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Determination of the Level of Heavy Metals in Liver and Kidney of Cow and Goat Used As Meat Source in Mubi Adamawa State

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Abstract: *This work has been carried out to determine the levels of some heavy metals (Cr, Pb, Cu, Zn, Cd, and Mn), in liver and kidney of some animals used as meat source in Mubi, Adamawa State, Nigeria by wet digestion method using Buck scientific VGP 210 Atomic Absorption Spectroscopy (AAS). The levels of heavy metals in liver and kidney of cow and goat ranged from BDL to 0.001±0.00 (µg/g) Cr, 0.004 to 0.005±0.002 (µg/g), Pb, 0.04 to 0.52±0.30 (µg/g) Cu, 0.02 to 0.04±0.01 (µg/g) Mn, 0.001 to 0.001±0.00006 (µg/g) Cd, and 1.02 to 1.32±0.06 (µg/g) Zn. The concentrations of all the metals in the liver and kidney of cow and goat were found to be statistically significant. Generally, liver of cow and goat were found to have the highest levels of metals whereas kidney has lowest levels. When compared with one another (cow and goat) it shows significant differences. From this Study, it shows that the concentrations of all the metals were within the recommended limit set by WHO and USEPA. Hence, the liver and kidney from cow and goat in Mubi may be considered safe for consumption.*

Keywords: *Cow, Goat Liver, kidney, heavy metal, organ, food safety.*

1. INTRODUCTION

Pollution of heavy metals is a global threat to the environment as they are widely present in the earth's crust, in air, water and food. The increased in the level of environmental pollutions by toxic heavy metals from various sources call for great concern, because of its impact on human health. Nowadays, it is agreed that, the development of modern agricultural technology and the rapid industrialization are among the foremost factors for environmental pollution [1].

The consumption of cow meat as a proteineous source for proper tissue formation, growth, and repair is daily on increase. The common animal protein sources in Nigeria includes; beef, liver, kidney, fish, mutton, fowl and other sources. The habitat of these animals are continually been polluted with heavy metals, as a result of dumping of waste materials on the land and water bodies and illegal mining of ores [2], [3]. The distribution of heavy metals is greatly influenced by activities of organisms, climate, topography, parent's materials and time (Joseph et al., 2017).

As reported by [1], the heavy metals in vital organs of cows and bulls at Jimeta Abattoir, Yola, Adamawa State, Nigeria. The levels of heavy metals in the heart, intestine, stomach, kidney and liver ranges from 1.91±0.00 to 3.96±0.00 mg/kg Zn; 0.15±0.00 to 0.17±0.00 mg/kg Pb; 0.20±0.00 to 1.98±0.00 mg/kg Cu; 0.03±0.00 to 0.27±0.00 mg/kg Cd; and 0.00±0.02 to 0.00±0.00 mg/kg Co; on average. The highest concentration of zinc and copper were found in the liver while lead is deposited more in the kidney and heart. Cadmium was found to be concentrated in the kidney, while cobalt was not detected in most of the tissues. The Analysis of Variance (ANOVA) test on the concentrations of

all the heavy metals in the heart, intestine, stomach, kidney, and liver resulted in ($p>0.05$), i.e. there is no significant difference in the amount of the elements in this samples. The concentrations of all the metals were low and within the international statutory safe limits therefore, reported to be safe for consumption.

Heavy metals are particularly dangerous, because they tend to bio-accumulate in the body tissues and organs [4]. Cattle and other ruminants graze freely in the contaminated environment and drink water from ponds, streams, rivers and other possible contaminated water sources. Toxic effect of heavy metals have been described in animal under relatively low levels of metal exposure [6], one of the earliest effect is the disruption of trace element metabolism [7]. When large amount of heavy metal like chromium, cadmium and lead are ingested, can cause reduction in the size, weight and can cause severe damage to liver and kidney, Cadmium can also accumulate in kidney where it damages filtering and causes excretion of essential proteins and sugar from the body [8]. Contaminated animal feed and rearing of livestock in proximity to polluted environment were reportedly responsible for heavy metals contamination in meat which can result to liver and kidney damage, hepatic injury and cancer. Despite the nutritional value of animal's liver and kidney to man, the toxic effect which may result due to heavy metal contaminants is of great concern. Hence the determination of some heavy metals accumulation on liver and kidney of some animals may serve as a means of risk assessment (intake) of those meat source consumed in Mubi.

