SERUM BIOCHEMICAL INDICES IN RABBITS FED MANCHURIAN WILD RICE HAY

Millam, J.J., *Jacob, M.G., Emmanuel, E. and Filibus, I.G.
Department of Animal Production, Adamawa State University, Mubi, Nigeria.
*Department of Fisheries and Aquaculture, Adamawa State University, Mubi, Nigeria.
Correspondence: Department of Animal Production, Adamawa State University, PMB 025, Mubi, Adamawa State, Nigeria; jacobjafiya@gmail.com; +234 8061 504 098

ABSTRACT
This study was conducted to evaluate the serum biochemical indices in rabbits fed diets containing Manchurian wild rice (MWR) hay at the Rabbit Unit of Adamawa State University Teaching and Research Farm, Mubi. Sixteen New Zealand bucks, weighing approximately 958.15 g, used for the study, were purchased from Rabbit City® in Jos, Plateau State. The rabbits were kept under close observation and acclimatisation for one week before the start of the experiment. They were housed in cages for the duration of the study, with each cage designed to accommodate a single rabbit and equipped with an individual feeding trough and drinker. The rabbits were randomly assigned to the dietary treatments: control, 10% MWR (10MWR), 20% MWR (20MWR), and 30% MWR (30MWR) (n = 4 per treatment) in a completely randomised design. All data collected were analysed using the SAS software. The results showed significant differences ($P<0.05$) in all measured parameters. All liver enzymes (ALT, AST and ALP) were least ($P<0.05$) in 10MWR (7.81, 10.02, and 11.72 U/L, respectively); higher ($P<0.05$) total protein and albumin were observed in 30MWR (76.41 and 41.76 g/L, respectively); bilirubin and cholesterol were least ($P<0.05$) in 10MWR (4.5 and 14.9 mg/dL, respectively); glucose was higher ($P<0.05$) in 30MWR (100 mg/dL); while BUN and creatinine were least ($P<0.05$) in 10MWR (3.01 mmol/L and 89.69 µmol/L, respectively). The study concluded that feeding rabbits with up to 30 g/kg MWR was adequate with no adverse effect.

Keywords: Blood sugar, Bucks, Grass, Kidney function, and Liver function.

DESCRIPTION OF PROBLEM
Rabbits, being herbivorous monogastric animals, depend heavily on the nutritional quality of their diets to maintain health, productivity, and optimal growth rates (1). As global demand for sustainable and cost-effective animal feed increases, the exploration of alternative and underutilised feed resources has gained significant attention in animal nutrition research (2). One such potential feed resource is Manchurian wild rice (*Zizania latifolia*), a fast-growing, widely available plant known for its rich phytochemical composition and adaptability to diverse environmental conditions (3). Despite its reputation as an agricultural weed, Manchurian wild rice contains bioactive compounds, minerals, and fibres that could contribute positively to animal nutrition (4).

The evaluation of this grass stems from both nutritional standpoints; determining the effects of Manchurian wild rice (MWR) on serum biochemical characteristics will offer insights into its suitability as a feed ingredient and whether or not it promotes a healthy system. Additionally, understanding how this plant interacts with the rabbit's physiology can provide broader implications for feed formulation in other small herbivores. From an ecological perspective, utilising the grass as a feed ingredient aligns with sustainable agricultural practices by turning a weed species into a valuable resource, potentially reducing competition with staple crops and decreasing reliance on conventional feed resources.

The present study focuses on evaluating the inclusion of Manchurian wild rice in the diet of rabbits and its subsequent effects on serum biochemical indices. Rabbits, being non-ruminant herbivores with a unique caecotrophic digestive system, are well-suited for the fermentation of fibrous plant materials (5). However, while the potential of this grass as a dietary component is promising, its effect on rabbits' biochemical indices remains largely unexplored. Therefore, the study aims to bridge the knowledge gap regarding the nutritional potential of Manchurian wild rice in rabbit diets, emphasising its effects on some serum biochemical indices. It is hypothesised that

incorporating the grass into rabbit diets, within specific inclusion limits, can support optimal serology while offering an environmentally sustainable alternative to conventional feed ingredients.

