



## Impact of sodium humate on performance, rumen microbial and faecal egg counts of West African dwarf goats fed cassava peel based diets

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### Abstract

*The problem of cyanide poisoning may be addressed with addition of feed additives with potentials for detoxification. This research was conducted to assess the performance, rumen microbial and faecal egg counts of West African dwarf (WAD) goats fed cassava peel based diets. Twenty WAD bucks were fed cassava peel based diets supplemented with sodium humate at 0, 5, 10 and 15 g/kg diet for a period of 87 days. The experiment was laid out in a completely randomised design. Data was collected on growth performance indices, rumen microbial count, apparent nutrient digestibility and faecal egg count and statistically analysed using SPSS. Results showed addition of sodium humate to cassava peels based diets improved ( $p < 0.05$ ) daily weight gain, feed conversion ratio and dry matter digestibility. Faecal egg count in WAD goats decreased ( $p < 0.05$ ) with addition of sodium humate in the diet. Increasing amount of sodium humate linearly decreased ( $p < 0.05$ ) protozoa count in the rumen of WAD goats. In conclusion, 5 g/kg diet of sodium humate is sufficient to ensure improved performance of WAD goats on cassava peel based diets.*

**Keywords:** sodium humate, cassava peel, performance, faecal count, WAD goats

### Introduction

Cassava peels have the potential to serve as dietary source of energy for domestic animals in many tropical countries. However, consumption of cassava is limited by its characteristic content of cyanogenic glycosides. This has limited its use in feed of domestic animals especially when it is wet. The toxic effects of the ingestion of cassava leaves by goats have been attributed to the action of cyanide released from cyanogenic glycosides, and not the glycosides directly (Soto-Blanco and Gorniak, 2010). It should be noted that Cyanide is one of the most potent and rapidly acting inorganic poisons and it can cause toxicity in animals, especially ruminants (Gensa, 2010). Although cyanides are released to environment in various forms, the natural source of cyanide ion from plants that contain enough cyanogenic glycosides are the most important cause of hydrogen cyanide poisoning in ruminants. Cassava peels could be safely used as livestock feed if they are treated to reduce the cyanogenic potential.

Several methods of detoxifying the cyanogenic potential of cassava peels have been documented. This includes boiling, ensiling, sun-drying, heap fermentation and soaking (Padmaja and Steinkraus, 1995; Tweyongyere and Katongole, 2002). The combination of sodium nitrite and sodium thiosulfate has also been reported as an antidote of choice in reducing cyanide poisoning in ruminants (Gensa, 2010). Such action to detoxify the cyanogenic potential of cassava peels may enhance improved performance in the animals. It is postulated that the role of humic substances to contribute towards the transportation, mobilization, and dissolution of metals and organics in the environment may have been responsible for its growth promoting effect (Nunes *et al.*, 2019) and this may be useful strategy in addressing the problems of cyanide poisoning in ruminants. The mobilization and dissolution of metals properties of humate may help to improve on the rumen health of ruminants, thereby improving the overall performance of the animal. This research therefore seeks to assess the effect of feeding sodium humate on the

performance, rumen microbial count and faecal egg count in West Africa dwarf goats fed cassava peel based diets.

## Materials and Methods

### Study area

The study was conducted at the Animal Science Teaching and Research Farm of Joseph Sarwuan Tarka University, Makurdi, Benue State, Nigeria. Makurdi lies between latitude 7° 44' 1.50" N and longitude 8° 31' 17.00" E in the guinea Savannah zone of Nigeria.

### Experimental design and animal management

The study lasted for 16 weeks. This was divided into the first six weeks as adaptation period for the West African dwarf goats and the next eleven weeks for the growth period. A total of twenty (20) West African dwarf bucks weighing between 5.54-11.39 kg were purchased from local farmers in wannune and Ikpayongo Markets in Benue State, Nigeria. During the six weeks quarantine period, PenStrep (1 ml/10 kg) was administered intramuscularly to the animals for prophylactic treatment against bacterial disease. They were also treated for ecto and endoparasites using Ivermectin (0.5 ml/10 kg) subcutaneously. Prior to the arrival of the bucks, the pens were thoroughly cleaned and disinfected using izal solution. The bucks were housed in separate pens measuring 1 x 1.5 m each. The house was constructed to have free flow of air; the floor of the pen is slated and made with wood with a zinc roof. The bucks were fed in the morning and afternoon (7:00am and 12:00pm), and fresh clean water was provided *ad-libitum*. The bucks were kept under hygienic condition and were confined throughout the experimental period.

