

Hematological, Serum Biochemical and Trace Mineral Indices of Cattle with Foreign Body Ruminal Impaction

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Abstract: This study was aimed at investigating the hematological, biochemical and trace mineral status of cattle with foreign body ruminal impaction. Hematological, serum biochemical and trace mineral parameters of cattle with Foreign Body Ruminal impaction (FBR) and normal cattle Without Foreign Body Ruminal impaction (WFBR) were analyzed in order to evaluate their influence as risk factors in the etio-pathogenesis of non-penetrating foreign body ruminal impaction. Blood samples with appropriate preservatives were analyzed using appropriate techniques for FBR and WFBR animals. The mean erythrocytic values of packed cell volume (PCV; 24.81%), Red blood cell count (RBC; $3.93 \times 10^6/\mu\text{L}$) and Hemoglobin (Hb; 7.04 g/dL) were significantly lower ($p < 0.05$) in FBR than in WFBR. Mean White blood cell count (WBC; $20.41 \times 10^3/\mu\text{L}$) was significantly higher ($p < 0.05$) in FBR than in WFBR animals. Mean biochemical values of serum total protein (5.74 g/dL), phosphorus (2.37 mg/L), glucose (31.08 mg/L), calcium (2.01 mmol/L), urea (1.42 mmol/L) and creatinine (131 $\mu\text{mol/L}$), were significantly lower ($p < 0.05$) in FBR than WFBR cattle. Mean serum values of sodium, potassium and Magnesium did not differ significantly ($p < 0.05$) between FBR and WFBR animals. Mean trace mineral values of copper (0.24 mg/L), Zinc (0.42 mg/L), cobalt (0.005 mg/L), Manganese (0.005 mg/L) and Selenium (0.076 mg/L), were significantly lower ($p < 0.05$) in FBR than WFBR animals. The results suggest that some hematological, biochemical and trace mineral parameters may influence foreign body ruminal impaction in cattle and these could be used as a basis for diagnosis and formulation of preventive measures.

Keywords: Cattle, hematology, ruminal impaction, serum biochemistry, trace minerals

INTRODUCTION

The indigenous ruminant livestock industry in Nigeria represents a very important national resource, contributing immensely to national health and wealth through supply of protein and industrial raw materials (FLDPCS, 1991). A high proportion of this livestock population are reared under the extensive system of animal husbandry characterized by uncontrolled movement over a large expanse of land, grossly inadequate feed intake, poor nutrition and high disease prevalence (Payne, 1990).

Ruminal impaction is a condition which results from the accumulation of indigestible foreign bodies such as nylon, ropes, polythene bags, twine, leather, plastics, metallic objects, among others. These materials interfere with the flow of ingesta, leading to distension of the rumen and passing of scanty feces (Abdullahi *et al.*, 1984). The ingestion of these indigestible materials may occur during period of draught and feed scarcity (Igbokwe *et al.*, 2003).

Unlike in penetrating foreign body that could be diagnosed using deep abdominal palpation and by

eliciting and detecting pain behind the Xiphoid process of the sternum, most non-penetrating foreign bodies are asymptomatic to be detected by physical examination in live animals, requiring expensive and sophisticated equipment such as radiography, ultrasonography and endoscopy (Radostits *et al.*, 2000; Hailat *et al.*, 1998). The condition, therefore poses a diagnostic challenge to the clinician.

Although fatalities associated with ingestion of indigestible foreign materials resulting in ruminal impaction have been documented (Akinrinmade *et al.*, 1988; Otesile and Akpokodje, 1991; Vanitha *et al.*, 2010), many of the previous reports on the prevalence of indigestible foreign body ruminal impaction in cattle and small ruminants had been largely based on abattoir surveys (Hailat *et al.*, 1998; Remi-Adewumi *et al.*, 2004; Fromsa and Mohammed, 2011; Akinrinmade and Akinrinde, 2012a; Akinrinmade and Akinrinde, 2012b). Reports on cattle, sheep and goats reared within urban and sub-urban environments in Nigeria indicated that impaction of the rumen resulted from the accumulation of non-biodegradable foreign bodies, interfering with normal flow of ingesta, leading to distension of the

rumen (Abdullahi *et al.*, 1984; Igbokwe *et al.*, 2003; Remi-Adewumi *et al.*, 2004; Akinrinmade and Akinrinde, 2012a; Akinrinmade and Akinrinde, 2012b). Similarly, the findings of Elsa *et al.* (1995), on the indications for rumenotomy in small animals ascribed 67.6% of cases to be due to foreign body rumen impaction.