MATERIALS AND METHODS

Study area: The study was conducted at the Rabbit Unit of Adamawa State University Teaching and Research Farm, Mubi Local Government Area. The area lies within the northern Guinea savannah zone of Nigeria. It is geo-located between latitude 10°16.6'6.9" north of the equator and longitude 13°16'1.2" East of the Greenwich meridian, at an elevation of 560 metres above sea level (6).

Source and processing of the Manchurian wild rice hay: The MWR hay was sourced from Kuva Gaya village in Hong Local Government Area, Adamawa State. It was freshly harvested from the rivers and streams in the area, shade-dried for over a month, then packaged and transported to the study location. The hay was shredded with a forage shredder into particles about five to eight millimetres long. It was then bagged and kept ready for the next stage trial.

Preparation of experimental rations: Four total mixed rations were formulated using the least-cost method to contain cowpea husk (control), and MWR hay was included at 100, 200 and 300 g/kg. Other ingredients used in each of the treatments to formulate the diets are presented in Table 1. The diets were formulated to meet the requirements of the rabbits according to the MSD Manual (7).

Table 1: Gross composition of experimental diets

Ingredients (kg)	Control	10MWR	20MWR	30MWR
Cowpea husk	30.00	-	-	-
Zizania latifolia hay	-	10.00	20.00	30.00
Maize	15.32	20.97	17.25	13.54
Maize bran	30.65	41.94	34.51	27.07
Groundnut meal	12.19	14.22	14.99	15.76
Local brewers' residue	6.09	7.11	7.50	7.88
Fish meal	3.00	3.00	3.00	3.00
Bone meal	1.00	1.00	1.00	1.00
Salt	0.50	0.50	0.50	0.50
Premix	0.25	0.25	0.25	0.25
Lysine	0.50	0.50	0.50	0.50
Methionine	0.50	0.50	0.50	0.50
Laboratory analysis (%)				
Dry matter	94.025	94.02	94.02	94.35
Organic matter	89.72	91.01	90.20	91.33
Crude protein	18.53	18.43	18.02	18.72
Ether extracts	2.96	2.21	2.02	2.92
Ash content	4.31	3.02	3.82	3.03
Nitrogen-free extracts	62.78	64.85	64.50	62.74
Neutral detergent fibre	52.78	48.98	46.02	44.02
Acid detergent fibre	46.76	52.52	52.02	53.07
Energy (ME, kcal/kg)	3162.69	3164.86	3121.14	3157.99

10MWR, 20MWR, 30MWR: 10, 20 and 30% Manchurian wild rice inclusion, ME: metabolizable energy

Ethical consideration: The Institutional Animal Care and Ethics Committee at Adamawa State University approved the research procedures and animal use under approval number ADSUIACEC/2023/014. It attests to the processes' compliance with global guidelines for the use and care of animals.

Experimental animals and management: Sixteen growing New Zealand bucks, at eight weeks of age, weighing ≈958.15 g, were purchased from Rabbit City® in Jos, Plateau State. The rabbits were kept under close observation and adaptation for one week before the commencement of the experiment.

Afterwards, the rabbits were housed in metal cages for the trial. The cages were washed and disinfected one week before the commencement of the experiment. Each cage (3×2×1 ft) was constructed to house one rabbit at a time, and it's equipped with individual feeding troughs and drinkers. Feed and water were supplied using an *ad libitum* feeding regime.

Experimental design and data collection: Four rabbits were randomly assigned to each treatment diet in a completely randomised design before the start of the experiment. Three rabbits from each treatment were used for blood sample collection at the end of the feeding trial. Blood was drawn by severing the jugular vein into Vacutainer bottles for analysis. Three millilitres and one millilitre of blood were placed in plain Vacutainer bottles and fluoride oxalate bottles for other biochemical indices measurements and glucose determination, respectively, according to the procedure described by Ochei and Kolhatkar (8). The blood samples were transported to the Laboratory Service Department, Specialist Hospital, Mubi, for measurement.

Dietary compositions of the experimental diets: Samples of the experimental ration were collected and oven-dried for proximate composition determination as described by AOAC (9). The cell wall constituent of the feed was also determined using the methods of Van Soest *et al.* (10). The analysis was conducted in the Animal Nutrition Laboratory, Department of Animal Production, Adamawa State University, Mubi. Metabolizable energy was calculated using the method documented by Pauzenga (11).

