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Metals in Fish from the Upper Benue River and Lakes Geriyo and Njuwa in Northeastern Nigeria

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Lakes Geriyo and Njuwa occupy natural depressions near the upper Benue River in northeastern Nigeria (Figure 1). The lakes are flooded by the river during the rainy season spanning the months of May to September. Fishing activities on the lakes and river provide fish for consumption by the local communities. Industrial activity around the upper Benue River and the lakes is low and there is no information on other activities with the potential for polluting the Benue River as it flows from neighboring Cameroon. However, an unconfirmed report (Egila et al. 1991) indicated high levels of lead in the upper Benue River, generally speculated as arising from biogeochemical factors.

Trace elements, some of which are toxic, may accumulate in edible marine organisms to levels which may be deleterious to human health (Grimanis et al. 1978).

For the upper Benue River and its associated lakes, Geriyo and Njuwa, there is yet no report of a systematic study to assess the levels of metals in fish found in these waters. This paper presents the results of a study on metal levels in fish collected from Lakes Geriyo and Njuwa and upper Benue River in northeastern Nigeria.

MATERIALS AND METHODS

Economic species of fishes were collected from the upper Benue River and Lakes Geriyo and Njuwa in Yola in Adamawa State. The species were **Tilapia zilli, Alestes baremose, Alestes nurse, Mormyrus macrophthalmus, Heterotis niloticus, Clairas geripienus, Synodontis ocellifer** and **Citharinus citharus.**

Sampling was conducted twice monthly during the period November to June, covering the dry season into the beginning of the rainy season. For each sampling, four fish of each species were collected. The fish samples for each month were washed with distilled water and the lateral muscles representing the edible portion of the fish were removed with a clean plastic knife and homogenized.

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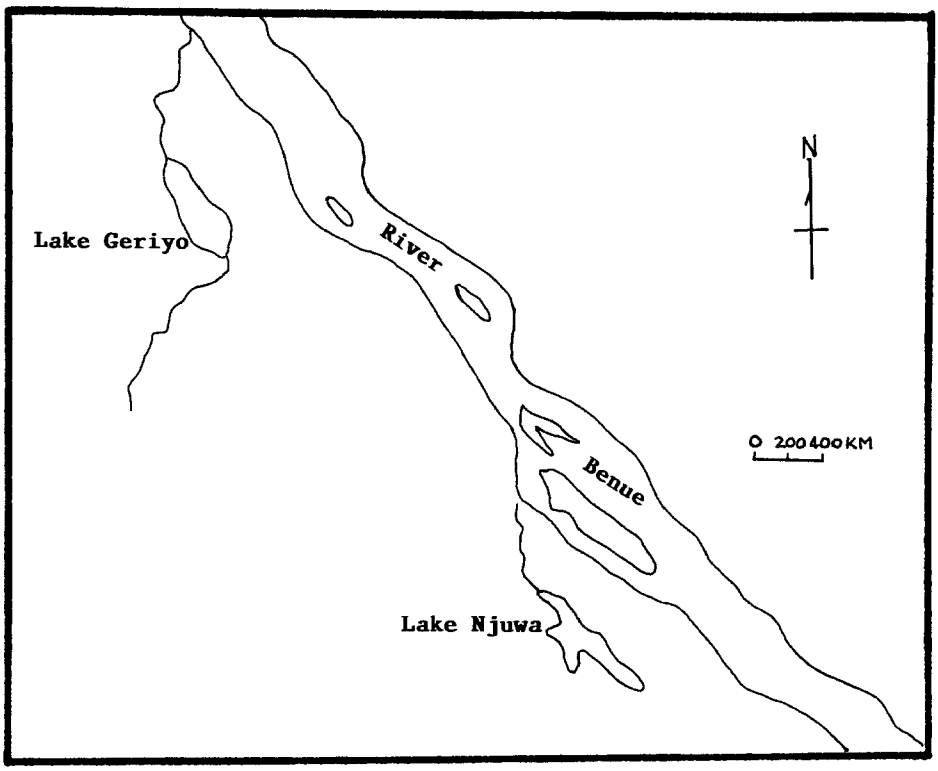

Figure 1. Upper Benue River and associated lakes in Yola, Adamawa State, on latitude 6½° and 11° north and longitude 9½° and 14° east.