The study was focused on the assessment of level of some heavy metals (Cr, Pb, Cu, Zn, Cd, and Mn), in liver and kidney of some animals used as meat source in Mubi Adamawa State.

2. Materials and Methods

2.1 Equipment/ Apparatus

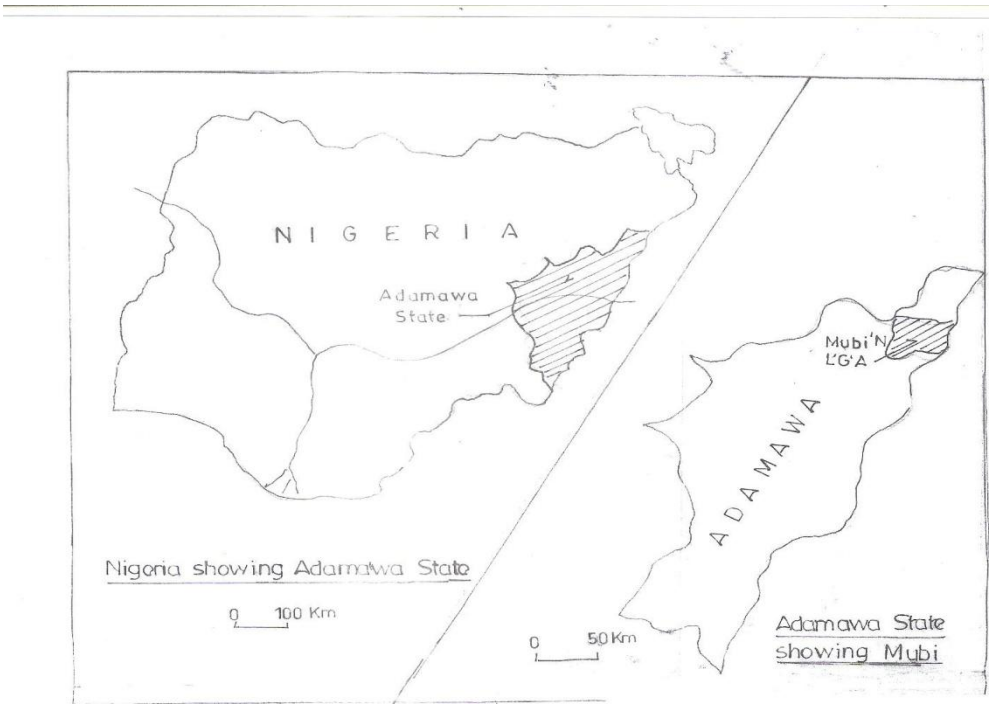
Digestion Flask, Volumetric flask, Weighing balance, Atomic Absorption Spectrophotometer (AAS), Stop Clock, Measuring Cylinder, Conical Flask, Filter Paper, Funnel, Kidney and liver Sample, Heating mantle, Dropping pipette, Retort Stand, Triple Stand, Wire gauge.

2.2 Chemicals/Reagents

Sulphuric Acid (Sg. 1.84), Hydrogen Peroxide (Sg. 1.13), Distilled water, Hydrochloric acid (Sg. 1.18), Nitric acid (70%), Zinc chloride.

2.3 Study Area

The study was carried out in Mubi central abattoir Mubi Nigeria located to the north eastern part of the Country, in Adamawa State.



2.4 Sample Collection

Fresh sample of liver and kidney of cattle and goat were collected from Mubi central abattoir Mubi metropolis, Adamawa state, Nigeria. The sample were collected in polyethylene bags and transported to the laboratory for analysis.

