Lake Njuwa (09°13’15"N, 12°30’12"E), Lake

Parya-Ribadu (09°18’36"N, 12°43’12"E) and Lake Parya (09°21’17"N, 12°43’27"E) (Figure 1). The study area falls within the southern part of the Sudan Savanna belt of Nigeria Characterized by a semi arid climate of six months wet and six months dry seasons. Annual precipitation values range from 656.70mm to 1113.30mm with peak rains recorded in the months of August and September, while driest months are January, February and March with annual evaporation values ranging from 1675.91mm to 3272.62mm (Upper Benue River Basin Development Authority-UBRDA, 2012). The lakes, being fluviatile by origin receive water inputs mainly from direct rainfall, runoffs and overflow of the Benue River in the wet seasons. The runoffs which are ephemeral in nature originate from hills and uplands in the study area and cut across various landuse zones mainly farmlands and build up areas from which they acquire most of the physicochemical parameters drained into the lakes.

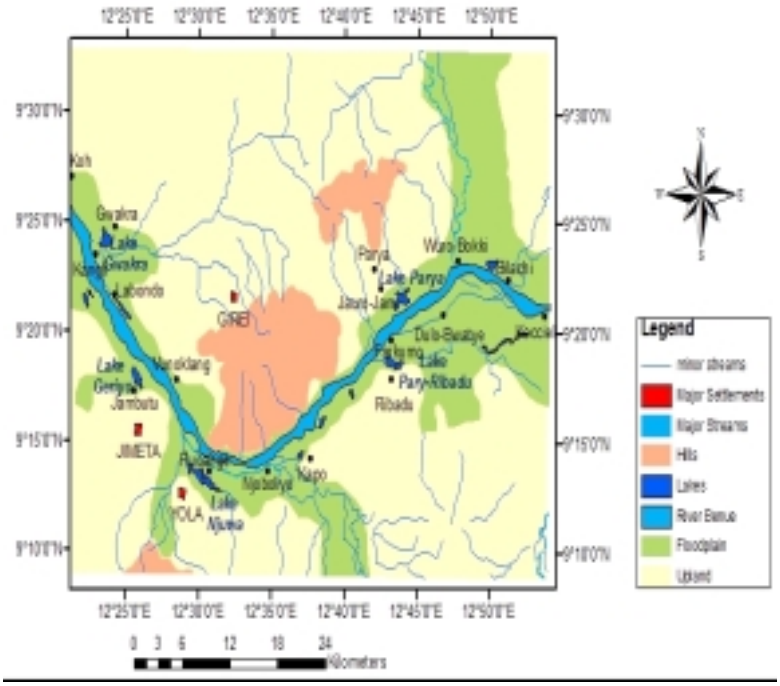

Figure 1: Study Area and the lakes

Laboratory Analysis: Lake water sampling and testing were conducted for dryer months (January, February and March) of 2013 as well as for the wetter months (July, August and September) of 2013. Water samples were collected in clean 2 liters containers from each lake for laboratory physicochemical tests. Total Dissolved Solids (TDS), were determined by Gravimetric method. pH values were obtained by colour match method, while hardness was determined as the sum of Ca and Mg concentrations. Nutrient concentrations such as Sodium (Na), Potasium (K), Magnesium (Mg), Calcium (Ca), Chlorine (Cl^-), Sulphate (SO_4^{2-}), and Nitrates (NO_3^-) were obtained by colorimetric method using Lamotte Smart 2 Colorimeter 10.07, while Heavy Metals such as Cadmium (Cd), Chromium (Cr), Nikel (Ni), Lead (Pb), Zinc (Zn) were tested by Atomic Absorption Spectrophotometric (AAS)

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method. Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD) were determined by Oxygen meter, and Winker's method respectively, while microbial agents (Total coli form counts) were obtained by Eijkman test. Values of observed parameters were assessed using water quality guidelines provided by NAS (1974) and Higgins, Carmen, and Amando (2008).

RESULTS AND DISCUSSION

Physicochemical Parameters of the lakes: pH values of the lakes ranged from 7.10 (Lake Parya Ribadu) to 8.57 (Lake Geriyo) in dry season and from 7.20 (Lake Parya Ribadu) to 8.07 (Lakes Geriyo and Parya) in wet season, indicating low alkalinity on a general note (see tables1 and 2). A p-value of 0.57 obtained from statistical T-test at 95 CI also indicates an insignificant seasonal variation in the pH levels of the lakes. Analyses also reveal that all seasonal pH values of the lakes were within the permissble limit of livestock drinking water quality provided by NAS (1974) except for Lake Geriyo in dry season which was slightly above the required standard (table 1). TDS is an indirect determinant of salinity. Its elevated levels (beyond permissible limits) in livestock driniking water may result to low feed intake and growth (Higgins, Carmen, and Amando, 2008). Higher values were obtained in the wet season than the dry season possibly as a result of more dissolution of solids by rain water and runoffs which eventually drain into the lakes in wet seasons. This nothwistanding, TDS values for all the lakes were considered very low in comparison to recommended upper limits by NAS (1974) (tables 1 and 2). Levels of nutrient concentrations of the lakes in dry and wet seasons are presented in tables 1 and 2, as potrayed by figures 2 and 3. Concentrations of calcium, magnesium and sodium were higher compared to those of chlorides, sulfates and nitrates. The high values of calcium and magnesium in the lakes could be linked to the influence of the area's geologic structure as pointed out by Ishaku *et. al* (2010). The concentrations of chlorides, sulfates and nitrates in the lakes could be attributed to human activities in the study area which range from application of Nitrate and fertilizers on farms, domestic solid waste and sewage disposals. However, the contents of these nutrients in the lakes were found to be low and acceptable for livestock consumption in accordance to NAS standards.

