

THE PHYSIOLOGICAL RESPONSES OF WISTAR RATS FED *Moringa oleifera* LEAF MEAL DIETS

Chinwe U. Nwachukwu, Okonkwo N. Uchenna and Oluwadamilola D. Ibhafidon

Department of Agricultural Science, School of Vocational and Technology Education, Alvan Ikoku Federal University of Education, Owerri, Imo State.

*Corresponding author: chinwe.nwachukwu@alvanikoku.edu.ng; +2348036788019

ABSTRACT

Moringa oleifera (MO) is a tropical herbal plant with several variety of ethnomedicinal values. The plant leaves, seeds, roots constituent numerous medicinal, biological, nutritional and phytochemical properties used pharmaceutically in traditional medicine. The medicinal properties of MO include cholesterol lowering, immune booster, blood sugar regulator, antioxidant activities. The study tested the hypothesis that supplementation of *Moringa oleifera* leaf meal will alter the performance of Wistar rats. A total of forty-eight (48) Wistar rats (both males and females, initial body weight = 150g; age = 90 days old) were used for the 12-week feeding trial. The animals were housed individually (14 x 14 x 15 cm) in a hutch and randomly assigned to four dietary treatments (n=12/group). The Wistar rats were supplemented with *Moringa oleifera* leaf meal diets at an inclusion rate (0, 2, 3, 4g/kg) per diet. Performance was monitored and recorded. At the end of feeding trials, performance was analysed. Inclusion of varying levels of *Moringa oleifera* leaf meal in Wistar rat diets increased ($p<0.05$) daily weight gain, weight gain, daily feed intake, feed intake, feed efficiency and feed conversion ratio in males when compared to females. However, the daily feed intake, feed intake, feed efficiency and feed conversion ratio ($p>0.05$) were not affected among gender and diet interactions. It was concluded that inclusion of *Moringa oleifera* leaf meal as feed supplement at 4% inclusion level improved the physiological responses in Wistar rat diets with no adverse effects on their performance. Therefore, we recommend the inclusion of *Moringa oleifera* leaf meal within the levels of 4g/kg as daily intake in Wistar rats' ration.

Keywords: *Moringa oleifera* leaf meal, Wistar rat, Performance, Weight gain, Feed intake

INTRODUCTION

Moringa oleifera (MO) is a herbal plant that is traditionally and naturally use for both food and medicine in some local communities of most tropical and subtropical countries in the world which Nigeria is included (Anwar, Latif, Ashraf, & Gilani, 2007). The herbal plant belongs to the family of Moringaceae known as drumstick tree or horse radish tree or miracle tree; its leaves, fruits, flowers, seeds, immature pods, stem bark, and roots are highly nutritive vegetables eaten fresh, cooked or stored as dried powder (Anwar et al., 2007; Moyo, Masika, Hugo, & Muchenje, 2011). *Moringa olerifera* as natural herbal feed supplement is used to sustain animal production, performance, improve health status, promote growth and increase immunity.

Many studies on *Moringa olerifera* have explored the nutritional, biological, therapeutic, pharmacological and medicinal values to be excellently rich in proteins, calcium, iron, phosphorus, potassium, copper, manganese, selenium, vitamins A and C, β -carotene, minerals, essential phytochemicals and natural antioxidant compounds of ascorbic acids, flavonoids, phenolics and carotenoids for both man and animal productions in many developing countries where inadequate nutrition is a challenge and of a serious concern (Anwar et al., 2007; Gopalakrishnan, Doriya, & Kumar, 2016; Moyo et al., 2011).

Moringa olerifera leaf meal (MOLM) serves as potential natural herbal feed source in both environmentally friendly and health safe for human consumption that contains polyphenols that helps in blood lipid metabolites; serves as antiseptic due to the presence of phytochemicals; rich in amino acids that boost immune systems; contains polyunsaturated fatty acids; and contains antioxidants values that suppress reactive oxygen species and free radicals productions (Liaqat, Mahmood, Ahmad, Kamran, & Koutoulis, 2016).

