



Research Article

Metal Levels in *Tilapia zilli*, *Clarias lazera* and *Barbus lagoensis* from River Hadejia and the Effects on Renal Failure

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ABSTRACT

Dietary exposure to toxic metals has been identified as a risk to human health due to large amounts of these metals disposed of in the environment either as industrial waste or other sources due to human activities. In this study, three species of fishes (*Tilapia zilli*, *Clarias lazera* and *Barbus lagoensis*) were obtained, air-dried, milled and digested. The digested samples were analyzed for cadmium, chromium, lead and mercury using atomic absorption spectrophotometer (AAS). The results of the analysis showed that the concentration of cadmium in *Tilapia zilli* (0.0088mg/kg) and *Barbus lagoensis* (0.5134mg/kg) were higher than the maximum permissible level (0.003mg/kg) of cadmium in food and water. Similarly, chromium concentration in *Barbus lagoensis* (0.069mg/kg) was higher than the permissible level (0.05mg/kg). Also, concentrations of lead in *Clarias lazera* (0.019mg/kg) and *Barbus lagoensis* (0.0739mg/kg) were above the maximum permissible level (0.01mg/kg) in food and water as recommended by the standard organization of Nigeria. The findings also revealed that mercury concentration in *Tilapia zilli* (0.0058mg/kg) was high and above the maximum permissible level (0.001mg/kg) stated in SON regulations. This study confirms the increased danger of consuming fish that is contaminated with these heavy metals, and if it is allowed to continue, long-term exposure may lead to kidney failure and other diseases associated with these heavy metals. Proper monitoring and enforcement by regulatory agencies are required.

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INTRODUCTION

Fish is one of the aquatics, cold-blooded vertebrates covered with scales and consists of two paired fins, and several unpaired fins that obtain oxygen through the gills. There are different types of fish with varieties of shape, size and colour. Fish is one of the most readily available sources of animal protein in the diet, especially for rural dwellers (Olaleye & Adesina, 2021). Heavy metals are a group of elements with diverse definitions. Some are necessary for human growth and development, such as iron, cobalt, copper, manganese, molybdenum and zinc. There is no clear evidence that other inorganic heavy metals like – lead, cadmium, arsenic, chromium etc. – serve any purpose in the human body, but they are known for direct effect on the kidneys and they are particularly nephrotoxic, even at “normal” levels (Sabatha & Robles-Osoriob, 2013). The study of the effects of heavy metals toxicity on humans has become very essential in the last 50 years, given that large amounts of these products were disposed of by the environment either as agricultural waste or other sources due to human activities, and they are non-biodegradable over long periods. For this

MATERIALS AND METHODS

Sample Collection

Three species of fish samples (*Tilapia zilli*, *Clarias lazera* and *Barbus lagoensis*) were obtained from Hadejia River, Jigawa State, Nigeria. The samples collected were washed, dissected and air-dried, the dried samples were milled using a pestle and mortar and then kept for further treatment (digestion). All chemicals used for this analysis were of analytical grade, obtained from both chemistry and biochemistry Department laboratories, Federal University Dutse, Jigawa State, Nigeria.

reason, even though strict regulations are enforced mainly to limit the disposal of heavy metals, high levels of these elements are still present in the soil, sediment and water, resulting in chronic exposure to the general population (Sabatha & Robles-Osoriob, 2013). Exposures of heavy metals by humans have been the main focus of attention among researchers, and health and nutrition experts due to their public health implications (Otitoju, 2012). Heavy metals may naturally occur as part of the earth's crust. Various human activities could also be responsible for the distribution of heavy metals at different levels. Environmental pollution by heavy metals, even at low levels, and their long-term health effects are the predominant global health concerns. Most of these heavy metals have long deleterious effects due to their non-biodegradable nature, and long biological half-lives and therefore can accumulate in different parts of the body. Fish is one of the cheap and readily available sources of protein in developing countries such as Nigeria. This research is therefore aimed at investigating the levels of the selected heavy metals in *Tilapia zilli*, *Clarias lazera* and *Barbus lagoensis* (samples A, B and C) and the effects of consuming them on humans.