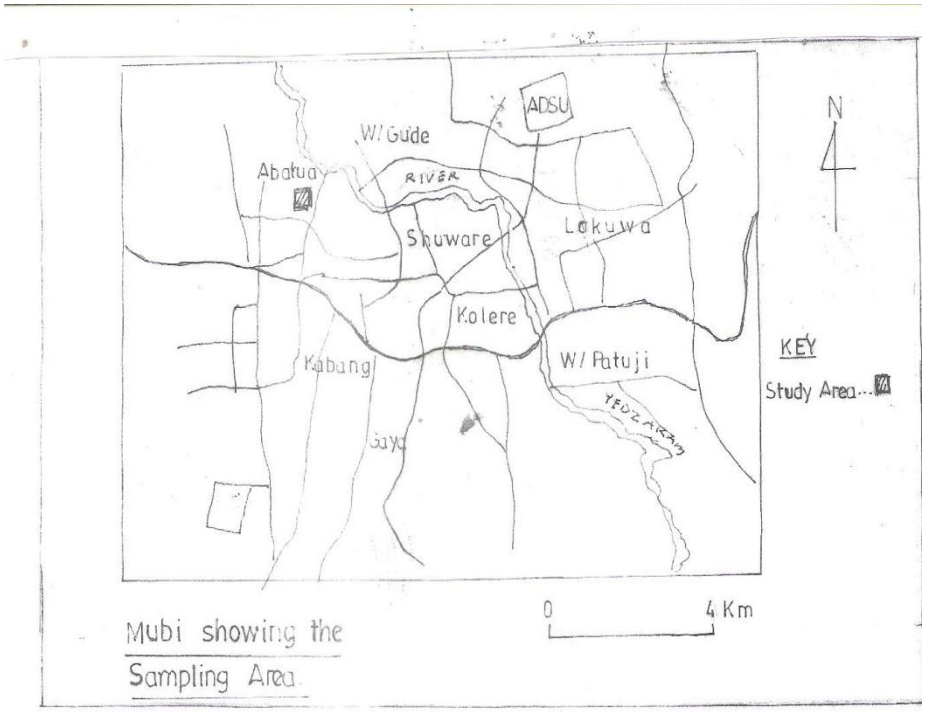


FIG. 1: MUBI TOWNSHIP SHOWING THE STUDY AREA.

2.5 Sample Preparation

The samples collected were decomposed by wet digestion method [9] for the determination of various metals. A known quantity, 10g of each sample (liver and kidney) was introduced into a digestion flask. 20cm^3 of sulphuric acid was added into it. The digestion flask was heated for 30min. When the flocculation settled, the flask was heated on high flame. After digestion, hydrogen peroxide was added drop wise until a clear solution is obtained. The content of the flask was filtered into a 50cm^3 volumetric flask and was made up to mark with distilled water.

2.6 Preparation of Stock Solution

A standard solution containing element to be determined was used in preparing the calibration curve. 1000ppm stock solution of each element to be determined was prepared from their salt. Reference solutions were prepared from the stock and finally the working standards, by the use of serial dilution as described below.

Copper was prepared by dissolving 1.00g of copper metal in 10ml 1:1 HNO_3 and diluted to the mark with distilled water in 1000ml volumetric flask. 2.13g of zinc chloride was dissolved in 200ml of distilled water and then dilute to mark in 1000ml volumetric flask. 1.599g of $Pb(N0_3)_2$ was dissolved in 1000ml volumetric flask. 5ml of 1.1 HNO_3 was added and made to mark with distilled water. 1.00g of chromium metal was dissolved in 50ml of 5M hydrochloric acid and then diluted to mark in a 1000ml volumetric flask. 1.00g of cadmium metal was dissolved in 10ml 1.1 HNO_3 and dilute to mark with distilled water in 1000ml volumetric. 1.00g of manganese metal was dissolved in 10ml 1:1 HNO_3 and then made to mark with distilled water in 1000ml volumetric flask.

2.7 Preparation of Various Working Standards from Stock Solution

In the preparation of standard solution, the serial dilution method was used in order to obtain the concentration. The calculated masses were dissolved in separate solutions of the metals. The solutions were further diluted to 100ppm by pipetting 10ml stock solution and made up to 100ml with distilled water. Working standard solutions were prepared from reference solution for each metal using serial dilution method ($C_1V_1 = C_2V_2$).

2.8 Heavy Metals Analysis (using AAS).

Determination of Cu, Cr, Pb, Zn, Cd and Mn in Liver and kidney sample were done directly on each of the prepared solutions using Atomic Absorption Spectroscopy (Buck scientific VGP 210 Atomic Absorption Spectrophotometer).

3. Result and Discussion

The standard deviation of concentration of replicate measurement was determined for each element.

