

Haemato-biochemical characteristics in Yankasa rams fed treated groundnut shells-based rations with xylanase

*Millam, J. J., #Abdu, S. B., #Yashim, S. M. and #Adamu, H. Y.

*Department of Animal Production, Adamawa State University, Mubi.

#Department of Animal Science, Ahmadu Bello University, Zaria.

Corresponding author: jacobjafiya@gmail.com +2348061504098



Abstract

The problem of high cost of feeding and scarcity of feed resources during the dry season has become a problem to livestock production especially in the northern region of this country. These problem can be alleviated by harnessing cheaply available crop residues. But because most of the crop residues have poor nutritional status, alkali treatment and use of exogenous enzymes have proven to improve its dietary compositions. Therefore, the present study examined the blood profile in Yankasa rams fed rations containing alkali treated groundnut shells (GNS) supplemented with xylanase. Sixteen yearling Yankasa rams with a mean weight of 17 ± 0.68 kg were used for the study. Four rations were formulated; control (without treated GNS and xylanase), urea treated groundnut shells with xylanase (UGNSx), lime treated groundnut shells with xylanase (LGNSx) and urea-lime treated groundnut shells with xylanase (ULGNSx); assigned to four groups of rams in a completely randomise design. Feed and water were supplied ad libitum. Blood were collected from the jugular vein for the determination of the blood profile. The results observed showed that there were significant ($p < 0.05$) effects amongst the treatments involved. Most of the haemato-biochemical parameters were within normal reference range of values for healthy sheep. The packed cell volume, haemoglobin, red blood cells and lymphocyte values were higher in LGNSx (36.5%, 12.1 g/dL, $12.27 \times 10^{12}/L$, and 85%, respectively). White blood cells, neutrophils and eosinophils values were higher in ULGNSx ($7.9 \times 10^9/L$, 25% and 2%, respectively) while monocytes was higher in UGNSx (5%). Alanine aminotransferase (16 IU/L) value was relatively higher in UGNSx among the treated groups. Total protein (7.57 g/dL), albumin (2.77 g/dL) and glucose (3.87 mmol/L) were higher in LGNSx while blood urea nitrogen (5.8 mmol/L) and creatinine (135.07 $\mu\text{mol}/L$) values were higher in ULGNSx. It was concluded that urea and lime treatment of groundnut shells supplemented with xylanase in Yankasa rams ration did not cause blood or organ ill-health after consumption throughout the 90-day trial.

Keywords: Exogenous enzyme; Haematology; Lime; Serum biochemistry; Urea.

Caractéristiques des hémato-biochimiques chez les béliers de Yankasa nourris avec des rations à base de coquilles d'arachide traitées avec de la xylanase



Résumé

Le problème du coût élevé de l'alimentation et de la rareté des ressources alimentaires pendant la saison sèche est devenu un problème pour la production animale, en particulier dans la région nord de ce pays. Ces problèmes peuvent être atténués en exploitant les résidus de culture disponibles à moindre coût. Mais comme la plupart des résidus de culture ont un mauvais état nutritionnel, le traitement alcalin et l'utilisation d'enzymes exogènes se sont avérés améliorer ses compositions alimentaires. Par conséquent, la présente étude a examiné le profil sanguin de béliers Yankasa nourris avec des rations contenant des coques d'arachide traitées à l'alcali (GNS) complétées par de la xylanase. Seize béliers Yankasa d'un

an d'un poids moyen de $17 \pm 0,68$ kg ont été utilisés pour l'étude. Quatre rations ont été formulées; témoin (sans GNS traité ni xylanase), coques d'arachides traitées à l'urée avec xylanase (UGNSx), coques d'arachides traitées à la chaux avec xylanase (LGNSx) et coques d'arachides traitées à l'urée-chaux avec xylanase (ULGNSx) ; attribués à quatre groupes de béliers dans un schéma complètement aléatoire. La nourriture et l'eau ont été fournies à volonté. Le sang a été prélevé de la veine jugulaire pour la détermination du profil sanguin. Les résultats observés ont montré qu'il y avait des effets significatifs ($p < 0,05$) parmi les traitements impliqués. La plupart des paramètres hémato-biochimiques se situaient dans la plage de valeurs normales de référence pour les moutons sains. Les valeurs d'hématocrite, d'hémoglobine, de globules rouges et de lymphocytes étaient plus élevées chez les LGNSx (36,5 %, 12,1 g/dL, $12,27 \times 10^{12}/L$ et 85 %, respectivement). Les valeurs de globules blancs, de neutrophiles et d'éosinophiles étaient plus élevées dans l'ULGNSx ($7,9 \times 10^9/L$, 25 % et 2 %, respectivement) tandis que les monocytes étaient plus élevés dans l'UGNSx (5 %). La valeur de l'alanine aminotransférase (16 UI/L) était relativement plus élevée dans l'UGNSx parmi les groupes traités. Les protéines totales (7,57 g/dL), l'albumine (2,77 g/dL) et le glucose (3,87 mmol/L) étaient plus élevés chez les LGNSx tandis que les valeurs d'urée sanguine (5,8 mmol/L) et de créatinine ($135,07 \mu\text{mol}/L$) étaient plus élevées chez ULGNSx. Il a été conclu que le traitement à l'urée et à la chaux des coques d'arachide complétées par de la xylanase dans la ration des béliers Yankasa n'a pas causé de problèmes de santé du sang ou des organes après la consommation tout au long de l'essai de 90 jours.