Data analysis: All data obtained were analysed according to the PROC GLM procedures of SAS (12). The effect of treatment means was tested at a probability level of 5% ($P<0.05$), and significant effects were compared using Dunnett's Test.

RESULTS AND DISCUSSION

The biochemical characteristics in the blood of rabbits fed diets containing MWR are presented in Table 2. All of the treatment means measured showed significant ($P<0.05$) effects. All liver enzymes (ALT, AST and ALP) were lowest ($P<0.05$) in 10MWR (7.81, 10.02, and 11.72 U/L, respectively), and were below reference ranges (45–80, 35–130 and 12–96 U/L, respectively) recommended for healthy rabbits (13). This implies that the hepatic and hepatobiliary systems are not under stress or harm resulting from the diet fed during the study (14). Higher ($P<0.05$) total protein (76.41 g/L) and albumin (41.76 g/L) values were observed in 30MWR and were within recommended ranges (54–75 and 27–50 g/L, respectively) for healthy rabbits (13). This signifies that the diet provided enough protein (Table 1) for amino acid metabolism and promoted better protection against fluid leakages from the blood vessels (15). Bilirubin (4.5 mg/L) and cholesterol (14.9 mg/dL) values were the lowest ($P<0.05$) in 10MWR and were within recommended ranges (0–7 and 10–80 mg/dL, respectively) for healthy rabbits (13).

Table 2: Serum biochemical indices in rabbits fed diets containing Manchurian wild rice

Parameters	Control	10MWR	20MWR	30MWR	SEM	Ref. values
ALT (U/L)	11.53^{b}	7.81^{c}	15.26^{a}	10.15^{b}	0.72	45–80
AST (U/L)	13.70^{a}	10.02^{b}	12.39^{ab}	11.37^{b}	1.02	35–130
Alkaline phosphatase (U/L)	18.42^{a}	11.72^{b}	16.84^{ab}	18.78^{a}	8.42	12–96
Total protein (g/L)	72.69^{b}	57.73^{d}	66.94^{c}	76.41^{a}	1.04	54–75
Albumin (g/L)	39.90^{b}	32.33^{d}	38.56^{c}	41.76^{a}	0.49	27–50
Bilirubin (mg/L)	5.77^{b}	4.50^{d}	5.12^{c}	6.34^{a}	0.22	0–7
Cholesterol (mg/dL)	18.61^{b}	14.90^{c}	19.35^{b}	21.00^{a}	0.81	10–80
Glucose (mg/dL)	75.70^{b}	69.30^{c}	80.00^{b}	100.00^{a}	0.31	75–155
Blood urea N (mmol/L)	3.01^{d}	3.87^{c}	5.03^{b}	5.94^{a}	0.13	7.1–16.1
Creatinine (µmol/L)	90.91^{c}	89.69^{d}	101.34^{b}	122.69^{a}	0.51	44.2–221

^{abcd}: Mean values within rows with different superscript letters are significantly different ($P<0.05$), 10MWR, 20MWR, 30MWR: 10, 20 and 30% Manchurian wild rice inclusion, AST: aspartate aminotransferase, ALT: alanine aminotransferase, N: nitrogen, SEM: standard error of means. Source of ref. values: (13)

The results indicate a normally functioning liver. It also shows that RBC oxidation or bile flow and hormonal/fat metabolism were not impaired, resulting from the diets fed during the trial (15). Glucose value (100 mg/dL) was higher ($P<0.05$) in 30MWR and was within recommended ranges (75–155 mg/dL) for healthy rabbits (13). This is an indication that the diet supplied adequate glucose (relatively high NFE and ME, Table 1) for energy metabolism or probably due to higher carbohydrate digestion, and the pancreas was not damaged (15). For the kidney function, blood urea nitrogen (3.01 mmol/L) and creatinine (89.69 µmol/L) were lowest ($P<0.05$) in 10MWR and were below (for BUN) and within (for creatinine) recommended ranges (7.1–16.1 mmol/L and 44.2–221 mol/L, respectively) for healthy rabbits (13). The result indicates a well-functioning kidney. It also signifies that the kidneys of the rabbits could clear up and filter toxins out of the system, and there was less muscle metabolism resulting from the wear and tear due to loss of weight (16).