Manganese (Mn^{2+}), Cadmium (Cd), Nikel (Ni), Zinc (Zn) and Lead (Pb) were the toxic metal detected in the lakes. Values of Mn ranged from 0.07mg/l for Lake Gwakra in dry season to 0.45mg/l for Lake Geriyo in wet season. Cd and Ni were not detected in lakes Parya Ribadu and Parya, while values of Cd detected in Lake Geriyo were slightly beyond permissible limts for livestock consumption (tables 3 and 4). Even though the contents of Mn and Zn were found to be very low, values obtained for Lakes Geriyo, Njuwa and Parya Ribadu were higher with Lake Geiryo taking the lead (figures 4 and 5). This could strongly be linked to the presence of build up areas around the lakes where Mn and Zn generating materials are found. Contents of Pb were almost uniform in all the lakes and highly connected to the valleys mineralogy (Ministry of Mines and Steel Development, 2010) and waste disposal.

Table 1: Means and Standard Deviations of the lakes' Physicochemical Parameters in Dry season 2013

Lakes	Na^+ (mg/l)	Mg^{2+} (mg/l)	Ca^{2+} (mg/l)	ClÉ (mg/l)	$SO_4{}^2É$ (mg/l)	$NO_3É$ (mg/l)	TDS (mg/l)	pH
Gwakra	20.42±0.02	19.11±0.02	24.6±0.02	9.12±0.09	8.01±0.01	5.5±0.01	85.33±0.50	7.83±0.06
Geriyo	23.69±0.11	23.13±0.03	26.14±0.20	10.48±0.02	6.07±0.13	7.23±0.01	87.00±0.00	8.57±0.06
Njuwa	19.89±0.05	17.07±0.06	20.07±0.16	8.19±0.02	6.09±0.06	3.27±0.01	87.00±0.01	8.07±0.06
Parya Ribadu	17.72±0.03	21.21±0.01	27.19±0.02	9.15±0.02	2.18±0.02	5.10±0.02	95.00±0.00	7.10±0.17
Parya	15.14±0.03	18.13±0.03	20.2±0.04	7.87±0.07	2.7±0.02	8.19±0.03	92.00±0.00	8.10±0.10
NAS Standards	300.00	100.00	150.00	300.00	300.00		5000.00	6.5-8.5

Source: Experimentation, 2013

Table 2: Means and Standard Deviations of the lakes' Physicochemical Parameters in Wet season 2013

Lakes	Na^+ (mg/l)	Mg^{2+} (mg/l)	Ca^{2+} (mg/l)	ClÉ (mg/l)	$SO_4{}^2É$ (mg/l)	$NO_3É$ (mg/l)	TDS (mg/l)	pH
Gwakra	24.17±0.58	24.04±.25	28.79±0.01	9.16±0.01	8.51±0.01	8.5±0.02	101.33±1.53	7.63±0.06
Geriyo	25.87±0.12	26.88±0.11	29.6±0.08	10.51±0.02	6.9±0.17	8.77±0.06	112.33±1.15	8.07±0.12
Njuwa	22.06±0.08	21.24±0.1	23.49±0.01	8.05±0.02	6.41±0.08	4.97±0.12	121±0.00	7.83±0.12
Parya Ribadu	19.95±0.05	25.13±0.10	29.9±0.09	9.11±0.01	3.14±0.04	7.5±0.10	102±0.00	7.2±0.00
Parya	18.87±0.11	23.17±0.04	22.38±0.03	7.84±0.06	3.14±0.03	10.1±0.10	121±0.00	8.07±0.06
NAS Standards	300.00	100.00	150.00	300.00	300.00		5000.00	6.5-8.5

Source: Experimentation, 2013

Table 3: Means and Standard Deviations of Toxic metals concentrations in dry season 2013

Lakes	Mn	Cd	Ni	Zn	Pb
Gwakra	0.07±0.01	0.04±0.00	0.03±0.00	0.12±0.01	0.02±0.00
Geriyo	0.38±0.00	0.06±0.00	0.05±0.01	0.48±0.06	0.03±0.00
Njuwa	0.2±0.02	0.02±0.00	0.01±0.00	0.38±0.01	0.02±0.00
Parya Ribadu	0.26±0.01	0.13±0.01	0.02±0.00		
Parya	0.17±0.00	0.11±0.00	0.02±0.00		
NAS Standards	**0.50**	**0.05**	**1.00**	**50.00**	**0.10**

Source: Experimentation, 2013

Table 4: Means and Standard Deviations of Toxic metals concentrations in wet season 2013

Lakes	Mn	Cd	Ni	Zn	Pb
Gwakra	0.17±0.02	0.04±0.00	0.03±0.00	0.13±0.01	0.03±0.00
Geriyo	0.45±0.00	0.06±0.00	0.05±0.00	0.48±0.004	0.03±0.00
Njuwa	0.25±0.03	0.03±0.00	0.01±0.00	0.38±0.01	0.03±0.00
Parya Ribadu	0.28±0.01			0.14±0.00	0.03±0.00
Parya	0.19±0.01			0.11±0.00	0.02±0.00
NAS Standards	**0.50**	**0.05**	**1.00**	**50.00**	**0.10**

Source: Experimentation, 2013

CONCLUING REMARKS

The result reveal that the tested physicochemical and toxic parameters of the lakes are generally in low contents and within permissible limits of water quality for livestock consumption. These qualify the lakes as good and viable water sources for livestock production in the area. However, the slight seasonal variations in the parametric values indicated the possibility of accumulation and future contamination of the lakes. Consequently, management strategies in terms of waste disposal and excessive application of agricultural inputs are required for protection and water quality sustainability of the lakes. Temporal evaluation of the lakes' physicochemical properties is also required for monitoring changes in the lakes water quality status.

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