The clinical and economic significance of foreign body rumen impaction have been elucidated with respect to severe loss of production and high mortality rates (Elsa *et al.*, 1995; Radostits *et al.*, 2000).

Hematological, biochemical and trace mineral indices have been used as diagnostic aids in the recognition of diseases especially chronic asymptomatic cases (Tietz, 1982; Jain, 1986). Besides, examination of blood and its constituents has been used to monitor and evaluate health and nutritional status of animals (Gupta *et al.*, 2007). Trace element assessment in particular, is normally done to determine the presence or prevalence of nutrient deficiencies and evaluate the efficacy of dietary supplementation or to compare available supplement. Physiological functions are progressively affected by deficiencies. Economically important effects on performance and health of animals can be affected by trace element deficiencies even before clinical signs are evident (Kincaid, 1999). Blood measures are frequently used in assessment because they are significantly correlated to nutritional status of some trace elements (Levander, 1986; Mills, 1987).

The results obtained from such determinations have proven to be rewarding in the formulation of appropriate therapeutic regimes and nutritional supplementation (Adeloye, 1998). Hematological and serum biochemical profiles of West African Dwarf (WAD) goats with indigestible foreign body rumen body impaction have been reported in southwest humid sub-tropical zone of Nigeria (Akinrinmade and Akinrinde, 2012c). Because the WAD goats are selective feeders and reared exclusively in the southern sub-tropical climatic zone as compared to cattle that are reared in the arid and sub-arid regions of the north that are characterized by long period of draught and grossly inadequate fodder resources, we hypothesized that the hematological, biochemical and trace mineral profiles of WAD goats and cattle with foreign body rumen impaction differ.

The present study was designed to investigate the hematological, biochemical and trace element profile of trade cattle with indigestible foreign body rumen impaction slaughtered in Ibadan Central Abattoir, southwest Nigeria.

MATERIALS AND METHODS

Study area: The investigation was carried out at the central abattoir of Ibadan, Nigeria a city located in the

southwest tropical sub-humid zone, along the north-south nomadic cattle trade route. The origins of cattle slaughtered at the abattoir were from the derived savannah, Sahel and sub-arid climatic zones of northern Nigeria and border countries such as Niger, Chad and Mali.

Study design: The study was conducted during the months of March to May, 2011 using the protocol previously described (Akinrinmade and Akinrinde, 2012a; Akinrinmade and Akinrinde, 2012b). Identification of animals was facilitated by the use of distinguishable color markings, tags, breed and sex. Jugular vein blood samples were collected and preserved appropriately using EDTA and sodium fluoride for hematological and glucose determinations, respectively, while for serum samples, blood was collected into anti-coagulant free plastic tubes and allowed to clot at room temperature within 3 h of collection. The serum samples were later stored at a temperature of 20°C for biochemical analysis. Blood samples were similarly obtained for hematological analyses in 50 cattle without foreign body rumen impaction, to serve as controls.

Hematological analyses: The Packed Cell Volume (PCV) was determined by Hawskeymicrohematocrit method (Schalm *et al.*, 1986). The Hemoglobin (Hb) concentration was measured spectrophotometrically by the cyanmethemoglobin method using the SP6-500UV spectrophotometer (PYE, UNICAM, England). The Red Blood Cell (RBC), total and differential White Blood Cell (WBC) counts were estimated by the hemocytometer method (Schalm *et al.*, 1986) using improved Hawskeyhemocytometer. Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin Concentration (MCHC) and Mean Corpuscular Hemoglobin (MCH) were calculated from PCV, Hb and RBC values (Schalm *et al.*, 1986).

Biochemical and trace mineral analyses: Sodium (Na) and Potassium (K) concentrations were measured using the flame photometer (Corning model 400, Corning Scientific Ltd, England). Calcium (Ca), Magnesium (Mg), Zinc (Zn), Copper (Cu), Cobalt (Co), Iron (Fe), Manganese (Mn) and Phosphorus (P) were determined using a BUX2000 Atomic Absorption Spectrophotometer (AAS). Total protein was estimated by the Biuret reaction (Peters *et al.*, 1982), while blood glucose was determined by enzymatic colorimetric test (QuimicaClinicaApplicaada, S.A. kit). Urea and creatinine concentrations were determined according to Harrison (1977).

