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SUPPLEMENTING COATED UREA IN WEST AFRICAN DWARF GOAT DIETS IMPROVES CARBON FOOTPRINT AS SUSTAINABLE REPLACEMENT FOR SOYBEAN MEAL.

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Abstract

Small ruminant production emits greenhouse gases from feeds and ruminal fermentation that contribute to environmental pollution and depletion of the ozone layer. This menace hampered sustainable production and supply of major livestock products. The use of slow release nitrogen sources as dietary supplement has been proposed as alternatives that can reduce urinary nitrogen from feeds. A feeding trial was conducted to examine the effect of replacing soybean meal (SBM) with 2.5 % and 5% coated urea (CU) on feed carbon footprint (CFP) and serum toxicity potential in growing West African Dwarf goats. Serum samples were obtained via jugular veins and analyzed using a cell Dyn 3500 hematology system. Results showed that replacing soybeans meal with coated urea up to 5 % did not negatively affect health status of bucks and serum biochemical indices were within the physiological range for healthy bucks, suggesting no indication of ammonia toxicity. Compared with the control (0% CU) diet, feed CFP decreased by 45% and 59% in 2.5% and 5%, respectively. Thus, indicating that coated urea can be used as a sustainable alternative to partially replace vegetable protein sources in small ruminant diets without negative effect on health status and the environment.

Keyword: small ruminants, greenhouse gases; coated urea; soybean meal; toxicity.

Introduction

Small ruminants (sheep, goat) are capable of converting inedible environmental resources to high quality animal protein (meat and milk) which is crucial for meeting the nutritional needs of both human and animals (Wilkinson and

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Garnsworthy, 2021). Increasing population growth and urbanization have contributed to a growing demand for animal protein, which has been speculated to increase by 70% between 2010 and 2050 (Herrero and Thornton, 2023). The sustainability of Goat production however, has attracted much public concerns owing to its adverse environmental impact. Thus, Goat production is faced with the challenges of meeting the thriving demand for animal products while reducing its environmental impacts. The environmental impacts of the ruminant sector are largely influenced by manure nitrogen excretion and greenhouse gas (GHG) emissions from enteric fermentation, as well as feed processing and production.

Emissions from small ruminant's feeds and enteric nitrogen manure from enteric fermentation of feeds contribute almost 38% of Green House Gas (GHG) emissions to the environment (Reddy *et al*, 2021). Similarly, the low nitrogen efficiency of small ruminants increases manure nitrogen excretion that negatively contribute to eutrophication and global warming through the release of nitrous oxide (Wilkinson and Garnsworthy, 2021). Opio *et al* (2021) estimated that GHG emission from goat production sector contributes about 4.5 gigatonnes CO_{2-} eq, representing 65% of the anthropogenic emissions from livestock sector. Feed emission also contributed about 36% of GHG to the environment (Owen *et al*, 2020). Reducing the carbon footprint of animal feeds therefore, is crucial for improving resource efficiency, environmental impact performance and sustainable production of small ruminant products. Thus, formulating environmentally friendly feeds may offer an opportunity to mitigate the negative impact of Livestock production on GHG emissions and climate change.

In recent decades, there has been increasing interest in developing dietary phytochemicals and non-protein nitrogen sources as rumen modifiers to mitigate enteric ruminal CH_4 emissions (Owen *et al*, 2020). Vegetable protein sources, such as Soybeans meal, are common supplement in small ruminant diets. Vegetable protein however, could constitute high Carbon footprint (CFP) in diets that when utilized could release much nitrous oxide and Carbon IV oxide to the atmosphere (Herrero and Thornton, 2023). This consequently, will promote global earth warming. The inclusion of low cost dietary non protein nitrogen sources, such as urea in livestock diets has been proposed by researchers as partial substitute for vegetable protein sources (Owen *et al*, 2020).