Currently, some studies have shown that inappropriate ratios of *Moringa olerifera* in the diets of livestock animals can negatively affect production and health of animals (Srinivasamurthy, Yadav, Sahay, & Singh, 2017). To establish that *Moringa olerifera* can be a feed source for Wistar rats, its safety must first be determined. On the above note, the effect of varying levels of supplemented MOLM on performance in Wistar rats were conducted.

4 Materials and Methods

Ethical approval and study location

The institutional research and ethics committee (Alvan Ikoku Federal University of Education, Owerri, Imo State, Nigeria) approved the animal study and its experimental protocols, which was performed in accordance to the

standard guidelines of Institution Animal Scientific procedures. Additionally, the study was conducted under the guide for the care and use of laboratory animals published by the U.S. National Institutes of Health (NIH Publication No. 85-23; revised 1996) for studies on experimental animals. The Wistar rats were brought from Covenant Farm, Gbolasire area, Iwo-road, Ibadan, Oyo State. The study was performed at the Animal Science unit of the Teaching and Research farm, Department of Agricultural Science, Alvan Ikoku Federal University of Education, Owerri, Imo State, Nigeria.

Experimental animals and housing

The Wistar rats (n=48; 50:50 ratio males to females) were age (90 days old) and body weight ($149 \pm 01\text{g}$). The animals were housed individually in 14 (length) x 14 (width) x 15 (height) cm metabolic cages in 12-weeks feeding trial. Animals were allocated to experimental groups based on body weight and gender. All animals were given one week of acclimatization in animal housing conditions before being used for the trial study. The experimental animals were maintained under a standardised pathogen-free animal house conditions of standard 12-hour natural light/dark photoperiod per day at an environmental ambient temperature of $25 \pm 2^\circ\text{C}$ fed *ad libitum* twice daily at 08:00 hours and 16:00 hours. For each animal, feed (15g) was weighed in, and the residual feed was weighed out the following morning and recorded daily.

Moringa oleifera leaves preparation

Moringa oleifera plants (1.5 years old) were collected from Amadi Abraham's farm at Umuahia North LGA, Abia State. The *Moringa oleifera* leaves were taken to a crop agronomist at Crop and Plant Science Unit, Department of Agricultural Science, Alvan Ikoku Federal University of Education, Owerri, Imo State for authentication, classification, and documentation. The *Moringa oleifera* leaves were air-dried under room temperature for 7 days, blended with electric blender (Kenwood appliance, United Kingdom), weighed, and included into the animal feeds.

Experimental feed preparation

The animal feed (Top feeds: Grower mash; Premier Feed mills, Sapele, Delta State, Nigeria) was made in isocaloric on a dry matter as-fed basis and fed to the animals throughout the feeding trials. The animal feed met the nutrient requirements of rodents according to (National Research Council, 2012). *Moringa oleifera* leaf meal (MOLM) were incorporated into the animal feed as diet 1 (Control; no MOLM), diet 2, 3, and 4 contains *Moringa oleifera* leaf meal of 2, 3 and 4g/kg respectively. The *Moringa oleifera* leaf meal was manually mixed with the animal diet (basal) and left at room temperature overnight before the commencement of feeding trial.

Growth indices measurement

The growth performance of Wistar rats were monitored, measured and recorded daily and weekly throughout the trials. Daily weight gain (DWG), weight gain, daily feed intake (DFI), feed intake, feed efficiency and feed conversion ratio (FCR) of individual rabbits were measured and recorded. The FCR was calculated dividing DFI with DWG.

Experimental design

Forty-eight Wistar rats of both males and females were randomly assigned to 4 dietary treatments of 12 animals per group for each feed trial. *Moringa oleifera* leaf meals (MOLM) were incorporated into diet 1 (Control; no MOLM), diet 2, 3, and 4 containing MOLM inclusion of 0, 2, 3 and 4g/kg respectively. All animals used in the different experimental groups were assessed blindly. The animals were subjected to performance.

Data analysis

For the experiment, experimental data values are presented as mean \pm SEM (standard error mean) or pooled SEM and $p < 0.05$ was declared significant. For each measured parameter, the data was blocked by replicates nested within and weeks of experiment. For performance indices, a 2×4 factorial design was used with genders and dietary treatments used as factors. The main effects and their interaction were included using GenStat 18th Edition (Hemel Hempstead, United Kingdom). A Student's Newman Keuls multiple comparisons test was used to determine the difference between varying levels of MOLM inclusion.