Table1. *Concentration (µg/g) of Heavy Metals in Liver of Cow and Goat in Mubi Adamawa State*

SAMPLE	Cr	Pb	Cu	Mn	Cd	Zn
Cow liver	0.001±0.00	0.004±0.001	0.52±0.30	0.04±0.01	0.001±0.0002	1.32±0.06
Goat liver	BDL	0.004±0.001	0.18±0.14	0.04±0.01	0.001±0.00006	1.27±0.08
WHO Standard (mg/L)	0.05	0.01	1-2	0.1-0.5	0.003	3.0

BDL: - Below Detected Limit. WHO: - World Health Organisation.

Table 2. *Concentration (µg/g) of Heavy Metals in Kidney of Cow and Goat in Mubi Adamawa State*

SAMPLE	Cr	Pb	Cu	Mn	Cd	Zn
Cow kidney	BDL	0.005±0.002	0.04±0.01	0.02±0.003	0.001±0.0001	1.02±0.08
Goat kidney	BDL	0.004±0.001	0.04±0.01	0.02±0.002	0.001±0.00007	1.22±0.20
WHO Standard (mg/L)	0.05	0.01	1-2	0.1-0.5	0.003	3.0

BDL: - Below Detected Limit. WHO: - World Health Organisation.

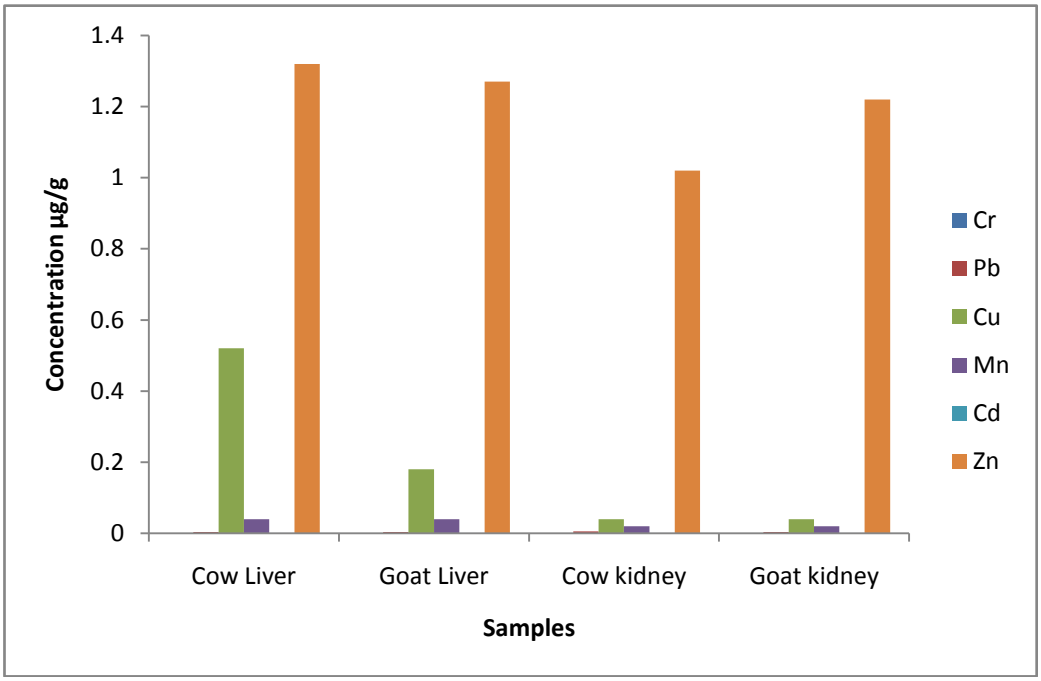


Fig 1. Mean Concentration (µg/g) of Heavy Metals in Liver and Kidney of Cow and Goat in Mubi Adamawa State.

Table 3. *World Health Organisation (WHO) and United State Environment Protection Agency (USEPA) Permissible Limit for Some Heavy Metals in Air, Soil, and Water.*

Heavy metal	Maximum conc. in air(mg/m^3)	Max. conc in sludge(soil) (mg/kg or ppm)	Max. conc in drinking water (mg/L)	Max .conc in H_2O Supporting aquatic life (mg/L or ppm)
Cd	0.1-0.2	85	0.003-0.005	0.008
Pb	_ _	420	0.01(0.0)	0.0058
Zn	1,5	7500	3.0-5.00	0.0766

Hg	_ _	<1	0.001-0.002	0.05
Ca	5	Tolerable	50	Tolerable >50
As	_ _	_ _	0.01	_ _

Source: WHO, 1992. USEPA, 1987.