Statistical analyses: The data obtained was expressed as mean and standard deviation (mean±S.D.) and

Table 1: Erythrocytic indices of cattle with and without foreign body impaction at the Bodija Central Abattoir, Ibadan

Indices/parameters	FBRI	WFBRI (control)	Oduye and Fasanmi (1971)	Olayemi (2004)	Olayemi and Oyewale (2002)	Vanitha <i>et al.</i> (2010)
PCV (%)	24.81±1.80*	32.15±3.98	34.08±4.12	35.45±5.61	32.41±5.65	29.75±1.38
RBC (10 ⁶ /μL)	3.93±1.220*	5.87±1.190	7.05±1.820	5.34±1.540	4.50±1.630	7.24±0.370
Hb (g/dL)	7.04±2.630*	10.88±2.87	9.80±1.370	11.44±0.94	11.65±1.29	10.18±0.45
MCV (fl)	64.29±11.20*	52.26±2.14	46.85±5.25	72.26±21.44	79.84±25.98	50.02±1.35
MCHC (g/dL)	29.01±4.85	35.84±6.71	ND	32.45±4.85	36.94±6.53	34.94±1.00
MCH (pg)	18.12±7.06	18.83±3.94	ND	23.61±8.70	29.78±11.92	14.37±0.98

*: Values differ significantly from control at p<0.05; ND: Not determined

Table 2: Leucocytes' values of cattle with and without foreign body impaction at the Bodija Central Abattoir, Ibadan

Indices/parameters	FBRI	WFBRI (control)	Oduye and Okunniyaya (1971)	Olayemi (2004)	Olayemi and Oyewale (2002)	Vanitha <i>et al.</i> (2010)
WBC (x10 ³ /μL)	20.41±0.88*	15.43±3.44	9.98±2.66	7.61±2.86	6.26±3.20 (X10 ³ /μL)	66.78±0.74 (X10 ³ /μL)
Neutrophils (x10 ³ /μL)	13.07±3.90*	6.88±4.18	ND	1.36±0.51	0.83±0.33 (X10 ³ /μL)	3.19±0.53
Lymphocytes (x10 ³ /μL)	7.37±3.12*	9.66±1.05	19.90±9.30 (%)	5.75±0.76 (x10 ³ /μL)	4.14±1.01 (X10 ³ /μL)	7.96±0.48
Basophils (x10 ³ /μL)	0.01±0.002	0.02±0.002	0	ND	ND	0.03±0.02
Eosinophils (x10 ³ /μL)	0.48±0.12	0.34±0.57	8.73±6.80 (%)	0.33±0.26 (X10 ³ /μL)	0.12±0.07 (X10 ³ /μL)	0.42±0.02
Monocytes (x10 ³ /μL)	0.41±0.01	0.39±0.05	0	0.16±0.18 (X10 ³ /μL)	0.03±0.03 (X10 ³ /μL)	0.32±0.02

*: Values differ significantly from control at p<0.05; ND: Not determined

Table 3: Serum biochemical indices of cattle with and without foreign body impaction at the Bodija Central Abattoir, Ibadan