RESULTS AND DISCUSSION

The growth performance of Wistar rats fed diets supplemented with varying levels of *Moringa oleifera* leaf meal is illustrated in Figure 1. Parameters such as weight gain, daily weight gain, feed intake (FI), daily feed intake (DFI), feed conversion ratio (FCR), and feed efficiency (FE) were significantly influenced ($p < 0.05$) by the supplementation levels and gender differences. Male rats exhibited a 10% higher weight gain and daily weight gain compared to females when fed diets supplemented with *Moringa oleifera* leaf meal. Specifically, males in groups fed diets 2, 3, and 4 showed significantly higher ($p < 0.05$) weight gain than those on the control diet, while females did not display similar improvements. A significant treatment-by-gender interaction ($p < 0.05$) was

observed for weight gain and daily weight gain, indicating enhanced performance in males across all treatments. In terms of feed intake, daily feed intake, and FCR, males outperformed females by 15% ($p < 0.05$). Males fed diets 2, 3, and 4 had significantly higher values ($p < 0.05$) than those on the control diet, but no treatment-by-gender interaction was noted for these parameters ($p > 0.05$). Conversely, feed efficiency decreased significantly ($p < 0.05$) in males compared to females. Males in groups fed diets 2, 3, and 4 exhibited lower feed efficiency than those on the control diet, with no significant treatment-by-gender interaction ($p > 0.05$). These findings highlight the differential effects of *Moringa oleifera* supplementation based on gender.

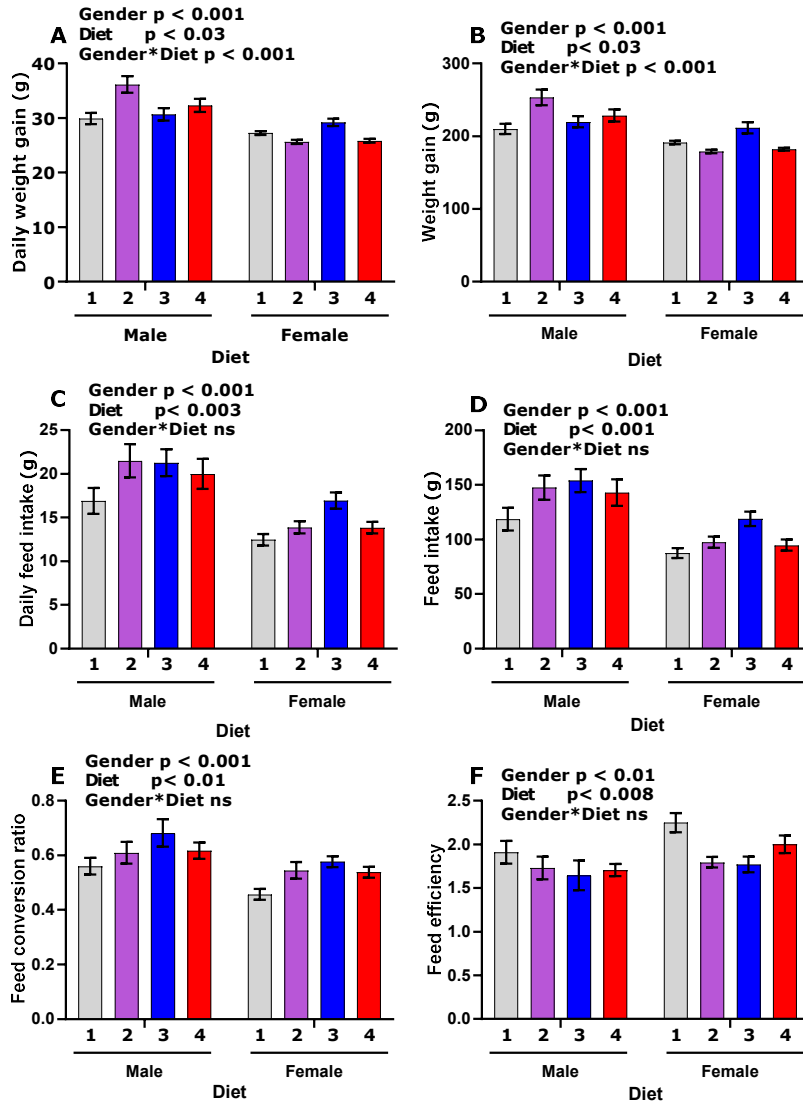


Figure 1: Growth performance of supplemented *Moringa oleifera* leaf meal diets fed Wistar rats