Mots-clés : Enzyme exogène ; Hématologie ; Chaux ; biochimie sérique ; Urée.

Introduction

One of the most significant impediments to effective small ruminant production in the tropics is feed unavailability, particularly during the dry season when roughages with low nutritional value are available (Millam *et al.*, 2020b). In recent years, the cost of livestock feeds and feedstuffs has skyrocketed. As a result, in many developing nations, such as Nigeria, the cost of feeding becomes a big issue for livestock producers. According to reports, feed costs account for roughly 70-80 percent of overall animal production costs (Otu *et al.*, 2021). This implies the need for and interest in discovering rich and underutilized feed supplies (threshing by-products), such as groundnut shells, which are commonly found on groundnut threshing locations in groundnut-producing states in the north (Millam *et al.*, 2020a). These threshing sites can be found throughout those states and are typically a source of environmental pollution, particularly when left to rot in the field or when rain washes them away, clogging

drainage systems and causing flooding; and air pollution when they are incinerated, causing greenhouse effects, which is a global concern (Millam, 2016).

Crop residue utilization as ruminant feed resources has piqued the interest of a number of animal nutritionists who want to learn more about it in order to combat the threat of groundnut shell problems, such as reducing their negative environmental impact, solving the problem of dry season feeding, and lowering production costs (Abid *et al.*, 2020). This will allow low-income farmers to switch between conventional and commercial feeds without affecting the animals' health or performance. Groundnut shells are easily available and inexpensive, particularly in threshing towns, and can be treated with alkali chemicals to weaken their fibrous structure and enhance their protein value (Abdel Hameed *et al.*, 2013). Treatment with alkali chemicals alone will not promote groundnut shell use; consequently, supplementation, particularly with exogenous fibrolytic enzymes, may be

beneficial (Millam and Abdu, 2017; Adesogan *et al.*, 2019).

The nutritional quality of a feedstuff should be higher in order for it to stand out as a better feed material and be used as an alternative to commercial/conventional feedstuff (McDonald *et al.*, 2010). The nutritional value of feeds can be determined by their performance in animals and the use of animal blood profiling (Nayawo *et al.*, 2017). Dietary studies should not be restricted to performance alone, but should also consider the effect on blood constituents as crucial instruments for diagnosing any deviation from normal in the animal's physical state (Wada *et al.*, 2014). Animals' physiological status can be measured using haematology and serum biochemistry status. Changes in these characteristics can be utilized to indicate how animals react to different physiological conditions (Maltz and Silanikove, 1996). When additional tissue-related data are unavailable, haemato-biochemical indices have been found to be effective for assessing body condition, nutritional health, and immunological status in animals (Millam *et al.*, 2020b). Therefore, the present study was undertaken to assess the effect of urea and lime treated groundnut shells supplemented with xylanase in rations of *Yankasa* rams on haematology and biochemical indices.

Materials and Methods

All research protocols and use of animals were approved by Adamawa State University, Institutional Animal Care and Ethics Committee (ADSUIACEC/2020/006). It certifies that the procedures adhere to the International standards on animal use and practice.

Description of study area

The study was conducted at the Small Ruminant Unit, Adamawa State University Teaching and Research Farm, Sahuda road,

Mubi North, Adamawa, Nigeria. It is a government-owned University located in the city of Mubi, Adamawa State. The University is located between latitude 10°16.6'6.9" north of the equator and longitude 13°16'1.2" east Greenwich Meridian with 560 meters above sea level (Weather Station, 2020).