Table 4. *Recommended (daily) dietary allowances (RDA) of the food and nutrition board (Published by the national academy of science, Washington U.S.A).*

	Age (yrs)	Weight (kg)	Ca (mg)	Fe (mg)	Mg (mg)	Zn (mg)
Infants	0- 1/2	6	360	10	60	3
	½ - 1	9	540	15	70	5
Children	1 – 3	13	800	15	150	10
	4 – 6	20	800	10	200	10
	7 – 10	30	800	10	250	10
Male	11 – 14	44	1200	18	350	15
	15 – 18	61	1200	18	400	15
	19+	67+	800	10	350	15
Female	11 – 18	44 – 54	1200	18	300	15
	19+	58	800	18(10)*	300	15
Pregnant			1200	18+**	450	20
lactating			1200	15	450	25

For female above 50yrs, figure cannot be met by ordinary diets. Therefore, use supplemental iron is recommended.

Table 5. *Guideline in Drinking Water by the World Health Organisation (WHO) and National Agency for Food and Drugs Administration and Control (NAFDAC). Nigeria.*

Heavy metal	Max. acceptable conc (WHO) mg/L	Max. acceptable conc (NAFDAC) mg/L
Zinc	5	5
Arsenic	0.01	0.0
Magnesium	50	30
Calcium	50	50
Cadmium	0.003	0.0
Lead	0.01	0.0
Silver	0.0	0.0
Mercury	0.001	0.0

Table 6. *WHO, USEPA and UK Standard Concentration of Metals in MgL^{-1} (Miroslav and Vladimir, 1999).*

Parameter	WHO	USEPA	UK
Al	0.2	0.05-0.2	0.2
As	0.01	0.05	0.05
Cd	0.003	0.005	0.05
Cr	0.05	0.10	0.05
Cu	1-2	1.0	-
Fe	0.3	0.3	0.2
Hg	0.001	0.002	0.001
Mn	0.1-0.5	0.005	0.005
Ni	0.02	0.1	0.05
Pb	0.01	0.015	0.05
Zn	3.0	5.0	-

4. DISCUSSION

The levels of heavy metals in the liver and kidney of cow and goat are presented in Fig 4.1. Chromium (Cr) concentration is from 0.001 and the rest were below detected limit (BDL), 0.005 and 0.004 µg/g Pb, 0.54 to 0.04 µg/g Cu, 0.04 to 0.02 µg/g Mn, 0.001 to 0.001 ±0.00006 µg/g Cd, and 1.32 to 1.02 µg/g Zn. The concentration of chromium (Cr) were only observed in the liver of cow (0.001±0.00 µg/g) in which the other samples (cow kidney, goat liver, and goat kidney) were below

detectable limit (BDL) as presented in table 4.1, 4.2 and Fig 4.1. Chromium is essential element helping the body to use sugar, protein and fat at the same time it is carcinogenic for organism (Institute of medicine, 2002). Excessive amount of chromium may cause adverse health effects such as reduce liver size and weight, liver and kidney damage [10], [8]. The concentration of chromium (Cr) in all the samples were within the permissible limit (0.05-0.1 mg/L) set by world health organisation and united state environmental protection agency (WHO/ USEPA).

Lead (Pd) as observed in the cow kidney show the highest concentration as 0.005±0.002 µg/g and the lowest concentration of 0.004±0.001µg/g in the cow liver, goat liver and goat kidney. Lead (Pb) is the most toxins of heavy metals, in the environment lead (Pb) arise from both natural and anthropogenic source. Exposure can occur through drinking water, food, air, soil and dust from old paint containing lead [11], [12]. Lead (Pb) poisoning also causes inhibition of the synthesis of haemoglobin, kidney dysfunctions, acute and chronic damage of nervous system (CNS) [13]. Higher concentration of Pb (1.34±0.23 µg/g) was obtained by [14] who determined lead concentration in liver and kidney of cattle within a 20Km radius of zinc refineries and compared these with cattle in unpolluted control area. Significantly higher amount lead in liver and kidney were found in cattle reared in the mining area and also higher than those in cattle in the rural area. The concentrations of lead (Pb) in all the samples were within the recommendation limit of 0.01-.0.015 mg/L set by (WHO/ USEPA).