Analysis for trace metals was done by the method of Kakulu et al. (1987). Specifically, 20 g of the fish sample was weighed into a 100-ml beaker and 30 ml of freshly prepared 1:1 (v/v) nitric acid-hydrogen peroxide mixture was added to it. The beaker was covered with a watchglass, allowed to stand for one hour, and heated on a hotplate at a temperature not exceeding 160°C. Boiling was continued for about 2 hr, at the end of which the volume of the fish digest had reduced to between 2 to 5 ml. The fish digest was transferred into a 50-ml volumetric flask and made to the mark with distilled water.

Standard stock solutions of metals were prepared from either the metal or a soluble salt (analytical reagent grade) of the metal (Kakulu et al. 1987). Specifically, copper and zinc stock solutions were prepared from their metals by dissolving with nitric acid and hydrochloric acid, respectively. Lead was prepared from its nitrate while iron was prepared from iron(II) sulfate to which sulfuric acid was added. The stock solutions of zinc and iron were made up to mark with 2% (v/v) hydrochloric acid and sulfuric acid, respectively. For lead and copper, the stock solutions were made up to the mark with 2% (v/v) nitric acid.

Determination of trace metals in the fish digest was made by atomic absorption spectrophotometry. Calcium and magnesium were determined by EDTA complexiometric titration using analytical grade reagents.

RESULTS AND DISCUSSION

Monthly results did not show a clear-cut trend, hence, the results are presented as mean values for the samples collected over a period of eight months (Tables 1 and 2). The mean concentrations of calcium and magnesium in Benue River fish were not greater than 43.1±5.5 and 34.9±11.9 mg/kg, respectively. The concentration of calcium appears low compared with the minimum value reported for fish flesh, i.e., 190 mg/kg, while magnesium concentration is comparable to the minimum value of 45 mg/kg reported by Ranken (1988). Species variation in calcium and magnesium concentrations was not apparent because of large standard deviations. The mean concentrations of zinc for fish from the upper Benue River were in the range of 34.2±6.2 to 40.4±7.2 mg/kg, the highest value being in the Trunk fish, **Mormyrus macrophthalmus**. Zinc concentrations are relatively high when compared with the mean concentrations for fish from parts of England and Wales which were not greater than 6.28 mg/kg wet weight (Portmann 1972) and from the Niger Delta area of Nigeria in the range of 1.03 to 17.85 mg/kg wet weight (Kakulu et al. 1987). However, high levels of zinc have been reported for fish from polluted areas of the Aegean sea (Grimanis et al. 1978). In particular, **Gobius niger** and **Sargus annularis** had levels of zinc up to 58±2.0 and 70±2.5 mg/kg, dry weight, respectively. For fish from the upper Benue River, species variation in zinc concentrations was not apparent and the highest mean concentration of 40.4±7.2 mg/kg was slightly below the Food Standards Committee (FSC) general limit of 50 mg/kg for zinc in foods (Egan et al. 1981). The mean concentrations of iron in fish from the upper Benue River were in the range of 2.3±1.3 to 3.2±0.2 mg/kg and are comparable with the mean value of 5.85 mg/kg wet weight for fish in the Niger Delta area of Nigeria (Kakulu et al. 1987). The mean concentrations of copper were not greater than 0.3±0.2 mg/kg, but are comparable to values reported for fish from other sources (Portmann 1972; Kakulu et al. 1987; Grimanis et al. 1978). The concentrations of lead in fish from the upper Benue River were high. The highest mean concentration of 14.4±8.1 mg/kg is 7-fold higher than the FSC recommended limit of 2.0 mg/kg for fish. As mentioned above, high levels of lead in Benue River have been reported (Egila et al. 1991). Hence, the high levels of lead in fish from the Benue River appear to corroborate the report. However, the lead levels are not traceable to industrial activities around the river other than sewage which is discharged into it from the city. High levels of lead up to 250 mg/kg dry weight were found in fish in some areas of Puget Sound in Washington (Malins et al. 1984). However, such levels of lead were associated with industrial activities, agricultural run-offs etc. For the Benue River, more studies are needed to assess the extent of pollution locally and upstream.