Source and processing of groundnut shells

The groundnut shells used in this study were obtained from a local farmer in Dirbishi Ward, Mubi South Local Government Area (LGA) of Adamawa State. The groundnut shells were milled using a local grinding machine to a size of half a centimetre, then stored in bags until required for further use. The processed groundnut shells were treated with urea, lime and urea-lime at five percent (i.e., five grams of urea dissolved in one litre of water to treat one kilogram of groundnut shells; five grams of lime dissolved in one litre of water to treat one kilogram of groundnut shells; two and half grams of urea plus two and half grams of lime mixed together dissolved in one litre of water to treat one kilogram of groundnut shells respectively). The lime used was an industrial lime [Ca(OH)₂] M=74.09 with a Lot no: 20170705 produced by Guangdong Guanghua Sci-Tech Co. Ltd. The urea used was a commercial urea fertilizer (45% N) from INDORAMA®. The solution of either that of urea, lime or urea-lime was uniformly sprayed on the milled groundnut shells and mixed thoroughly using a shovel on a clean concrete floor, according to the methods of Can *et al.* (2004). The treated groundnut shells were ensiled in airtight Purdue Improved Cowpea Storage (PICS) bags for a period of 21 days as described by Al-masri and Guenther (1999). Thereafter, the treated groundnut shells were spread on a polythene sheet to air-dry, bagged and then stored before the commencement of the experiment.

Experimental rations and proximate compositions

Four rations were formulated using computer method (least-cost ration

formulation) to include the treated groundnut shells, maize offal, cotton seed cake, bone meal and salt with the enzyme (Table 1).

Table 1: Gross compositions of the experimental rations

Ingredients (kg)	Control	UGNSx	LGNSx	ULGNSx
Cowpea husk	40.00	0	0	0
Treated groundnut shells	0	40.00	40.00	40.00
Maize offal	40.5	48.00	46.10	55.00
Cotton seed cake	17.5	10.00	11.90	3.00
Bone meal	1.50	1.50	1.50	1.50
Salt	0.50	0.50	0.50	0.50
Xylanase	0.00	0.10	0.10	0.10
Proximate compositions (%)				
Energy (Kcal/Kg)	2818.6	2177.10	2093.40	2446.65
Dry matter	98.5	93.5	93.0	91.5
Crude protein	13.5	11.3	11.3	13.5
Crude fibre	16.8	33.6	38.35	30.25
Ether extract	2.0	6.5	7.0	6.5
Ash	5.4	7.0	6.0	8.0
Nitrogen free extract	60.7	34.7	31.2	40.0
	62.22	53.11	60.44	57.38

UGNSx: urea treated groundnut shell with xylanase, LGNSx: lime treated groundnut shell with xylanase, ULGNSx: urea-lime treated groundnut shell with xylanase

The other ingredients used for the experimental rations were obtained from *TIKE* livestock market, Mubi South LGA, Adamawa State. Xylanase was purchased from RONOZYME® Multi Grain (MG), DSM Nutritional Products Ltd, Switzerland: xylanase (Endo-1, 4-β-xylanase; EC 3.2.1.8). The formulation was made to meet the requirements of the rams. The enzyme was incorporated in the rations at rates recommended by the manufacturer (100 g/ton). Each ration was thoroughly mixed at a time on a clean concrete floor using shovel, then bagged and kept safe for the experiment. A sample from each experimental ration was collected, and its proximate compositions was determined using the procedures described by AOAC (2005). The proximate analysis was carried out in the Nutrition and Biochemistry Laboratory, Department of Animal Production, Adamawa State University,

Mubi.

Management of experimental animals

Sixteen yearlings *Yankasa* (*Ovis aries*) rams with an average weight of 17±0.68 kg used for the study were purchased from the *TIKE* livestock market in Uba Town, Askira/Uba LGA, Borno State. Prior to the commencement to the experiment, the animals were ear-tagged (for identification). The rams were also given prophylactic treatments, consisting of intramuscular application of long-lasting antibiotics (Oxytetracycline LA®) and multivitamin at a dosage of 1 mL/10 kg body weight of the animals. The rams were also drenched with 1 mL/10 kg body weight of albendazole and treated against ectoparasites with 0.5 mL/10 kg body weight of ivermectin (Ivomec®). The rams were quarantined for 4 weeks. Adequate feed and clean fresh water were provided daily to the rams *ad libitum*.

Experimental housing, design and data collection

The experimental animals were housed in a well ventilated, individual enclosure (1.5×1.5 m dimension) with corrugated iron roof, concrete floors and equipped with individual feeders and water troughs. These stalls were washed properly and disinfected a week before the commencement of the feeding trial. Each ration was assigned randomly to a group of four rams in a complete randomised design. The formulated rations and clean fresh water were provided daily to the rams *ad libitum* throughout the period of the feeding trial which lasted for 90 days. The ration for a day was divided into two portions of equal weight and supplied to the animals at 8:00 h and 14:00 h.