The experimental design was a completely randomized design (CRD). Four experimental diets (Table 1) were formulated as follows: Control (0 g/kg diet of sodium humate), 5HNa (5 g/kg diet of sodium humate), 10HNa (10 g/kg diet of sodium

humate) and 15HNa (15 g/kg diet of sodium humate)

### Data collection

#### Growth performance (Weight change and feed intake)

Weight changes of the bucks were obtained on weekly basis by determining the average weight of the bucks per treatment for the week and subtracting from the previous week.

$$\text{Weight gain (kg)} = \text{Final weight} - \text{Initial weight}$$

Feed intake was determined by subtracting feed left over from feed offered to the animals.

$$\text{Feed intake (kg)} = \frac{\text{Amount of feed offered} - \text{Amount of feed left over}}{\text{Number of animals}}$$

Feed conversion ratio (FCR) was determined by calculating the ratio of total feed consumed in gram to total weight gain in gram per treatment.  $FCR = \frac{\text{feed consumed}}{\text{weight gain}}$

### Rumen microbial count

A 6<sup>th</sup> dilution factor was prepared and inoculated on the surface of solidified potato dextrose agar (PDA) and nutrient algae (NA) for fungi and bacteria, respectively and plated. The plates were incubated at 25°C for 24 hours and colonies of fungi and bacteria were counted after 24 hours (Dehorty, 1984). About 5 ml of the rumen sample were added to 5 ml of formalin, 2.0 ml aliquot of the samples were pipetted into 18 ml of glycerol-buffer-methyl green mixture and allowed to stand for 4 hours, counting was carefully done in the counting chamber using x10 objective.

### Apparent nutrient digestibility

At the end of the 77 days feeding trial, the animals were moved into metabolic cages for faecal collection. They were allowed seven days to acclimatize; thereafter faecal samples were collected from each of the animals for

three days daily in the morning and afternoon. Faeces were collected from wire-mesh nets placed under the floor of metabolism crates. Collected faecal samples were weighed daily then oven-dried at 65 °C for 48 hrs. Thereafter, the samples were ground to pass through a 1-mm screen, bulked on a replicate basis, and stored in an airtight container for chemical analysis. Samples of the experimental diets and faecal samples were analyzed for dry matter (DM) crude protein (CP), crude fiber (CF), ash, ether extract (EE) [AOAC, 2005], neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were also analyzed (Van Soest *et al.*, 1991).

### Faecal egg count

Individual faecal samples were collected at days 84, 85, 86 of the experiment before the morning feeding to measure faecal egg count (FEC; without egg differentiation). All the aliquots of faeces from each animal were bulked and mixed completely, the pooled samples were analysed for FEC using the modified McMaster technique (Ueno and Gonçalves, 1998).

### Statistical analysis

The data generated on performance indices, faecal egg count, rumen bacteria, fungi, and protozoa count was subjected to analysis of variance using SPSS (Version 23) statistical software (SPSS, 2011). Significantly different means were separated using Duncan's Multiple Range test at ( $p < 0.05$ ) level of probability.

## Results

### Effect of sodium humate as feed additive on growth performance of West African dwarf goats fed cassava based diets

The results of performance indices of WAD goats as affected by inclusion of sodium humate in cassava peel based diets is shown in Table 2. Daily weight gain increased ( $p < 0.05$ ) in all sodium humate groups. Higher comparable values of daily weight gain were found in 5HNa, 10HNa and 15HNa groups (39.43, 39.14 and 43.51

g/day, respectively), compared to the control group (27.71 g/day). Also a similar trend as in daily weight gain was observed for feed conversion ratio. There were comparably better ( $p < 0.05$ ) feed conversion in the sodium humate groups (16.94, 16.83 and 16.39 for 5HNa, 10HNa and 15HNa, respectively) compared to control (22.34). Other parameters measured such as concentrate and forage intake were not affected ( $p > 0.05$ ) across the treatment groups.

### Effect of sodium humate as feed additive on rumen microbial count of West African dwarf goats fed cassava based diets

Table 3 shows the result of rumen microbial count of WAD goats on cassava peel based diet as affected by addition of sodium humate. Rumen protozoa of WAD goats on cassava based diets decreased ( $p < 0.05$ ) as the amount of sodium humate in the diet increased. Highest protozoa count was 113.50 cells/ml in control, and least in 15HNa group (49.60 cells/ml). 5HNa and 10HNa groups had protozoa count of 85.00 and 73.00 cells/ml, respectively. However, the numbers of bacteria and fungi populations in the rumen of WAD goats fed cassava peel based diets were not affected ( $p > 0.05$ ) by the inclusion of sodium humate in the diets.