Ruminants have the unique ability of converting non-protein sources, such as Urea, into high quality protein through microbial protein synthesis in the rumen. Also, the low cost of urea has increased its use as partial replacement for most vegetable protein sources, to supply rumen degradable protein in ruminant diets. It`s use could reduce the effect of land use changes that is associated with the cultivation and processing of plant protein sources, and improve carbon footprint of ruminant production (Vellinga *et al*, 2021). The supplementation of unprotected urea in small ruminant diets however, recorded poor performance due to its rapid ruminal

hydrolysis to ammonia exceeding the rate of carbohydrate fermentation (Opio *et al*, 2021). This condition reduces rumen microbial protein outflow and metabolizable protein availability for maintenance and production needs (Vellinga *et al*, 2021). The rapid ruminal hydrolysis of unprotected urea could also limit nitrogen utilization efficiency of animals, resulting in negative environmental impact from increased nitrogen excretion and ammonia emission from manure (Owen *et al*, 2020). Rapid degradation and metabolism of dietary urea in rumen also, may increase blood ammonia concentration and the risk of ammonia toxicity that can hampered health (Salami *et al*, 2022). Therefore, dietary urea supplementation is limited to 1% of total dietary dry matter or 0.3 g/kg body weight in animals.

To further alleviate this limitations, several research efforts have been made toward developing coated urea products with reduced rate of hydrolysis in the rumen and, improving the efficiency of microbial protein synthesis, while limiting nitrogen excretion and toxicity (Reddy *et al*, 2021). Owen *et al* (2020) reported a slow-release form of urea supplementation of 1.2-1.9% to exert no detrimental effect on the health and performance of ruminants. 900g of urea consumption in tung- and linseed-oil-coated urea was reported that would be required to cause ammonia toxicity in steers (Reddy *et al*, 2021). Similarly, another commercial slow-release urea product from Alltech Inc (*urea prills embedded in a lipid matrix*) demonstrated a reduction in the rate of urea ruminal degradation and improved nitrogen use efficiency compared to unprotected feed-grade urea (Salami *et al*, 2022). The rate of microbial urea hydrolysis in slow-release urea based diet was in synchrony with bacteria ammonia assimilation and fermentable energy availability.

Data from the Dutch Feed Print software revealed that isonitrogenous replacement of soybeans nitrogen with slow release urea will reduce the carbon footprint of diets. Feeding strategies aimed at utilizing coated urea to replace vegetable protein sources must be developed however, without impairing rumen function and production performance towards sustainable livestock products supply. This study therefore examined the effects of replacing soybeans meal with dietary coated urea on feed carbon Footprint and toxicity potential when fed up to 5% of goat diet.

MATERIALS AND METHOD

*D*escription of Experimental location

The experiment was conducted at the Research farm of the Department of Animal Health and Production Technology, Kogi State Polytechnic, Itakpe which is located on Latitude 6° 7 N and Longitude 6° 5 E (Google earth, 2021). The research protocol and Animal care followed the European Union Directive on the protection of Animals used for scientific purposes.

Animals, diets and experimental design

Twenty-four growing West African Dwarf bucks (3-4 month old), sourced commercially from Itakpe livestock market were at the commencement of the research administered intravenous injection of tetramycin, 2.5 mg/kg BW and ivermectin, 0.2 mg/kg to prevent respiratory disease and internal/external parasites,

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respectively. The bucks were then randomly assigned each to one of three diets: a control diet, basal mash feed without coated urea (CU) supplementation (CON), or basal mash feed reconstituted with either 2.5% CU or 5% CU as replacement for soybean meal on an as-fed basis. Coated urea was made from 90% urea covered with a semi permeable vegetable fat matrix under mild heat. Energy and crude protein levels were balanced in all diets to meet the nutrient requirements recommended for growing goat (Table 1). Bucks were housed individually in pens of 1.4 x 2.0 m, with two feeders (mash feed and straw) and watering trough. Feeds and water were provided *ad libitum* for 50 days.

Determined parameters

Performance indices

Animal live weights were measured with a weighing balance on d0, and weekly. Individual intake of experimental mash diets and straw was recorded daily.