Moringa oleifera leaf meal was added at 0, 2, 3, 4g/kg in animal feeds of both genders (males and females). The effect of treatment shown on (a) Daily weight gain (g), (b) Weight gain (g), (c) Daily feed intake (g), (d) Feed intake (g), (e) Feed conversion ratio, (f) feed efficiency. The data are mean \pm SEM (standard of means) $n = 12$ /treatment, both genders.

The supplementation of Wistar rat diets with *Moringa oleifera* leaf meal significantly increases weight gain and daily weight gain, particularly in male rats, who experience about 10% greater weight gain than females. Studies indicate that male Wistar rats exhibit a statistically significant improvement in weight gain metrics when supplemented with *Moringa oleifera*, suggesting a gender-specific response to the supplementation. This variation in response may be attributed to differences in metabolism and growth patterns between male and female rats (Nurhayati et al., 2023; Selim, Seleiman, Hassan, Saleh, & Mousa, 2021; Zhang et al., 2024). *Moringa oleifera* leaves are rich in proteins and essential nutrients, with a crude protein content of approximately 28%, which supports the growth and overall health of the rats. The enhanced weight gain observed in supplemented rats may

be linked to increased feed intake, as studies suggest that Moringa supplementation stimulates appetite in adult Wistar rats. The high bioavailability of nutrients from Moringa oleifera compared to standard feed likely improves nutrient absorption and utilization, thereby promoting growth. This combination of increased appetite and superior nutritional content makes Moringa oleifera leaf meal a valuable addition to animal diets. (Selim et al., 2021). The observed treatment by gender interaction effect highlights the complexity of nutritional responses and the importance of considering gender-specific dietary studies. Male rats consistently show greater weight gain and daily weight gain across different treatment levels, suggesting that they may be more responsive to nutritional interventions involving Moringa oleifera. The underlying mechanisms driving these gender differences require further investigation, with potential factors including hormonal variations, digestive efficiency, and energy expenditure.

A deeper understanding of these mechanisms could inform both research methodologies and practical applications in animal nutrition. (Cui et al., 2018; Sun et al., 2018; Zhang et al., 2024). Moringa supplementation also results in increased feed intake, daily feed intake, and improved feed conservation ratios, particularly in male rats. Studies show that the total feed intake and daily feed intake in supplemented Wistar rats are significantly enhanced, with males experiencing an approximate 15% increase compared to females. Moreover, male rats exhibit a greater improvement in feed conservation ratio, suggesting they not only consume more feed but also utilize it more effectively for growth. This indicates that Moringa oleifera positively influences feed consumption and utilization efficiency (Mhlomi, Unuofin, Otunola, & Afolayan, 2022; Uwaifo, 2020). However, despite increased feed intake and conservation ratio improvements, males exhibit lower feed efficiency than females. This suggests that although male rats consume more food and gain more weight, the weight gained per unit of feed is lower compared to females. This discrepancy may indicate metabolic differences in how males and females process and convert Moringa supplementation into body mass. Further research is necessary to explore these metabolic variations and optimize dietary strategies for growth in laboratory and agricultural settings. While both genders benefit from increased feed intake and conservation ratios, the lower feed efficiency in males remains an important area for further exploration to refine nutritional strategies for animal production (Adeyemi & Elebiyo, 2014; Nurhayati et al., 2023).

CONCLUSION AND RECOMMENDATION

The results suggest that MOLM possess good dietary protein quality for optimal growth in Wistar rats and be incorporated in the Wistar rats' diets up to 4% inclusion levels without any detrimental effects on the growth performance of growing rats.