The rams were fasted for 12 hours before blood samples were collected from the jugular vein using five millilitre syringe over EDTA (Ethylenediaminetetraacetic acid) bottle for packed cell volume, haemoglobin count, red blood cells and white blood cells determination, centrifuge bottle for total protein, liver enzymes, creatinine and blood urea determination and fluoride oxalate bottle for total glucose determination. The samples were taken to Laboratory Service Department in General Hospital, Mubi for the blood analyses. Haemoglobin (Hb) and packed cell volume (PCV) were determined by acid haematin method (Benjamin, 1985) and Wintrobe's tube (Hawk, 1965), respectively. Liver enzymes was determined using the methods adopted by Ahmadov *et al.* (2018). Determination of the blood glucose levels was done by the Glucose Oxidase Principle (Beach and Turner, 1975), total

protein (TP) was determined by the method of Henry and Stobel (1957), Creatinine was determined according to the method described by Lamb (1991) and blood urea nitrogen (BUN) was determined by the method of Tannins and Maylor (1968).

Statistical analysis

The data were analysed using the Generalised Linear Model procedure (PROC GLM) of SAS (2002). The effects of dietary treatments were tested at probability level of 95% ($p < 0.05$) and significant difference among the treatment means were determined by Duncan Multiple Range Test.

Results and Discussion

Blood haematological profile

Table 2 depicts haematological profile of the experimental rations. A significant ($p < 0.05$) interaction was observed among all the rations fed except for basophils. Addition of xylanase and alkali treatment had higher significant ($p < 0.05$) values in all parameters measured. The PCV, Hb and red blood cells (RBC) were higher in LGNSx (36.5%, 12.1 g/dL and $12.27 \times 10^{12}/L$, respectively). White blood cells (WBC), neutrophils and eosinophils were higher in ULGNSx ($7.9 \times 10^9/L$, 25% and 2%, respectively). Lymphocytes and monocytes were higher in LGNSx (85%) and UGNSx (5%), respectively. Most of the haematological values were well within the normal physiological ranges for healthy sheep (Fielder, 2015) suggesting general health of rams in the dietary treatment groups remained normal throughout the experiment. However, lymphocyte counts are above reference range.

Table 2: Blood haematology in Yankasa rams

Parameters	Control	UGNS	LGNS	ULGNS	SEM	Ref. ranges
Packed cell volume (%)	32.00 ^b	31.50 ^b	36.50 ^a	28.50 ^c	0.86	27-45
Haemoglobin (g/dL)	10.48 ^b	10.16 ^{bc}	12.10 ^a	9.44 ^c	0.24	9-15
Red blood cell ($\times 10^{12}/L$)	9.67 ^b	11.50 ^a	12.27 ^a	10.00 ^b	0.46	9-15
White blood cell ($\times 10^9/L$)	5.60 ^b	7.67 ^a	7.87 ^a	7.90 ^a	0.52	4-8
Neutrophils (%)	20.5 ^b	20.00 ^b	12.50 ^c	25.00 ^a	1.48	10-50
Eosinophils (%)	1.50 ^b	1.50 ^b	1.00 ^c	2.00 ^a	0.07	0-10
Basophiles (%)	0.00	0.00	0.00	0.00	0.00	0-3
Lymphocytes (%)	73.45 ^b	73.50 ^b	85.00 ^a	70.50 ^{bc}	1.50	40-55
Monocytes (%)	3.50 ^{ab}	5.00 ^a	0.50 ^c	2.50 ^b	0.18	0-6

^{abc} Mean values within same row with different superscript are significantly ($p < 0.05$) different, UTGNS: untreated groundnut shells, UGNS: urea treated groundnut shells, LGNS: lime treated groundnut shells, ULGNS: urea-lime groundnut shells, SEM: significant error of means (Source for reference ranges: Fielder, 2015)

The higher values of PCV, Hb and RBC in the group of rams receiving LGNSx might be due to improved nutrition of the animals by enzyme supplementation and lime treatment involved. It improved the erythropoiesis or reduced the establishment of adult nematodes (Beigh *et al.*, 2018b), as immature parasite (larval stage) causes seepage of blood from injured tissue due to migration, thereby lowering haemogram levels. This is an indication that neither the total cell concentration of the blood was affected by the chemical treatment involved in the ration and the enzyme supplementation to cause anaemia, nor the oxygen carrying capacity of the blood was affected by chemical treatment involved and the enzyme supplementation while the rams were consuming the ration (Millam *et al.*, 2020b). The results of the present study are not in accordance with the findings of Rivero *et al.* (2016) who reports that supplementation of exogenous enzymes to rations of growing lambs had no effect on any measured haematological parameters. But it is similar to the values reported by Millam *et al.* (2020b) who fed xylanase and glucanase combination in the rations of Yankasa rams.

The increase values for WBC counts in the group of rams receiving ULGNSx might be related to the production of more immune

cells (antibodies) that play important role in the defence of the biological system against infection (Osita *et al.*, 2018). The results of WBC observed in this study are not in agreement with those of Millam *et al.* (2020b) who also reported a higher value above normal ranges when Yankasa rams were fed with ration containing xylanase and glucanase combinations.