The highest copper concentration was found in the liver of cow (0.52±0.30µg/g, and the least value was observed in the kidney of cow and goat (0.04±0.01µg/g), these might be because blood detoxification and purification take place in the liver. The copper concentration in all the samples were below the recommendation limit 2 mg/L set by (WHO/USEPA). [15] In there work ‘‘level of toxic elements and functional structure in populations of small mammals under conditions of technogenic pollution’’ found high levels of copper and zinc in the liver and kidney of mutton and beef (3.04±0.02 µg/g). Copper is essential for good health, but vary high intake can cause health problem such as liver and kidney damage [16]. Copper can also cause public health hazards in high concentration [17]. In humans, 10-30 mg/L of orally ingested copper from foods stored in copper vessels may cause intestinal discomfort, dizziness and headaches, while excess accumulation of copper in liver may result in hepatitis and in a haemolytic crisis similar to that seen in acute copper poisoning [18]. However, none of the samples in this study had copper content exceeding the permissible limit 1-2 mg/L set by (WHO and USEPA).

Daily intake of small amount of manganese (Mn) is needed for growth and good health in humans, otherwise deficiency of Mn can cause nervous system problem [19]. It was observed that the liver of cow and goat showed the highest manganese (Mn) concentration of 0.04±0.01µg/g and the lowest concentration of 0.02±0.002 µg/g was observed in goat kidney. The results revealed that the concentrations of manganese (Mn) in the liver and kidney of cow and goat were lower than the permissible limit 0.1-0.5mg/L set by (WHO and USEPA) and these might be due to rearing of animals in unpolluted and control environment.

Highest cadmium (Cd) concentration was observed in the liver of cow (0.001±0.0002 µg/g) table 4.2, while the lowest (0.001±0.00006 µg/g) was in the goat liver table 4.1. Cadmium is toxic to virtually every system in the animal body. It is almost absent in the human body at birth, however, accumulated with age. Cadmium accumulated in the kidney and liver over a long time have been reported by [20] that Cadmium interacts with a number of minerals mainly Zn, Fe, Cu, and Se due to chemical similarities and competition for binding stage. It is also reported that Cadmium can affect Ca, P and bone metabolism in both industrial and people exposed to Cadmium in general environment [21]. [22] in his work˝Distribution of lead , cadmium and zinc in tissue of hens and chickens from Slovenia˜ found higher level of Cd and Zn in the liver and kidney of the hens and chickens , which exceed the official tolerance levels. From the result of these study, the concentration of cadmium (Cd) content in all the samples studied were found to be within the permissible limit 0.003-0.005 mg/L set by (WHO and USEPA). These might be as a result of rearing of these animals in less polluted environment.

Zinc concentration was found to be higher in the liver of cow (1.32±0.06 µg/g), while the least value was in the kidney of cow (1.02±0.08 µg/g) and these may be because filtration of blood takes place in the liver. Zinc is an essential element in human diet. Too little zinc can cause problem e.g. bloody urine, diarrhoea, vomiting, uterus (yellow mucus membrane), liver and kidney failure and anaemia

[23], however, too much Zn is harmful to human health, such as system dysfunctions that result in impairment of growth and reproduction [24], [25], [10]. The concentrations of zinc in all the samples studied were below the benchmark 3.0-5.0 mg/L set by (WHO and USEPA).

5. CONCLUSION

From the results of this study, the concentration of all the metals in the liver and kidney of cow and goat were found to be statistically significant ($p<0.05$). Generally, liver of cow and goat were found to have the highest significant level of heavy metals and kidney of cow and goat the lowest levels, this may be because detoxification and purification of blood take place in the liver. When compared to one another (cow and goat), it show significant difference in the levels of heavy metals. Hence, the concentrations of all metals were within the recommended limit set by World Health Organisation (WHO) and United State Environmental Protection Agency (USEPA) tolerance limits. Hence, the liver and kidney from cow and goat in Mubi may be considered safe for consumption.

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