CONCLUSION AND APPLICATION

Based on the study, feeding rabbits up to 30 g/kg of Manchurian wild rice in their diets enhances the function of their accessory digestive organs without impairing their functions. It is recommended to include this in their diet.

REFERENCES

1. Awang, Z. E., Shaahu, T. D., Tuleun, D. C., Okpanachi, U. and Okwori, I. A. (2023). Evaluation of the serum biochemistry and haematology of rabbits fed straws and haulms diets. *Nigerian Journal of Animal Science*, 25(3): 154–163.
2. FAO (Food and Agriculture Organisation of the United Nations). (2019). The future of livestock in Nigeria. Opportunities and challenges in the face of uncertainty. Africa Sustainable Livestock 2050. Rome. Pp 60. https://openknowledge.fao.org/server/api/core/bitstreams/7e8189db-340f-48f2-b7ba-bd0ab7d0506d/content.
3. Millam, J. J., Jacob, M. G., and Kosontyav, J. (2024). Nutrient composition of Manchurian wild rice (*Zizania latifolia*) hay. In Ola S. I., Olayemi, W. A., Williams, G. A., Osineye, O. M., Kareem-Ibrahim, K. O., Mafimidiwo, A. N., Adebayo, B. J., Asafa, A. R. and Yashim, S. M. (Eds), *Proceedings of the 29th conference of ASAN, 8–12 September 2024, Lagos*, Nigeria. Pp 902–904. ISSN: 9783477722.
4. Zhang, X. K., Wan, A., Wang, H. L., Zhu, L. L., Yin, J., Liu, Z. G., and Yu, D. P. (2016). The overgrowth of *Zizania latifolia* in a subtropical floodplain lake: Changes in its distribution and possible water level control measures. *Ecological Engineering*, 89: 114–120.
5. Osei, D. Y., Apori, S. O., Hagan, J. K., Amedorme, D. and Ayizanga, R. (2024). Growth performance and carcass characteristics of rabbits fed concentrate diets containing graded levels of *Brassica oleracea* outer leaves and *Musa paradisiaca* leaves. *World Rabbit Science*, 32: 21–29. https://doi.org/10.4995/wrs.2024.19616.
6. Meteorological Enclosure. (2023). *Weather Report for Mubi Climate: Department of Geography, ADSU-Mubi*. Adamawa State University (ADSU), Mubi.
7. MSD (Merck, Sharp & Dohme) Manual (2025). *Veterinary manual: Nutrient requirements of rabbits*. Merck and Co., Inc., Rahway, NJ, USA. https://www.msdvetmanual.com/multimedia/table/nutrient-requirements-of-rabbits.
8. Ochei, J. and Kolhatkar, A. (2007). *Medical laboratory science: Theory and practice*. Tata McGraw-Hill Pub. Co. Ltd, New Delhi, India, pp 200.
9. Association of Official Analytical Chemists (AOAC). (2005). *Official methods of analysis.* Helrich, K. (ed). 15th Ed. Arlington, Virginia, USA.
10. Van Soest, P. J., Robertson, J. B., and Lewis, B. A. (1991). Methods for dietary fibre, neutral detergent fibre, and nonstarch polysaccharides in relation to animal nutrition. *Journal of Dairy Science*, 74(10): 3583–3597. https://doi.org/10.3168/jds.S0022-0302(91)78551-2.
11. Pauzenga, U. (1985). Feeding parent stock. Zootech. International. pp 22–25
12. SAS (Statistical Analysis Systems). (2002). *Statistical Package for Analysis*. North

Carolina, USA: Statistical Analysis Systems Institute, Cary.

13. Fielder, S. E. (2015). *Normal reference ranges for blood profiles of various animals*. Clinical Pathology, Oklahoma State University. Content modified from MSD Veterinary Manual www.msdvetmaual.com/special-subjects/reference-guides.
14. Davis, C. P. (2021). *Liver blood tests (normal, low, and high ranges and results)*. Retrieved from MedicineNet website: https://www.medicinenet.com/liver_blood_tests/article.htm
15. Williams, K., Ruotsalo, K., and Tant, M. S. (2022). *Serum biochemistry*. Retrieved from VCA Animal Hospitals website: https://vcahospitals.com/know-your-pet/serum-biochemistry#:~:text=