Sample Digestion and Analysis

The fish samples were digested following the methods described by Allen *et al.*, (1991) and also by Akinola *et al.*, (2011). 1g of the milled fish samples was weighed into a beaker using weighing balance. 3ml of 60% hydrochloric acid and 10ml of 70% trioxonitrate (V) acid were added to the fish samples. The beakers were then placed on laboratory hot plate for digestion until the white fumes coming from the beakers became brown. These digests were allowed

to cool and then filtered through a Whatman's filter paper, leaving a whitish residue. The filtrates were then made up to 100ml using distilled water and stored for subsequent analysis. The digested samples were analyzed for Lead (Pb^{2+}), Cadmium (Cd^{2+}), Chromium (Cr^{2+}) and Mercury

(Hg^{2+}) concentrations using Atomic Absorption Spectrometry (AAS). Absorbance values were measured from the AAS machine and the results were converted to actual concentrations of the aforementioned ions in the sample

RESULTS AND DISCUSSION

The concentrations of cadmium (mg/kg) in three species of fish were presented in Table 1. The Table revealed that cadmium concentrations (mg/kg) of 0.0088 ± 0.08 , 0.00 ± 0.00 and 0.5134 ± 0.363 were found in fish samples: *T. zilli*, *C. lazera* and *B. lagoensis* respectively. The mean levels of cadmium in *B. lagoensis* (0.5134 mg/kg) were comparatively higher than those in *T. zilli* and *C. lazera*. The mean level of cadmium in *T. zilli*

and *B. lagoensis* (0.0088 mg/kg and 0.5134 mg/kg respectively) were well above the maximum permissible level of cadmium in water and food (0.003 mg/kg) as stated by Standard Organisation of Nigeria (SON, 2019). However, the concentration of Cd in *T. zilli* was lower than the 0.3 mg/kg maximum permissible limit set by WHO (2007), 0.44 - 0.85 mg/kg, 0.32 - 0.96 mg/kg and 0.23 - 1.05 mg/kg in spinach, kholrabi and papaya (Uddin *et al.*, 2019).

Table 1: Concentrations of cadmium (mg/kg) in *T. zilli*, *C. lazera* and *B. lagoensis*

Samples	Mean \pm S.D (mg/kg)	Range (mg /kg)
<i>T. zilli</i>	0.0088 ± 0.08	0.0008 – 0.0168
<i>C. lazera</i>	0.00 ± 0.00	0.00
<i>B. lagoensis</i>	0.5134 ± 0.363	0.01504-0.6216