### Effect of sodium humate as feed additive on apparent nutrient digestibility (%) and faecal egg count in West African dwarf goats fed cassava based diets

The apparent nutrient digestibility and faecal egg count in WAD goats fed cassava peel based diet with inclusion of sodium humate is shown in able 4. Dry matter digestibility increased ( $p < 0.05$ ) in all sodium humate based groups with 5HNa, 10HNa and 15HNa having comparable values (84.45, 88.54 and 89.91%, respectively). Least dry matter digestibility was observed in the control group (74.13%). Crude protein however increased ( $p < 0.05$ ) in 5HNa group (82.61%) compared to control group (74.47%) but not in 10HNa and 15HNa groups (77.68 and

75.71%, respectively). Digestibility of ash increased in 10HNa group (46.49%) compared to all other groups which had comparable similar values (32.29, 35.34 and 36.63% for control, 5HNa and 15HNa, respectively). Ether extract digestibility was higher ( $p < 0.05$ ) in 15HNa group (86.32%) compared to control, 5HNa and 10HNa groups (80.59, 82.10 and 81.27, respectively). Addition of sodium humate in cassava based diets reduced ( $p < 0.05$ ) faecal egg counts compared to control group (1978.00 egg/g)

### Discussion

Increased weight gain in sodium humate groups is consistent with reports by other researchers in dairy, beef and grazing goats (Livestock, 2003; Agazzi *et al.*, 2007; Cusack, 2008; Ikyume *et al.*, 2021). Improved weight gain has been attributed to the effect of humic substances to increased metabolic activity of cell membranes which accelerates oxidative processes, thereby increasing nutrient uptake (Islam *et al.*, 2005). This increase in nutrient uptake may have resulted in the stimulation of certain functions for improved weight gain. A better feed conversion ratio observed in sodium humate groups may have ensured due to the ability of sodium humate to stabilize pH and intestinal microbiota (Cusack, 2008; Ikyume *et al.*, 2020a), thus ensuring improved nutrient utilization.

A decrease in fungi count with increasing amount of sodium humate in cassava peel based diet will mean less amount of methane production in the rumen of the animals. Protozoa contributes to methane production as donors of hydrogen. A reduction in protozoa will mean less hydrogen available in the rumen. This implication is however not consistent with report of increased hydrogen production in sodium humate diets under *in vitro* conditions (Ikyume *et al.*, 2020b). Also, under *in vivo* conditions, protozoa counts in grazing West African dwarf goats were not affected with inclusion of sodium humate in the diets (Ikyume *et al.*, 2020a). The

management conditions and composition of the substrate may have accounted for the discrepancies observed in the various reports mentioned above.

Improved digestibility of cassava peel based diets with addition of sodium humate could be because of the presence of trace mineral elements within humic substance. This can act as cofactors in nutrient digestibility (Hayirl *et al.*, 2005), thereby increasing the activity of enzymes involved in nutrient digestion. This same action may be responsible for improved crude protein digestibility in 5HNa group compared to control as well as increase in ether extract digestibility observed in 15HNa group. It should be noted that such actions to increase digestibility of crude protein and ether extract were dose dependent. Reduced total FEC with sodium humate addition is indicative of its positive effect of on stimulation of the immune system of animals to strengthen the resistance against pathogens. This is because immune system stimulation due to humic substance antibiotic properties resulted in increased resistance to diseases, as well as parasite manifestation due to the anti-parasitic activity of humate substances (Trckova *et al.*, 2005). The addition of sodium humate in diet of West African goats may be an effective way of controlling internal parasite infestation in the animals.

### Conclusion

Sodium humate addition in cassava peel based diets may have effectively addressed the problem of possible cyanide poisoning in West African dwarf goats by improving on the daily weight gain and feed conversion rate of the animals. The addition of sodium humate in the diet may have sufficiently addressed the problem of parasite infestation through reduced populations of faecal eggs in the animals. The inclusion of sodium humate in cassava peel based diets of West African dwarf goats at 5 g/kg diet is recommended.