Table 1. Mean metal concentrations in fish from the upper Benue River (mg/kg wet weight). n is total number of fish

Fish	n	Ca	Mg	Zn	Fe	Pb	Cu
Tilapia zilli (Mango fish)	48	43.1±5.5	34.9±11.9	34.2±6.2	3.1±1.6	12.6±7.6	0.3±0.1
Alestes baremose (Silver - side)	56	38.4±11.1	14.4±2.9	35.1±4.9	3.1±1.7	14.4±8.1	0.2±0.1
Alestes nurse (Silver-side)	48	33.3±10.4	12.9±4.6	39.2±11.7	2.3±1.3	11.5±5.2	0.3±0.2
Mormyrus macrophthalmus (Trunk fish)	56	39.2±13.9	17.4±5.8	40.4±7.2	3.2±0.2	14.3±8.8	0.1±0.0

Table 2. Mean metal concentrations in fish from (G) Lakes Geriyo and (N) Njuwa (mg/kg wet weight). n is total number of fish

Fish		n	Ca	Mg	Zn	Fe	Pb	Cu
Tilapia zilli	G	64	50.9±17.5	18.2±14.5	35.1±4.5	2.4±1.7	23.3±14.6	0.1±0.1
(Mango fish)	N	48	37.7±15.6	17.5±6.7	45.4±15.2	1.8±1.2	21.2±12.6	0.3±0.4
Heterotis niloticus	G	48	49.4±29.1	17.6±7.3	42.4±5.5	1.8±1.0	21.4±8.2	0.0
	N	48	63.8±5.7	28.0±8.3	48.5±15.2	1.7±1.3	22.0±9.3	0.3±0.2
Claires geripienus	G	48	52.4±4.3	10.5±4.1	34.7±9.6	2.4±2.0	20.4±19.6	0.0
(Mud fish)	N	56	47.8±15.0	20.5±6.2	42.7±9.6	1.9±1.5	18.2±12.9	0.2±0.2
Synodontis ocellifer	G	56	37.2±16.9	6.8±2.5	25.3±12.6	2.3±1.9	15.5±13.5	0.3±0.4
(Cat fish)	N	56	22.9±5.9	10.1±1.7	48.7±19.9	2.2±1.6	40.0±26.8	0.2±0.2
Citharinus citharus	G	48	52.5±11.0	15.6±8.6	37.0±4.8	2.3±1.3	14.0±7.3	0.0
(Moon fish)	N	48	56.1±11.3	27.4±11.7	37.0±15.9	2.2±1.3	49.7±29.6	0.3±0.4

The concentrations of metals in fish from Lakes Geriyo and Njuwa are presented in Table 2. The mean concentrations of calcium for fish from the two lakes are within the same range, the highest value being 63.8±5.7 mg/kg. Similarly, the mean concentrations of zinc for fish from the lakes are comparable but appear to be slightly higher than the values from the Benue River. The highest mean concentration of zinc was 48.7±19.9 mg/kg in catfish from Lake Njuwa. The mean concentrations of iron and copper in fish from the lakes are not greater than 2.4±2.0 and 0.3±0.4 mg/kg, respectively, and are comparable to the corresponding values for the Benue River. Lead levels were in the concentration range of 14.0±7.3 to 49.7±29.6 mg/kg, the upper concentration value being for **Citharinus citharus** from Lake Njuwa. This was considerably higher than the upper concentration of 14.4±8.1 mg/kg for lead in fish from the Benue River. Of particular note are the levels of lead in **Tilapia zilli** from Lakes Geriyo and Njuwa which are 2-fold the value for the same species of fish from the Benue River. The levels of lead in the lake fish may have been accentuated by the immobility of water in the latter, resulting in the higher concentration of metals in solution and in the sediments.

Of the trace metals analyzed, zinc, copper and iron concentrations in the fishes from the Benue River and Lakes Geriyo and Njuwa are within acceptable limits of the Food Standards Committee (Egan et al. 1981) for these metals in foods. In constrast, lead was relatively high in the fishes and there is the need to ascertain the source of lead pollution in the Benue River for effective control of the metal concentration and for ensuring minimal levels of the metal in fishes from the river and the lakes.

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