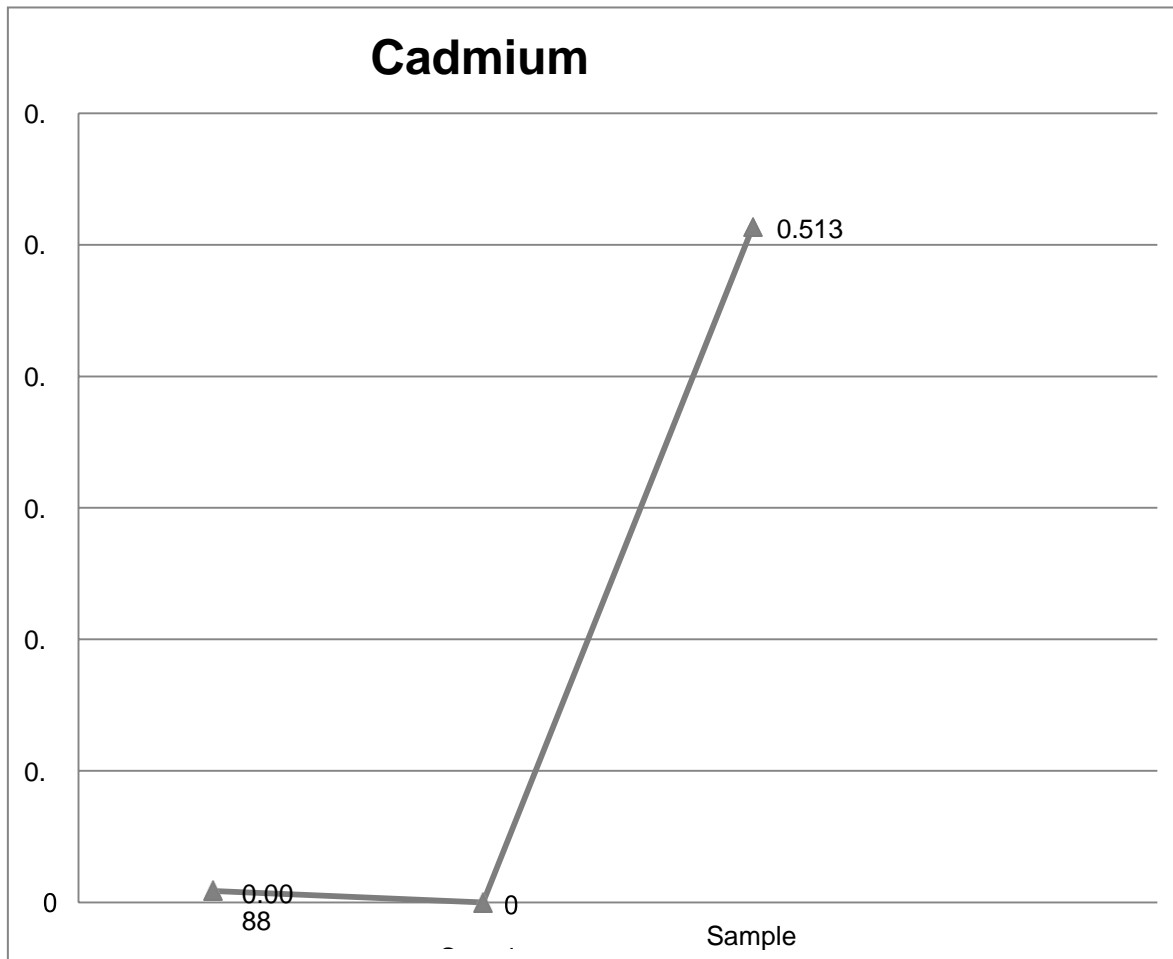


Figure 1: Concentrations of cadmium in *T. zilli*, *C. lazera* and *B. lagoensis*

The concentrations of chromium (mg/kg) in three species of fish were presented in Table 2. Concentrations of Cr in the three samples (*T. zilli*, *C. lazera* and *B. lagoensis*) were $0.0305 \pm$

0.034 , 0.0414 ± 0.026 and 0.069 ± 0.037 respectively. The mean concentration of chromium in sample C (0.069 mg/kg) was comparatively higher than that in *T. zilli* and *C. lazera*.

Table 2: Concentrations of chromium (mg/kg) in *Tillapia zilli*, *Clarias lazera* and *Barbus lagoensis*

Samples	Mean \pm S.D (mg/kg)	Range (mg /kg)
<i>T. zilli</i>	0.0305 ± 0.034	-0.0035 – 0.0645
<i>C. lazera.</i>	0.0414 ± 0.026	0.0154 – 0.0674
<i>B. lagoensis</i>	0.069 ± 0.037	0.032 – 0.06