Indices/parameters	FBRI	WFBRI (control)	Oduye and Fasanmi (1971)	Olayemi <i>et al.</i> (2001)
Sodium (mmol/L)	133.26±2.15	131.41±2.10	134.80±19.0 (mmol/L)	141.83±8.84 mmol/L
Potassium (mmol/L)	4.97±0.880	4.56±0.93	4.47±0.80 (mmol/L)	5.22±1.09 mmol/L
Magnesium (mmol/L)	0.80±0.130	0.99±0.45	-	ND
Calcium (mmol/L)	2.01±0.120* (mmol/L)	2.96±0.39 (mmol/L)	9.81±1.52 mg/dL; 2.45±1.52 mmol/L	2.15±0.03 mmol/L
Total protein (gm/dL)	5.74±1.350*	7.96±0.67	7.55±2.5 g/dL	79.80±16.70 g/L
Inorganic phosphate (mg/L)	2.37±1.230*	2.46±1.30	6.08±1.05 mg/dL	1.62±0.78 mmol/L; 5.02±0.78 mg/L
Glucose (mg/L)	31.08±1.25*	46.21±2.13	61.08±4.48 mg/L	ND
Albumin	ND	ND	2.56±1.04 g/dL	25.00±6.80 g/L
Globulin	ND	ND	4.96±2.68	55.30±24.30 g/L
Urea (mmol/L)	1.42±2.01*	2.67±1.80	ND	1.93±1.30 mmol/L
Creatinine (μmol/L)	131±18.7*	159±21.21	ND	161.77±58.34 μmol/L
Indices/parameters	Kamalu <i>et al.</i> (2003)	Olayemi (2004)	Kapu (1975)	Vanitha <i>et al.</i> (2010)
Sodium (mmol/L)	153.48±15.73	144.60±8.11 mmol/L	-	ND
Potassium (mmol/L)	6.27±0.3	5.26±1.28 mmol/L	290.0±89 mg/L	ND
Magnesium (mmol/L)	0.85±0.0	ND	23.83±4.23 mg/L	ND
Calcium (mmol/L)	3.77±0.9 mmol/L	2.15±0.04 mmol/L	97.82±11.24 mg/L	10.92±0.32 mg/dL
Total protein (gm/dL)	ND	82.00±11.60 g/L	-	6.76±0.14 mg/L
Inorganic phosphate (mg/L)	5.61±0.6 mg/L	1.63±0.72 mmol/L	-	-
Glucose (mg/L)	-	ND	-	-
Albumin	-	25.70±6.10 g/dL	-	-
Globulin	-	56.30±10.30 g/dL	-	-
Urea (mmol/L)	-	2.44±2.17 mmol/L	-	-
Creatinine (μmol/L)	-	167.96±59.23 μmol/L	-	-

*: Values differ significantly from control at p<0.05; ND: Not determined

statistically analyzed using analysis of variance (ANOVA). Anonymous (1998) statistical computer software was used. P values less than or equal to 0.05 were considered significant using Students't-test.

RESULTS

The erythrocyte values of cattle with foreign body rumen impaction and control animals are presented in Table 1. There was a significant difference (p<0.05) in the PCV, RBC and Hb values in cattle with foreign body rumen impaction as compared to control animals. The values were also significantly lower (p<0.05) than other reference values reported by previous workers in the same environment. The MCV, MCHC and MCH

values were, however, not significant different from those of control or reference values.

Table 2 shows the leukocyte values of cattle with foreign body rumen impaction and those of animals without foreign body rumen impaction. Cattle with foreign body rumen impaction had significantly lower (p<0.05) WBC, neutrophils and lymphocyte values than control animals. The values of basophils, eosinophils and monocytes were not significantly different (p<0.05) between animals with and without foreign body impaction.

Table 3 presents the mean values of biochemical parameters in cattle with and without foreign body rumen impaction. The mean values of sodium, potassium, magnesium and calcium were not

Table 4: Trace element status of cattle with and without foreign body impaction at the Bodija Central Abattoir, Ibadan

Indices/parameters	FBRI	WFBRI	Olayemi (2004)	Kapu (1975)	Puls (1988) and Kincaid (1999)
Copper (mg/L)	0.240±0.150	0.48±0.120	1.14±0.06 µg/L	1.05±0.16 mg/L	0.5-0.7 g/mL
Zinc (mg/L)	0.420±0.180	0.78±0.250	1.14±0.05 µg/L	1.28±0.28 mg/L	0.5-0.8 g/mL
Manganese (mg/L)	0.005±0.002	0.02±0.013	0.37±0.09 µg/L	ND	210-1,200 ng/mL
Selenium (mg/L)	0.076±0.058	0.20±0.090	ND	ND	-
Cobalt (mg/L)	0.005±0.003	0.006±0.001	ND	ND	130-250 g/100 mL
Iron (mg/L)	3.640±1.220	4.04±0.710	2.89±0.18 µg/L	ND	10-40 g/100 mL

*: Values differ significantly from control at $p < 0.05$; ND: Not determined

significantly different ($p < 0.05$) between cattle with foreign body impaction and control animals. However, the values of total protein, inorganic phosphate, glucose, urea and creatinine were significantly lower ($p < 0.05$) in cattle with foreign body impaction than in control animals.