REFERENCE

- Adeyemi, O. S., & Elebiyo, T. C. (2014). Moringa oleifera Supplemented Diets Prevented Nickel-Induced Nephrotoxicity in Wistar Rats. *J Nutr Metab*, 2014, 958621. doi:10.1155/2014/958621
- Anwar, F., Latif, S., Ashraf, M., & Gilani, A. H. (2007). Moringa oleifera: a food plant with multiple medicinal uses. *Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives*, 21(1), 17-25.
- Cui, Y.-m., Wang, J., Lu, W., Zhang, H.-j., Wu, S.-g., & Qi, G.-h. (2018). Effect of dietary supplementation with Moringa oleifera leaf on performance, meat quality, and oxidative stability of meat in broilers. *Poultry science*, 97(8), 2836-2844. doi:<https://doi.org/10.3382/ps/pey122>
- Gopalakrishnan, L., Doriya, K., & Kumar, D. S. (2016). Moringa oleifera: A review on nutritive importance and its medicinal application. *Food science and human wellness*, 5(2), 49-56. <http://10.1016/j.fshw.2016.1004.1001>
- Liaqat, S., Mahmood, S., Ahmad, S., Kamran, Z., & Koutoulis, K. (2016). Replacement of canola meal with Moringa oleifera leaf powder affects performance and immune response in broilers. *Journal of Applied Poultry Research*, 25(3), 352-358. <https://doi.org/310.3382/japr/pfw3018>.
- Mhlomi, Y. N., Unuofin, J. O., Otunola, G. A., & Afolayan, A. J. (2022). Assessment of rats fed protein-deficient diets supplemented with Moringa Oleifera Leaf Meal. *Current Research in Nutrition and Food Science Journal*, 10(1), 45-55.
- Moyo, B., Masika, P. J., Hugo, A., & Muchenje, V. (2011). Nutritional characterization of Moringa (Moringa oleifera Lam.) leaves. *African Journal of Biotechnology*, 10(60), 12925-12933. <http://12910.15897/AJB12910.11599>
- National Research Council. (2012). *Nutrient requirements of poultry*: National Academies Press,.
- Nurhayati, T., Fathoni, M. I., Fatimah, S. N., Tarawan, V. M., Goenawan, H., & Dwiwina, R. G. (2023). Effect of Moringa oleifera Leaf Powder on Hematological Profile of Male Wistar Rats. *J Blood Med*, 14, 477-485. doi:10.2147/jbm.S407884

- Selim, S., Seleiman, M. F., Hassan, M. M., Saleh, A. A., & Mousa, M. A. (2021). Impact of Dietary Supplementation with Moringa oleifera Leaves on Performance, Meat Characteristics, Oxidative Stability, and Fatty Acid Profile in Growing Rabbits. *Animals (Basel)*, 11(2). doi:10.3390/ani11020248
- Srinivasamurthy, S., Yadav, U., Sahay, S., & Singh, A. (2017). Development of muffin by incorporation of dried Moringa oleifera (Drumstick) leaf powder with enhanced micronutrient content. *Development*, 2(4), 65-71.
- Sun, B., Zhang, Y., Ding, M., Xi, Q., Liu, G., Li, Y., . . . Chen, X. (2018). Effects of Moringa oleifera leaves as a substitute for alfalfa meal on nutrient digestibility, growth performance, carcass trait, meat quality, antioxidant capacity and biochemical parameters of rabbits. *Journal of Animal Physiology and Animal Nutrition*, 102(1), 194-203.
- Uwaifo, F. (2020). Evaluation of Weight and Appetite of Adult Wistar Rats Supplemented with Ethanolic Leaf Extract of Moringa oleifera. *Biomedical and Biotechnology Research Journal (BBRJ)*, 4(2), 137-140. doi:10.4103/bbrj.bbrj_17_20
- Zhang, Y.-W., Wang, F.-J., Cai, M., Liu, Y.-P., Liu, J.-Y., & Huang, B.-Z. (2024). Evaluation of the feeding safety of Moringa (Moringa oleifera L.) in the Sprague Dawley rat. *Scientific reports*, 14(1), 10647. doi:10.1038/s41598-024-51442-8