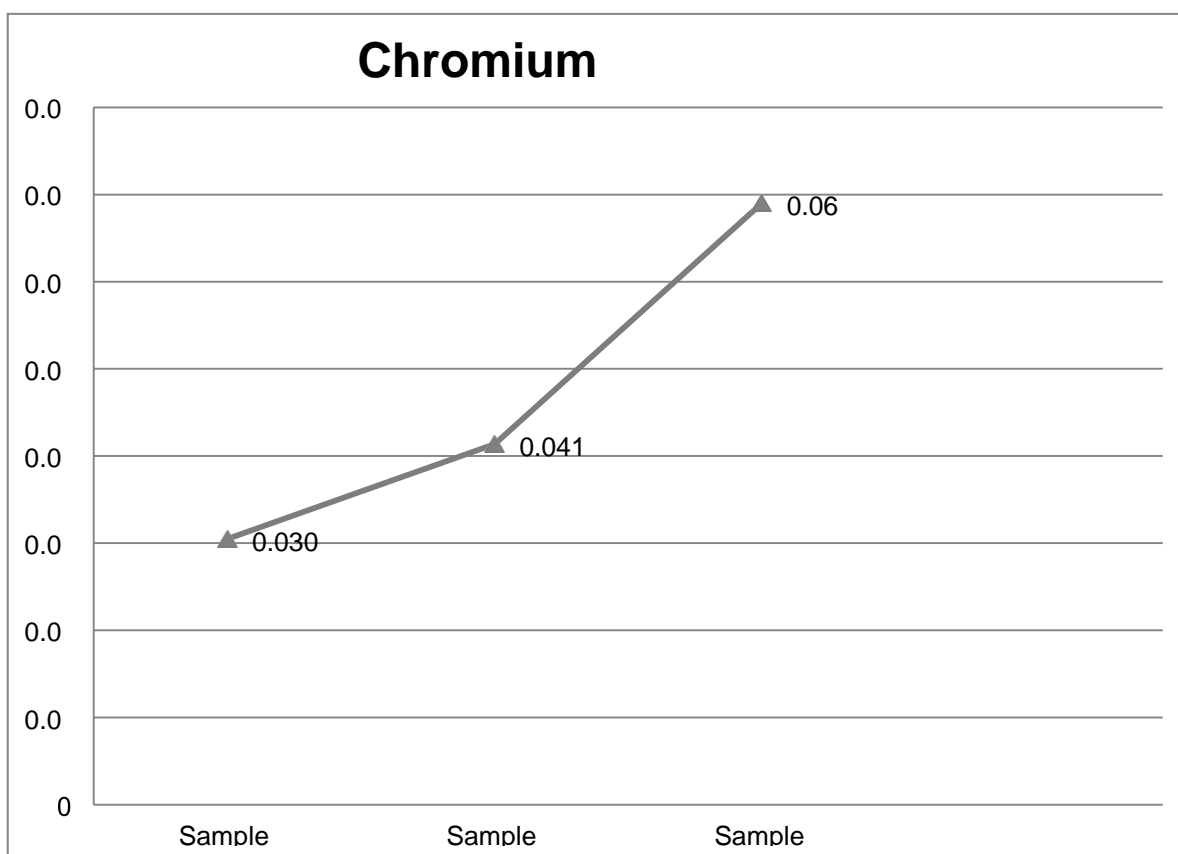


Figure 2: Concentrations of chromium in *T. zilli*, *C. lazera* and *B. lagoonensis*

The lead concentrations in three species of fish are presented in Table 3. Lead concentrations of 0.0148 ± 0.026 , 0.019 ± 0.017 and $0.0739 \pm$

0.046 (mg/kg) were found in samples A, B and C respectively. The mean concentration of lead in *B. lagoonensis* (0.0739 mg/kg) was higher than those in *T. zilli* and *C. lazera*.

Table 3: Concentrations of lead in *Tillapia zilli*, *Clarias lazera* and *Barbus lagoonensis*

Samples	Mean \pm S.D (mg/kg)	Range (mg /kg)
<i>T. zilli</i>	0.0148 ± 0.026	-0.0112 – 0.0408
<i>C. lazera</i>	0.019 ± 0.017	0.002 – 0.036
<i>B. lagoonensis</i>	0.0739 ± 0.046	0.0279 – 0.1199

The mean concentration of lead in fish *B. lagoonensis* (0.0739 mg/kg) was higher than the maximum permissible level of lead in water and food (0.01 mg/kg) according to the Standard Organisation of Nigeria (SON, 2019) standard. Concentrations of Pb in this study were lower than $1.62 - 13.4$ mg/kg in vegetable samples in some parts of Bangladesh (Uddin *et al.*, 2019) $3.00 - 4.00$ mg/kg in traditional herbal preparation in Northeast Ethiopia (Meseret *et al.*, 2020).