For the blood differential WBC counts, the neutrophils, eosinophil and monocytes values were within normal physiological range for healthy sheep (Fielder, 2015) suggesting that the animals are not likely to be predispose to infection (Eclinpath, 2020); or there was no problem with the cell production nor leukaemia (Chen, 2005). It may also mean that the rams were safe from parasitic infestation of the intestine and any form of allergy (Etim *et al.*, 2013). The results were comparable with the findings of several authors who studied the haematology of Yankasa rams in the semi-arid areas of the Nigeria (Njidda *et al.*, 2014; Amuda and Okunlola, 2018). Obviously, the lymphocyte count was observed to be above normal range, it may be attributed to the animals having sufficient potential to ward off attacks that could cause health challenge (Ayoade *et al.*, 2015; Osita *et al.*, 2018). The observed results are in tandem with the findings of

some authors (Egbe-Nwiyi *et al.*, 2000; Njidda *et al.*, 2014) who reported that similar values for sheep in the Arid zone of Nigeria while Chirkena *et al.* (2016) recorded lower values.

Serum biochemical indices

Blood metabolites concentrations are presented in Table 3. The results showed that all the dietary treatments had no effect ($p>0.05$) on aspartate aminotransferase and alkaline phosphatase while other parameters measured were significantly ($p<0.05$) affected. However, higher ($p<0.05$) values were recorded in both the control and treated groups. Alanine aminotransferase (ALT) was relatively higher in UGNSx (16 IU/L) compared to the treated groups. Total protein, albumin and glucose were higher in LGNSx (7.57 g/dL, 2.77 g/dL and 3.87 mmol/L, respectively). Blood urea nitrogen and creatinine were higher in ULGNSx (5.8 mmol/L and 135.07 μ mol/L, respectively). Most of the biochemical indices measured were within normal reference ranges

recommended for healthy sheep (Fielder, 2015) which indicates that the rams were in a state of normal health condition during the study.

Blood biochemical test determines the levels of certain parameters to assess the level of energy metabolism, liver damage and kidney malfunction in a body system. Furthermore, levels of some of these parameters that are above or below reference range are of great concern. For the liver function test profile of the rams, ALT values are below normal physiological range for healthy sheep (Fielder, 2015), suggesting that ALT (been liver specific) are still been produced within the liver and are not spilled into the blood stream to show that there is no injury/damage to the liver (Eclinpath, 2020). The results of the present study are not in accordance with the findings of Rivero *et al.* (2016) and Omidi *et al.* (2014) who recorded non-significant differences in the levels of hepatic enzymes for sheep and goats when fed rations supplemented with exogenous enzymes.

Table 3: Serum biochemical indices in Yankasa rams

Parameters	Control	UGNS	LGNS	ULGNS	SEM	Ref. ranges
Aspartate aminotransferase (IU/L)	58.50	64.50	65.00	65.00	5.83	60-280
Alanine phosphatase (IU/L)	15.50	19.00	17.50	18.00	2.49	68-387
Alanine aminotransferase (IU/L)	18.50 ^a	16.00 ^b	11.00 ^c	8.50 ^d	0.98	26-34
Total protein (g/dL)	7.37 ^{ab}	7.37 ^{ab}	7.57 ^a	7.07 ^b	0.21	6.0-7.9
Albumin (g/dL)	2.80 ^b	2.50 ^c	2.77 ^a	2.60 ^b	0.04	2.4-3.0
Glucose (mmol/L)	3.57 ^{ab}	2.97 ^c	3.87 ^a	3.40 ^b	0.09	2.78-4.44
Urea Nitrogen (mmol/L)	4.10 ^d	4.97 ^c	5.17 ^b	5.80 ^a	0.28	2.8-7.1
Creatinine (μ mol/L)	119.70 ^{ab}	127.87 ^a	106.52 ^b	135.07 ^a	8.66	106-168

Values within same row with different superscript are significantly ($p<0.05$) different, UTGNS: untreated groundnut shells, UGNS: urea treated groundnut shells, LGNS: lime treated groundnut shells, ULGNS: urea - lime groundnut shells, SEM: significant error of means (Source for reference ranges: Fielder, 2015)

In the hepatic functioning, the mean values for TP and albumin were within normal physiological range for healthy sheep (Fielder, 2015). Higher values for TP and albumin in the group of rams receiving LGNSx could be an indication that the animals received an adequate dietary protein supply that was sufficient for

protein metabolism in the liver. The result observed for albumin being within the normal reference range may also be due to iso-albuminemia as a result of acceptable protein supply in the ration (Portea Medical, 2019).