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**Table 1: Gross composition and chemical analysis of experimental diets**

Ingredients	Treatments/Diets			
	Control	5HNa	10HNa	15HNa
Maize offal	28	28	28	28
Cassava peel	32	32	32	32
Soybean meal	20	20	20	20
Rice offal	12	12	12	12
Bone meal	6	6	6	6
Vitamin premix	1	1	1	1
Salt	1	1	1	1
Total	100	100	100	100
Sodium humate (g)	0	500	1000	1500
<b>Determined analysis</b>				
Dry matter	86.32	85.93	86.46	86.70
Crude protein	12.86	12.92	12.94	13.01
Ash	5.43	6.32	6.43	6.57
Ether extract	4.13	4.21	4.06	4.16
Neutral detergent fibre	57.32	56.10	54.04	55.46
Acid detergent fibre	18.43	19.00	23.00	20.00

Control= 0 g/kg diet of sodium humate

5HNa= 5 g/kg diet of sodium humate

10HNa= 10 g/kg diet of sodium humate

15HNa= 15 g/kg diet of sodium humate

**Table 2. Effect of sodium humate as feed additive on growth performance of West African dwarf goats fed cassava based diets**

Parameter	Treatment Diets				SEM
	Control	5HNa	10HNa	15HNa	
Initial weight (kg)	8.16	8.17	8.12	8.16	0.34
Final weight (kg)	10.29	11.20	11.13	11.51	0.41
Daily weight gain (g)	27.71 <sup>b</sup>	39.43 <sup>a</sup>	39.14 <sup>a</sup>	43.51 <sup>a</sup>	1.95
Daily concentrate intake (g)	206.85	233.81	247.79	262.82	11.68
Daily forage intake (g)	408.85	429.47	401.27	436.58	11.71
Total daily feed intake (g)	615.70	663.29	649.06	699.40	17.79
Feed conversion ratio	22.34 <sup>b</sup>	16.94 <sup>a</sup>	16.83 <sup>a</sup>	16.39 <sup>a</sup>	0.70

<sup>a,b</sup>Means with different superscript along the row are significant (p<0.05)

Control= 0 g/kg diet of sodium humate

5HNa= 5 g/kg diet of sodium humate

10HNa= 10 g/kg diet of sodium humate

15HNa= 15 g/kg diet of sodium humate

**Table 3. Effect of sodium humate as feed additive on rumen microbial count of West African dwarf goats fed cassava based diets**

Parameter	Treatment Diets				SEM
	Control	5HNa	10HNa	15HNa	
Bacteria count	3.03	3.50	3.80	3.23	0.16
Fungi count	13.63	13.68	11.30	11.20	0.63
Protozoa count	113.50 <sup>a</sup>	85.00 <sup>b</sup>	73.00 <sup>c</sup>	49.60 <sup>d</sup>	5.79

<sup>a,b,c,d</sup>Means with different superscript along the row are significant ( $p < 0.05$ )

Control= 0 g/kg diet of sodium humate

5HNa= 5 g/kg diet of sodium humate

10HNa= 10 g/kg diet of sodium humate

15HNa= 15 g/kg diet of sodium humate

**Table 4. Effect of sodium humate as feed additive on apparent nutrient digestibility (%) and faecal egg count in West African dwarf goats fed cassava based diets**

Parameter	Treatments				SEM
	Control	5HNa	10HNa	15HNa	
Dry matter	74.13 <sup>b</sup>	84.45 <sup>a</sup>	88.54 <sup>a</sup>	89.91 <sup>a</sup>	1.99
Crude Protein	74.47 <sup>b</sup>	82.61 <sup>a</sup>	77.68 <sup>ab</sup>	75.71 <sup>ab</sup>	1.29
Ash	32.29 <sup>b</sup>	35.34 <sup>b</sup>	46.49 <sup>a</sup>	36.63 <sup>b</sup>	1.51
Ether extract	80.59 <sup>b</sup>	82.10 <sup>b</sup>	81.27 <sup>b</sup>	86.32 <sup>a</sup>	0.63
Neutral detergent fibre	64.63	73.17	66.25	67.93	1.44
Acid detergent fibre	50.36	49.98	43.16	43.71	1.71
Acid detergent lignin	53.85	46.89	43.39	49.13	1.77
FEC (egg/g)	1978.00 <sup>a</sup>	1096.00 <sup>b</sup>	960.00 <sup>b</sup>	846.00 <sup>b</sup>	117.39

<sup>a,b</sup>Means with different superscript along the same row differ significantly ( $p < 0.05$ )

Control= 0 g/kg diet of sodium humate

5HNa= 5 g/kg diet of sodium humate

10HNa= 10 g/kg diet of sodium humate

15HNa= 15 g/kg diet of sodium humate