Trace mineral values of cattle with and without foreign body rumen impaction are shown in Table 4. Mean values of copper, zinc, manganese, selenium and cobalt were significantly lower ($p < 0.05$) in cattle with foreign body rumen impaction than in animals without foreign body rumen impaction. The mean value of iron was not significantly different ($p < 0.05$) in both categories of cattle.

DISCUSSION

In the present study, significant decrease in mean values of PCV, total erythrocyte count and hemoglobin concentration were observed in animals with foreign body rumen impaction. This observation may be due to inadequate dietary intake or reduced absorption as a result of presence of foreign materials in the rumen. The observation corroborates earlier reports in goats (Akinrinmade and Akinrinde, 2012c) and cattle (Mayer *et al.*, 1992; Vanitha *et al.*, 2010) with foreign body rumen impaction.

Erythrocyte values are indicators of the oxygen-carrying capacity and general health status of the animal. Low values of Hb, RBC and PCV may also not be unrelated to ecto- and endo-parasitosis and other gastro-intestinal diseases as these animals lack adequate anthelmintic control under the extensive system of management in which they are kept (Akinrinmade *et al.*, 1988; Otesile and Akpokodje, 1991; Remi-Adewumi *et al.*, 2004).

The highly significant increase in mean values of neutrophils with a significant decrease in mean lymphocyte values may be due to presence of foreign bodies (Hailat *et al.*, 1996) and sloughing, stunting, erosion inflammatory response and hyperplasia due to pressure on the wall of the rumen caused by foreign bodies (Hailat *et al.*, 1996).

Leucocytic cell distribution is affected by breed, temperature, environmental, as well as body's demand and health status (Mbassa and Poulsen, 1993). The observed decrease in mean lymphocytic values may suggest increased susceptibility to infection in animals with foreign body impaction.

Mean values of total protein, BUN and creatinine were significantly lower in animals with foreign body impaction. This may be due to inadequate feed intake and malnutrition (Mayer *et al.*, 1992), absence of prophylactic anthelmintic medication against blood-sucking parasites (Otesile and Akpokodje, 1991), rumen fermentation and reduced microbial activity associated with presence of foreign body materials (Hobson, 1988).

Mean values of Na, Potassium and Magnesium obtained in this study did not differ significantly ($p < 0.05$) in both categories of animals except for calcium. Hypocalcaemia may be due to dietary deficiency and failure of calcium absorption due probably to reduced rumen motility (Elsa *et al.*, 1995; Igbokwe *et al.*, 2003). Electrolytes are not synthesized in the body, but are supplied by the feed, the level of feed intake, the availability of the materials and absorption from the gut (Underwood, 1981; McDowell, 1992).

Mean serum glucose value in cattle with foreign body impaction was significantly ($p < 0.05$) lower than in animals without foreign body impaction and other reference values (Oduye and Fasanmi, 1971; Vanitha *et al.*, 2010). The hypoglycemia observed may be due either to inadequate nutrition or reduced utilization. Low level of glucose in animals with foreign body rumen impaction could also be ascribed to high levels of free fatty acids and cholesterol associated with reduced energy intake, decreased water deprivation and decreased glucose synthesis (McDowell, 1992).

In the present study, hypophosphatemia was observed in both categories of animals investigated. The values were significantly ($p < 0.05$) lower than those by other workers (Oduye and Fasanmi, 1971; Olayemi *et al.*, 2001; Kamalu *et al.*, 2003; Vanitha *et al.*, 2010). This implied that animals brought in for slaughter were either severely or marginally deficient of phosphorus. This finding corroborates the report of McDowell (1992) to the effect that most livestock grazing areas of tropical countries contain soils and plants low in phosphorus. Similarly, Sowande *et al.* (2008) reported a significant decrease in phosphorus concentration in the blood of WAD goats and sheep grazing natural pastures in southwest Nigeria. Deficiency of phosphorus is regarded as the most widespread and economically important of all the mineral disabilities affecting grazing livestock (McDonald *et al.*, 1995). Since one of the clinical manifestations/signs/symptoms of non-

penetrating foreign body rumen impaction in cattle is pica or depraved appetite, determination of phosphorus level could be of value in diagnosis and formulation of appropriate mineral supplementation.