The metabolizable energy in feed varied among rations as observed in Table 1,

nevertheless none of the supplemental rations affected plasma glucose because all values were within normal physiological range for healthy sheep (Fielder, 2015). However, the concentration of plasma glucose showed higher values in the group of rams receiving LGNSx. This may have stem from the enzyme supplementation which was able to hydrolyse the fibre fraction probably due to crude fibre digestibility of the ration which consequently increased its absorption along with the non-structural carbohydrates in the ration (Millam *et al.*, 2021). It might also be attributed to increased intake of carbohydrates, leading to increased level of blood glucose (Wada *et al.*, 2014; Nayawo *et al.*, 2017). The results support the findings of some authors who reported that values of blood glucose concentration in sheep were correlated with the energy in their rations (Njidda *et al.*, 2014; Nayawo *et al.*, 2017; Amuda and Okunlola, 2018; Rahman *et al.*, 2018).

Looking at the kidney function attributes of the *Yankasa* rams, values of measured parameters (BUN and creatinine) in all the group of animals were within normal physiological range for healthy sheep (Fielder, 2015). Increased observed levels of BUN in the group of rams receiving ULGNSx probably might be due to efficient utilization of dietary proteins by addition of xylanase more than other treatments (Beigh *et al.*, 2018a). It might also be attributed to optimum rate of protein degradation along with better utilization of generated ammonia in the rumen caused by optimal nitrogen usage which was represented in terms of normal BUN in the ULGNSx groups (Millam *et al.*, 2020b). The levels of serum creatinine were higher in the group of rams receiving ULGNSx, which suggest that the enzyme supplementation had no adverse effect on the glomerular filtration, thus safe for renal functioning. Also, creatinine being within

the normal reference range is an indication of normal wear and tear of the muscle in the system created during normal functioning of the muscle (Portea Medical, 2019). The findings of significant effect on serum creatinine in the present study are not similar to those described by Rivero and Salem (2015) for feed additive supplementation in sheep. The levels of creatinine in conjunction with BUN concentration points towards a normal kidney functioning.

Conclusions

The study showed that urea-lime treated groundnut shell-based ration did not pose any health implication when fed throughout the trial. This is because most of the indices measured were within normal reference range of values for healthy sheep. Thus, urea or lime treated groundnut shells with xylanase supplementation can be incorporated in the rations of yearling *Yankasa* rams without any health hazards on haem, liver and kidney.

References

- Abdel Hameed, A. A., Fedel, E. L., Seed, A. M., and Salih, A. M. 2013. Growth performance and rumen fermentation of lambs fed untreated or urea treated groundnut hull with different protein sources. *Journal of Animal Production Advances*, 3(3), 86–96.
- Abid, K., Jabri, J., Ammar, H., Said, S. Ben, Yaich, H., Malek, A., ... Kamoun, M. 2020. Effect of treating olive cake with fibrolytic enzymes on feed intake, digestibility and performance in growing lambs. *Animal Feed Science and Technology*, 261(1), 1 – 8. <https://doi.org/10.1016/j.anifeedsci.2020.114405>
- Adesogan, A. T., Arriola, K. G., Jiang, Y.,

- Oyebade, A., Paula, E. M., Pech-Cervantes, A. A., ... Vyas, D. 2019. Symposium review: Technologies for improving fiber utilization. *Journal of Dairy Science*, 102(6), 5726–5755. <https://doi.org/10.3168/jds.2018-15334>
- Ahmadov, E., Hasanova, J., Topchiyeva, S., Mammadova, F., and Mammadova, S. 2018. Determination of the activity of ALT and AST enzymes of blood in the sheep infected with helminthes toxicology? : Open access. *Toxicology*, 4(1), 10–12. <https://doi.org/10.4172/2476-2067.1000138>
- Al-masri, M. R., and Guenther, K. D. 1999. Changes in digestibility and cell-wall constituents of some agricultural by-products due to gamma irradiation and urea treatments. *Radiation Physics and Chemistry*, 55, 323–329.
- Amuda, A. J., and Okunlola, D. O. 2018. Haematological parameters and serum biochemistry of west african dwarf sheep fed ensiled maize stover and concentrate supplements. *Journal of Agriculture and Veterinary Science*, 11(5), 57–63. <https://doi.org/10.9790/2380-1105015763>
- AOAC, (Association of Analytical Chemist). 2005. *Official Method of Analysis* (17th ed.). Maryland, USA: AOAC International.
- Ayoade, J. A., Wuanor, A. A., and Ochepe G O. 2015. Performance, haematology and serum biochemistry of grazing Bunaji bulls supplemented varying levels of agro industrial by-product based diet. *Journal of Agriculture and Veterinary Science*, 8(8), 95–100.
- Retrieved from <http://54.194.51.196/read/perform-ance-haematology-and-serum-biochemistry-of-grazing-bunaji-bulls-supplemented-varying-levels-of-an-agro-industrial-by-product-based-diet/file.pdf>
- Beach, G. E., and Turner, T. D. 1975. *Toxicology*. Oxford England: Oxford University Press.
- Beigh, Y. A., Ganai, A. M., Ahmad, H. A., Mir, D. M., Bhat, M. A., and Muzamil, S. 2018a. Blood metabolic profile of lambs fed complete diet supplemented with exogenous fibrolytic enzymes cocktail. *Journal of Animal Health and Production*, 6(4), 96–102. <https://doi.org/10.17582/journal.jahp/2018/6.4.96.102>
- Beigh, Y. A., Ganai, A. M., Mir, M. S., Ahmad, I., Amin, U., and Mehraj, F. 2018b. Hematobiochemical characteristics of lambs on dietary feed additives (exogenous fibrolytic enzymes, Artemisia absinthium Linn.) supplementation. *Comparative Clinical Pathology*, 27(6), 1473 – 1485 . <https://doi.org/10.1007/s00580-018-2759-5>
- Benjamin, M. M. 1985. *Outline of Veterinary Clinical Pathology*. Kalyani Publishers: New Delhi, India.
- Can, A., Denek, N., Tufenk, S., and Bozkurt, A. 2004. Determining effect of lime and urea treatment on crude and digestible nutrient content of wheat straw. *Journal of Animal and Veterinary Advances*, 3(7), 479–482.
- Chen, W. C. 2005. Different types of blood cells and their roles in the human body. Retrieved January 15, 2021, from SciCom MIT website:

- <http://web.mit.edu/scicom/www/blood.html#bib1>
- Chirkena, K., Getachew, S., Gashaw, B., and Dinede, G. 2016.** Hematological parameters of sheep: an aid in the diagnosis of gastrointestinal and respiratory diseases. *Nature and Science*, 14 (5) , 97 – 102 . <https://doi.org/10.7537/marsnsj14051614>
- Eclinpath. 2020.** *Quick test interpretations*. Retrieved January 15, 2021, from College of Veterinary Medicine, Cornell University website: <https://eclinpath.com/chemistry/chemistry-quick-guide/>
- Egbe-Nwiyi, T., Nwaosu, S. C., and Salami, H. A. 2000.** Haematological values of apparently healthy sheep and goats as influenced by age and sex in arid zone of Nigeria. *African Journal of Biomedical Research*, 3(32), 109–115.
- Etim, N. N., Enyenihi, G. E., Williams, M. E., Udo, M. D., and Offiong, E. E. A. 2013.** Haematological parameters: Indicators of the physiological status of farm animals. *British Journal of Science*, 10(1), 33–45.
- Fielder, S. E. 2015.** *Normal reference ranges for blood profiles of various animals*. Retrieved January 15, 2021, from MSD Veterinary Manual website: www.msdsvetmanual.com/special-subjects/reference-guides
- Hawk, P. B. 1965.** *Hawk's physiological chemistry* (14th ed.). London: McGraw Hill Book Company.
- Henry, R. J., and Stobel, C. 1957.** Determination of serum protein by burette reaction. *Journal of Analytical Chemistry*, 92, 1491–1497.
- Lamb, G. N. 1991.** *Manual of veterinary laboratory technique*. Kenya: CoBA-GEIGY.
- Maltz, E., and Silanikove, N. 1996.** Kidney function and nitrogen balance of high yielding dairy cows at the onset of lactation. *Journal of Dairy Science*, 79(9), 1621–1626.
- McDonald, P., Edwards, R. A., Greenhalgh, J. F. D., Morgan, C. A., Sinclair, L. A., and Wilkinson, R. G. 2010.** *Animal nutrition* (7th ed.; C. A. Morgan, J. F. D. Greenhalgh, L. A. Sinclair, and R. G. Wilkinson, Eds.). Harlow, England: Prentice Hall.
- Millam, J. J. 2016.** Effects of urea and lime treated groundnut shell in mixed diets on nutrient intake and in situ degradation in Yankasa rams. M. Sc thesis, Department of Animal Science, Ahmadu Bello University, Zaria.
- Millam, J. J., Abdu, S. B., Yashim, S. M., and Adamu, H. Y. 2021.** Alkali treated groundnut shells with xylanase in rations of Yankasa rams on growth performance and nutrient digestibility. *International Journal of Agriculture and Earth Science*, 7(2), 39–48.
- Millam, J. J., and Abdu, S. B. 2017.** Chemical composition and ruminal degradation of urea and lime treated groundnut shells in Yankasa rams. In A. A. Adeloye, E. O. Oyawoye, A. A. Toyé, and B. T. Adesina (Eds.), *Proceedings of 42nd Annual Conference of the Nigerian Society for Animal Production (NSAP), 26th–30th March 2017, Landmark University* (pp. 394–397). Omu-Aran, Kwara State: Nigerian Society for Animal Production.
- Millam, J. J., Bello, S. S., Abbaya, H. Y.,**