Serum biochemical determination

Blood samples were collected from each West African Dwarf buck on d0 and 50 from jugular veins in the morning prior feeding. 10ml of blood was collected into labeled sterilized bottles without anticoagulant for biochemical analysis. The sample was centrifuged at 3000 rpm and at 5°C for 15 minutes. Plasma glucose concentration was determined by hexokinase method, serum urea followed GLDH method, serum uric acid determined by uricase/peroxidase method, and serum ammonia by method of molecular absorption spectrometry. Serum albumin, total protein, alkaline phosphate, alanine aminotransferase and aspartate aminotransferase were also determined.

Carbon foot print of feeds/ diets

The impact of replacing soybeans meal with coated urea on feed carbon footprint (CFP) was determined by calculating the sum of the CFP of feed raw materials in 0%, 2.5% and 5% diets. The contribution of the feed raw materials to feed CFP was estimated by multiplying the inclusion level by the CFP per kg of raw material (g $CO_{2\text{-}eq}$/Kg).The CFP values of feed materials were retrieved from the Dutch Feed Print software developed to get insight into GHG emissions during utilization chain of feed (Table 2).

Statistical analysis

Data obtained from the research were analyzed using a generalized linear mixed effects model on Statistical Software System (SAS). Turkeys HSD test was used to compare and separate significant ($P<0.05$) mean difference.

RESULTS AND DISCUSSION

Serum biochemistry result observed showed significant ($P<0.05$) differences in the activities of aspartate aminotransferase, alanine aminotransferase and alkaline phosphate (Table 2). The values were lower in bucks fed CU diets compared to bucks

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on control diets and were similar to the normal biochemical values recommended for healthy goats reported by Reddy *et al* (2021). Thus, implies that CU supplementation even at 5% caused no toxicity and damage to the liver and kidney of bucks and have no negative influences on the organs associated with blood welfare and metabolism. Chronic urea toxicity could result in severe hepatic nitrogen metabolism, which is expressed by higher serum activity of AST, ALT and ALP enzymes (Salami *et al,* 2021). Similarly, serum glucose, urea concentration, uric acid concentration, serum ammonia concentration, albumin content and total protein concentration were significantly lower ($P<0.05$) in bucks fed diets containing CU compared to bucks on control diet and were below toxic limits (5 mg/dL). The low levels of serum urea, uric acid and serum ammonia indicated lower toxicity of supplemented samples (CU) and optimum ruminal hydrolysis of urea. It may be attributed to lower rate of tissue protein catabolism that is associated with adequate protein supply (Salami *et al*, 2021). Thus, the biochemical indices determined in this study that were within normal physiological ranges for healthy goats, suggest that 5% Coated Urea inclusion in diets of goats was well tolerated and had no negative effect on bucks health. Hence, offers a safer alternative to feed-grade urea (Owen *et al*, 2020).

The results for carbon feedprint of diets (Table 2) shows that replacing soybeans with 2.5% and 5% CU in the diets of growing bucks decreased calculated feed carbon footprint (CFP) by 45% and 59 %, respectively suggesting that diets supplemented with coated urea (CU) released lower content of CO_2, a greenhouse gas that act with methane and nitrous oxide to promote global warming and environmental hazard (Vellinga *et al,* 2021). CU based diets therefore, has potential of limiting the emission of greenhouse gases from feeds and production units toward a sustainable production of livestock products. Coated Urea based diets has lower feed Carbon footprint and the ability of not rapidly converting emitted carbon in feeds into carbon dioxide equivalent or other greenhouse gases.

CONCLUSION

The results from this study demonstrated that coated urea (CU), a non-protein nitrogen can replace vegetable protein source, Soybean meal at 5 % in West African Dwarf (WAD) bucks diets without detrimental effect on animal health. Coated Urea based diets could reduce Carbon footPrint of small ruminant diets thereby, reducing environmental impact of commercial small ruminant production while, promoting sustainable production of milk, meat and skins from small ruminant production. It is therefore, imperative for livestock producers to adopt this cheap and available feed option toward producing healthy products and sustainable goat production.