There was a significant decrease ($p < 0.05$) in the mean values of copper, zinc, manganese, selenium and cobalt, respectively in animals with foreign body impaction, while the mean values of iron in both categories of animals were significantly higher ($p < 0.05$) than the values reported by other workers (Awolaja *et al.*, 1997; Kincaid, 1999). The observed decrease in the mean values of these trace elements could be ascribed to the presence of foreign bodies in the rumen. In ruminants, efficiency of absorption of many trace minerals and dietary factors that affect bioavailability of minerals differ greatly. Because ruminant diets are usually high in fiber and considerable digestion of fiber occurs via microbial fermentation in the rumen, this process may be hampered by the presence of foreign body materials.

Association of minerals with fiber fractions in feedstuff (Whitehead *et al.*, 1985) and/or binding of minerals to indigestible constituents may alter bioavailability of some trace minerals in ruminants (Kabaija and Smith, 1988). This probably explains the observed decrease in the mean values of these minerals in this study.

Although diet analyses provide useful supporting data, the blood measures utilized in this study are frequently used in assessment of trace mineral status in ruminants because they are significantly correlated to nutritional status of some trace elements (Levander, 1986; Mills, 1987) and blood is less invasive to sample than the liver which is the organ that often represents the status of several trace elements in animals (McDowell, 1992).

The precise role of individual trace element in the etio-pathogenesis of foreign body rumen impaction in cattle could not be ascertained in this study, because we did not perform analyses of those elements with important interactions. Copper absorption in ruminants is low relative to values reported in non-ruminants and this is largely due to complex interactions that occur in the rumen environment (Spears, 2002). A three-way interaction between copper, molybdenum and sulphur had been shown to form thiomolybdates, which associate with rumen ingesta to prevent the absorption of copper (Suttle, 1991).

We are of the opinion that presence of non-biodegradable impacted materials in the rumen might heighten this already complex interaction, thereby reducing the bioavailability of the element. Since our analyses did not include sulphur and molybdenum, it may be possible that these elements abound in ingested foreign materials. This finding is considered to be of clinical significance in view of the fact that copper deficiency is now thought to be the second most common mineral deficiency in cattle worldwide (Suttle, 1991; Wikse *et al.*, 1992; Geengelbach, 1994).

The low level of zinc observed in cattle with foreign body rumen impaction may be ascribed to the effects of stress, infection, water deprivation and feed restriction (Kincaid, 1999). Zinc plays important role in ruminants including gene expression, mitosis and apoptosis of lymphoid cells (Shanker and Prasad, 1998).

Low mean values of cobalt observed in animals with foreign body impaction may be related to significantly low mean erythrocytic indices. Cobalt is required by rumen micro-organisms for the production of vitamin B (Black and French, 2004). Cobalt intake and bioavailability are influenced by rumen environment, stress and starvation (Kennedy *et al.*, 1995; Guylot *et al.*, 2009). This probably explains the normocytic, normochromic anaemia observed in the affected animals.

Previous investigations indicated age, sex and inadequate fodder resources as risk factors of foreign body rumen impaction in ruminants (Igbokwe *et al.*, 2003; Remi-Adewumi *et al.*, 2004; Fromsa and Mohammed, 2011; Akinrinmade and Akinrinde, 2012a; Akinrinmade and Akinrinde, 2012b). The present study was perhaps the first to investigate the role of trace minerals and suggest probable interactions with other blood indices and risk factors in the etio-pathogenesis of foreign body impaction. Based on our findings from this study, formulation of appropriate nutritional supplement and other preventative measures could be facilitated.

Animals investigated in this study were derived mainly from arid and sub-arid zones and kept under extensive husbandry with neither feed nor water supplementation. They are therefore at increased risk as they desperately scavenge around refuse dumps to meet their nutritional demands in the face of ever-dwindling fodder resources. The diagnostic challenge posed by and the economic loss due to foreign body rumen impaction and its associated fatalities, cost of surgical treatment, loss of body weight and productivity is yet to be quantified and appreciated and may continue to pose a great threat to efforts at developing the indigenous livestock industry in sub-Saharan Africa.

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