- and John, P. A. 2020a.** Growth performance and serum biochemical profile in *Yankasa* rams fed alkali-treated groundnut shells. *FUDMA JOURNAL OF SCIENCES*, 4(3), 52–59. <https://doi.org/10.33003/fjs-2020-0403-251>
- Millam, J. J., Joel, M., and Eli, B. A. 2020b.** Xylanase and glucanase supplementation on growth performance and blood profile of *Yankasa* rams fed crop residues. *Journal of Animal Science and Veterinary Medicine*, 5(5), 166–172.
- Nayawo, A. A., Isyaku, S., Mijinyawa, M. A., Ehoche, W. O., Otaru, S. M., and Abdu, S. B. 2017.** Serum biochemical profiles of fattening *Yankasa* rams fed diets containing different proportions of urea treated rice straw and gamba hay. *International Journal of Agriculture and Earth Science*, 3(7), 18–23. Retrieved from www.iiardpub.org
- Njidda, A. A., Shuai'bu, A. A., and Isidahomen, C. E. 2014.** Haematological and serum biochemical indices of sheep in semi-arid environment of northern Nigeria. *Global Journal of Science Frontier Research (D)*, 14(2), 48–56.
- Omidi, A., Rahdari, S., and Fard, M. H. 2014.** A preliminary study on antioxidant activities of saffron petal extracts in lambs. *Veterinary Science Development*, 4(5161), 22 – 25 . <https://doi.org/10.4081/vsd.2014.5161>
- Osita, C. O., Ani, A. O., Ezema, C., Oyeagu, C. E., Uzochukwu, I. E., and Ezemagu, I. E. 2018.** Hematological and biochemical indices of West African Dwarf sheep fed diets containing yeast (*Saccharomyces cerevisiae*), grass, grass/legume (50:50) and legume. *Pakistan Journal of Nutrition*, 18 (1) , 34 – 41 . <https://doi.org/10.3923/pjn.2019.3441>
- Otu, B. O., Banjo, A. A., Kolo, S. P., Balogun, A. M., and Dabban, A. I. 2021.** Growth performance and nutrient digestibility of broiler chickens fed diets containing varying inclusion levels of dried watermelon rind at the starter phase. *Nigerian Journal of Animal Production*, 48(3), 134–141.
- Portea Medical. 2019.** *Diagnostic test*. Retrieved January 15, 2021, from <https://www.portea.com/labs/diagnostic-test/>
- Rahman, M. K., Islam, S., Ferdous, J., Uddin, M. H., Hossain, M. B., Hassan, M. M., and Islam, A. 2018.** Determination of hematological and serum biochemical reference values for indigenous sheep (*Ovis aries*) in Dhaka and Chittagong Districts of Bangladesh. *Veterinary World*, 11 (8) , 1089 – 1093 . <https://doi.org/10.14202/vetworld.2018.1089-1093>
- Rivero, N., and Salem, A. Z. M. 2015.** Biochemical parameters in sheep fed diet in presence of mixed *Salix babylonica* extract and exogenous enzyme as feed additives. *Indian Journal of Animal Sciences*, 85(2), 189–194.
- Rivero, N., Salem, A. Z. M., Ayala, M., Elghandour, M. M. Y., Kholif, A. E., Barbabosa, A., ... Cipriano, M. 2016.** Influence of *Salix babylonica* extract, exogenous enzyme of xylanase and their combination on blood

- haematological and biochemical profile in sheep and goats. *Indian Journal of Animal Sciences*, 86(10), 1140–1144. <https://doi.org/10.18805/ijar.8601>
- SAS, (Statistical Analysis Systems). 2002.** *Statistical package for analysis*. North Carolina, USA: Statistical Analysis Systems Institute, Cary.
- Tannins, R. J., and Maylor, A. W. 1968.** Physical and chemical studies of a low molecular weight form of cheese. *Biochemical Journal*, 108(77), 324–358.
- Wada, N. I., Njidda, A. A., Adamu, M., and Chibuogwu, C. I. 2014.** Variation in haematological and serum biochemical indices of sheep fed *Ziziphus mucronata* and *Parkia biglobosa* (A comparative study). *Global Journal of Biology, Agriculture and Health Science*, 3(4), 39–47.
- Weather Station. 2020.** *Weather report for mubi climate: Department of Geography, ADSU-Mubi*. Adamawa State University (ADSU), Mubi.

Date received: 3rd March, 2022.

Date accepted: 26th August, 2022.