REFERENCES

Herrero, M.J. & Thornton, P.K. (2023). Livestock and global change: Emerging issues for sustainable food systems. *Nat'l Acad Sch,* USA, 110: 20878-20881.

Opio, C.C., Gerber, P.; Mottet, A.A.; Falcucci, A T; Tempe, G.A & MacLeod, A. (2021). *Gas emissions from Ruminants supply chains-A Global life cycle assessment*; Food and Agriculture Organization of the United Nations: Rome, Italy, p.23.

EDITOR-IN-CHIEF
Prof. H. U. Nwanjo [Nigeria]

Owens, F.A., Lusby, K.A.; Mizwicki, K.K. & Forero, O.A. (2020). Slow ammonia release from urea: Rumen and metabolism studies. *J Anim Sci,* 50:527-531.

Reddy, P.R.K., Kumar, D.S.; Rao, E.R., Seshiah, C.V. & Hyder, I.A. (2021). Assessment of eco-sustainability a-vis zoo-technical attributes of soybeans meal (SBM) replacement with varying levels of coated urea in Nellore sheep *PLoS ONE, 4* e0220252.

Salami, S.A., Devant, A.M.; Apajalahti, J.A.; Holder, V.A. & Salomaa, S.S. (2022). Slow –release urea as a sustainable alternative to Soybean meal in Ruminant Nutrition. *Sustainability* 13: 2464. https//doi.org/10.3390/su13052464.

Vellinga, T.V., Blonk, H.A.; Marinussen, M.H.; Van, Z.A. & Starmans, D.A. (2021). *Methodology used in feedprint: A tool quantifying Greenhouse gas emissions of feed production and utilization*; Wageningen UR livestock research: Wageningen, Netherlands. Pp.1570-8616,

Wilkinson, J.A. & Garnsworthy, P.D. (2021). Impact of diet and fertility on greenhouse gas emissions and nitrogen efficiency on livestock production *Livestock* 22:140-144.

Table 1: Composition of Experimental mash diets.

Parameters	0% CU	2.5% CU	5%CU
Maize	37.80	38.50	40.00
Maize bran	31.50	31.50	31.50
Wheat	5.50	5.50	5.50
Dried brewer waste	13.50	13.50	13.50
Soybean meal	9.70	6.50	2.50
Mineral supplement	1.50	1.50	1.50
Coated urea	0.00	2.50	5.00
Salt	0.50	0.50	0.50
	Analyzed nutrient content (% DM)		
Dry matter	87.45	87.55	87.51
Crude protein	18.22	18.23	18. 24
Ash	5.50	5.41	5.40
Ether extract	4.56	4.54	4.56
Neutral detergent fibre	25.35	25.34	25.57
CU- coated urea			

Table 2: Effect of Coated Urea (CU) on Serum Biochemical indices of Bucks

Parameters	0% CU	2.5% CU	5%CU	SEM	*p*-Value
Serum biochemical Indices					
Glucose (mg/dL)	12.00[a]	10.00[b]	10.00[c]	2.52	0.085
Urea (mg/dL)	21.30 [a]	19.20[b]	16.20[c]	3.00	0.065
Uric acid (mg/dL)	0.50 [a]	0.23[b]	0.19[c]	0.02	0.100
Albumin (g/dL)	3.50 [a]	3.00[b]	2.88[c]	0.02	0.005
Ammonia (mg/dL)	0.70 [a]	0.65[b]	0.62 [c]	0.01	0.085
Total protein (g/dL)	6.60[a]	6.85[b]	6.98 [c]	0.08	0.006
AST (u/l)	19.85[a]	18.80 [b]	18.65[c]	0.07	0.001
ALT (u/l)	10.85	10.50	10.45	0.55	0.101
ALP (u/l)	20.64	20.60	20.54	0.85	0.002
Calculated feed CFP	1100[a]	600 [b]	450[c]	25.05	4.850
% reduction in CFP	-	45 [b]	59[a]	15.25	5.000

AST-Aspartate aminotransferase, ALT-Alanine aminotransferase, ALP-alanine phosphate , CFP-Carbon footprint

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