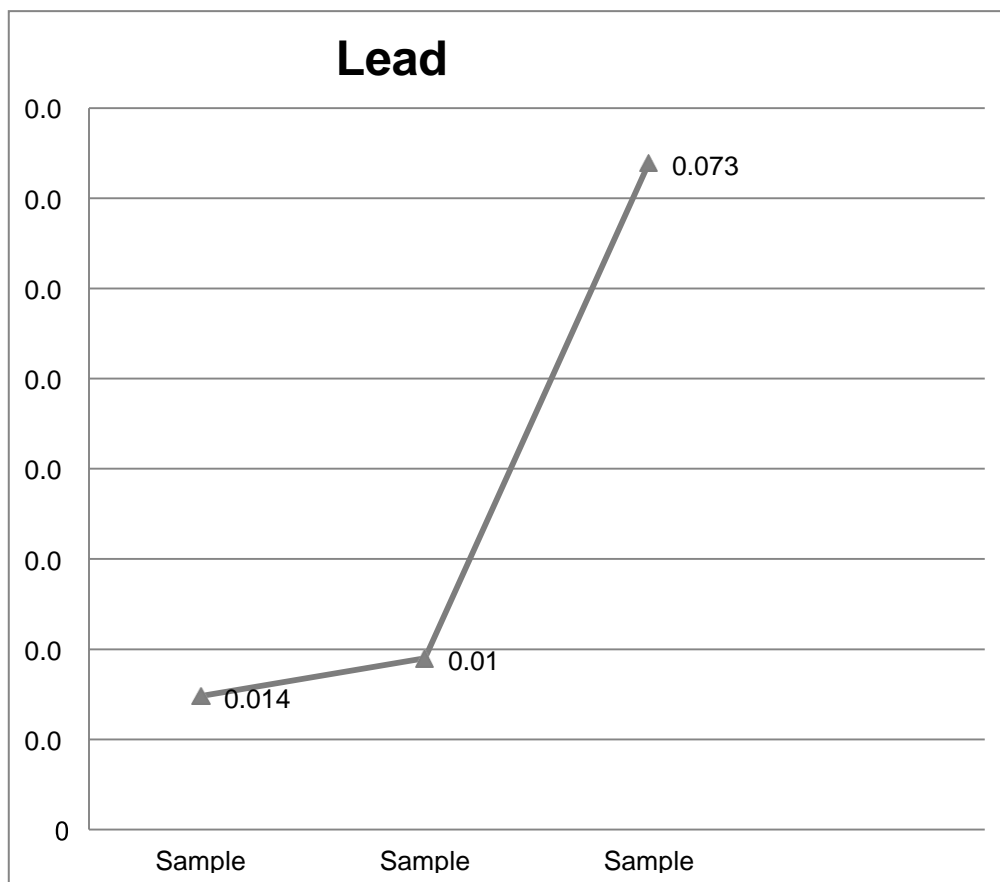


Figure 3: Concentrations of lead in *T. zilli*, *C. lazera* and *B. lagoensis*

Table 4 shows the concentration of mercury (mg/kg) in *Tilapia zilli*, *Clarias lazera* and *Barbus lagoensis*. The concentrations of mercury 0.0058 ± 0.010 , 0.00 ± 0.00 and 0.00 ± 0.00 were found in fish samples A, B and C respectively. From the results, mercury was recorded 0.00mg/kg in *Clarias lazera* and *Barbus lagoensis*.

Table 4: Concentrations of mercury in *T. zilli*, *C. lazera* and *B. lagoensis*

Samples	Mean \pm S.D (mg/kg)	Range (mg /kg)
<i>T. zilli</i>	0.0058 ± 0.010	-0.0042 – 0.158
<i>C. lazera</i>	0.00 ± 0.00	0.00
<i>B. lagoensis</i>	0.00 ± 0.00	0.00

Concentrations of Hg in this report were lower than 0.02mg/kg, 0.20 mg/kg and 0.02mg/kg maximum limits set by the European Union (2006), Chinese Department of Preventive Medicine (1994) and WHO/FAO (2007) respectively. This shows that the environment where the samples were taken is not contaminated with Hg.

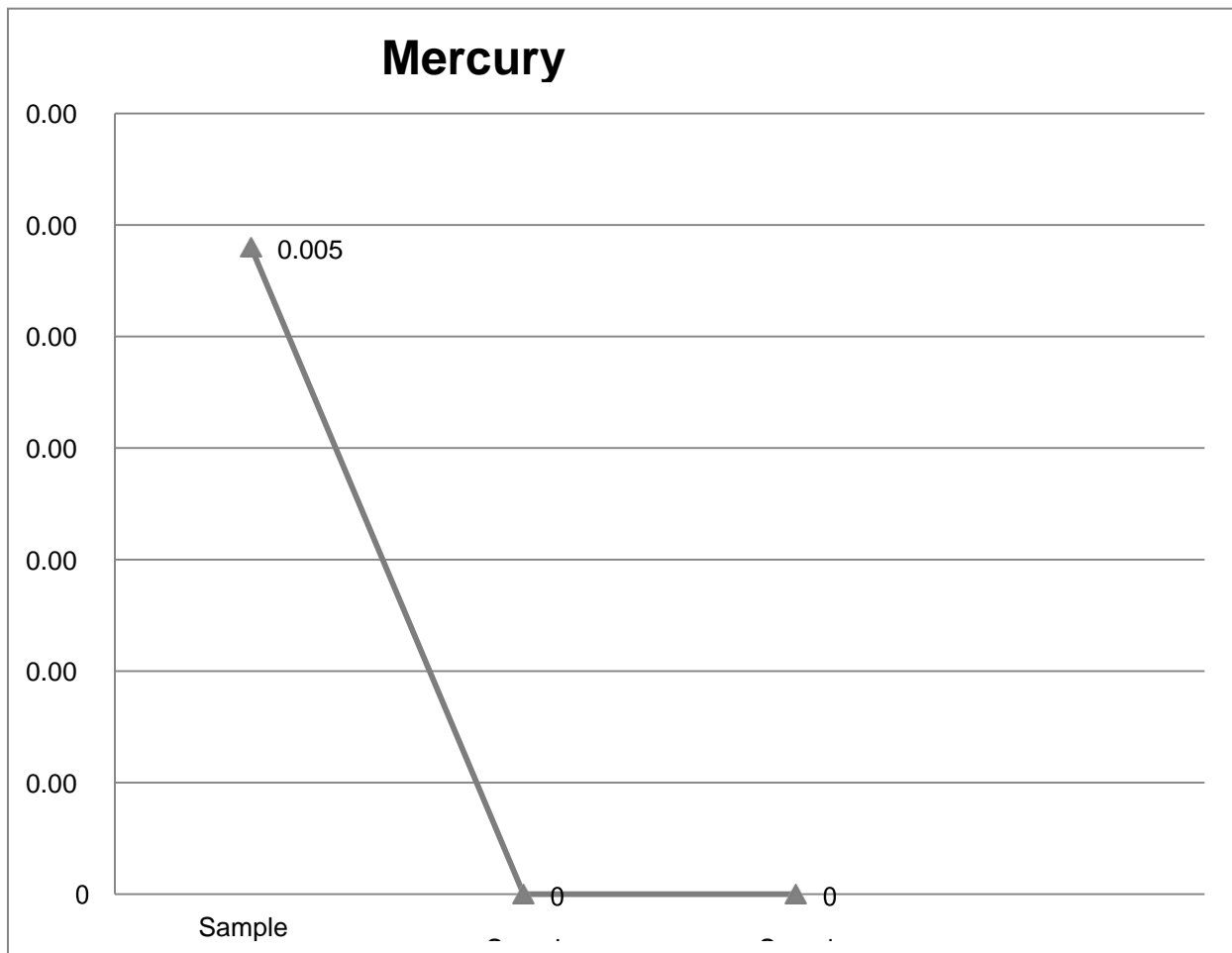


Figure 4: Concentrations of mercury in *T. zilli*, *C. lazera* and *B. lagoensis*

However, the mean concentration of mercury in fish sample A (0.0058 mg/kg) was higher than the maximum permissible level of mercury in water and food (0.001 mg/kg) (SON, 2019).

CONCLUSION

The result of this research work indicates that concentrations of cadmium, chromium and lead are high in sample C (*Barbus lagoensis*). The concentration of mercury is high in sample A (*Tilapia zilli*) compared to the maximum permissible levels of these elements as recommended by the Standard Organisation of Nigeria (SON, 2018), Food and Agricultural Organisation (FAO, 2018) and World Health Organisation (WHO,

2018). High levels of these metals in the fish samples place the consumers at high risk of renal failure with time unless proactive measures are taken. A high level of heavy metals in the fish samples is not desirable as it might be due to pollution of the environment. Further research is therefore needed to be conducted on the soil and water samples in the area to be sure whether or not the pollution is coming from the environment where the fishes reside.

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CONFLICT OF INTEREST

There was no conflict of interest to declare.

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