# Growth Performance and Haematological Evaluation in Female Rabbit Fed Diets Containing supplemental levels of Dried Date (*Phoenix* *dactylifera*) Fruit Meal

**ABSTRACT**

*This study was carried out to assess the growth performance and haematological profile of female rabbits that were fed dried date fruit meal (DDFM) as supplement in their diets. Thirty-six (36) female rabbits (does) were used for the study. The rabbit does were randomly allotted to 4 experimental groups in a completely randomized design with 9 does in each treatment group. The does in each treatment group were regrouped into 3 replications with 3 animals per replicate. The four experimental diets containing the dried date fruit meal at 0.00, 0.50, 1.00 and 1.50% supplemental levels respectively, were tagged T1, T2. T3, and T4. The study lasted for 168 days (24 weeks). The growth parameters that were assessed in the study were initial body weight, final body weight, total and daily body weight gain, total and daily feed intake, and feed conversion ratio. Blood samples were collected at the end of the 24 weeks study from each replicate for haematological analysis to evaluated packed cell volume (PCV), red blood cells (RBC), white blood cells (WBC), hemoglobin (HB), mean corpuscular hemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), mean corpuscular volume (MCV), Neutrophils, monocytes, eosinophils, basophils and lymphocytes. The results revealed that there were significant differences (P=.05) in final body body weight, total body body weight gain, daily body body weight gain, and feed conversion ratio of the does across the treatments. The results revealed significant effects (P=.05) of the DDFM on Packed Cell Volume (PCV), Platelet count, and Haemoglobin (Hb) concentration. The PCV value was highest for the does fed diet T3 (36.67%), which was significantly higher than the values recorded for the animals fed on diets T1 (30.33%) and T2 (30.67%). Conclusion: including DDFM as supplement in rabbit does diets at 1.00% can improve growth traits and haematological indices, to enhance the overall health status of rabbits.*

# Keywords: Date Fruit, Female Rabbits, Growth Performance, Haematology

# INTRODUCTION

# Rabbits produce a nutritious white meat that is high in protein and low in fat and cholesterol than chicken, turkey, beef, and pork (Flanders, 2012). Compared with the meat of other species, Flanders (2012), stated that rabbit meat is richer in proteins and certain vitamins and minerals. According to Hassan *et al.* (2012), the rabbit's fast growth rate, high prolificacy, high genetic selection potential, high feed conversion efficiency and economic utilization of space make suitable for increased animal protein production. Taiwo *et al.* (2004), further added that the high fecundity, low cost of investment, and the short generation interval, as well as their ability to utilize diverse forages are - advantages for increased production.

# Date fruit have a very high nutritional value because of their components. The fruit contains a lot of carbohydrates, vitamins, and minerals (Ardekani *et al.,* 2010). Some benefits of the date fruit have been identified as anti-inflammatory, anti-diabetic, nephroprotective, hepato-protective anti-oxidants and fertility (Hafez and El-Sohaimy, 2010). Al-Shwyeh (2019) also reported date fruit as a rich source of phenolic antioxidants with antibacterial and anti-inflammatory activity property and so can serve as a resourceful ingredient in animal feed. But the effect of including the fruit in rabbit feed particularly on their blood parameters is not commonly considered in scientific investigation, therefore, this study was designed to investigate the effect of dried date fruit meal on the growth performance and haematological characteristics of female rabbits.

# 2. MATERIALS AND METHODS

**2.1 Experimental Site**

The research was carried out at the Rabbit Unit of the Teaching and Research Farm, Department of Animal Science, University of Uyo, Akwa Ibom State. Uyo is situated at a latitude of 4º 591 to 5º 041 N and a longitude of 7º 531 to 8º 001 E, with an elevation of approximately 60.96 meters above sea level. The region exhibits a bimodal rainfall pattern with an average annual rainfall of 2190 millimeters and a mean relative humidity of 81% (Solomon *et al.,* 2024).

**2.2 Experimental Design**

A completely randomized design (CRD) was employed to allocate the 36 rabbit does to 4 experimental diets that contained varying supplemental levels of DDFM at 0.00% (control), 0.50%, 1.00% and 1.50% and designated as T1, T2, T3, and T4 accordingly. Each treatment group consisted of 3 replicates, with each replicate comprising 3 rabbits; making 9 rabbits per treatment. The experimental feeding period for each replicate was twenty-four weeks (168 – days).

**2.3 Experimental Animals and Management**

Thirty-six female growing rabbits aged between 8 and 10 weeks were utilized for the study. A two-week acclimatization period was implemented, during which all the rabbits were fed a formulated ration. Subsequently, the rabbits were randomly assigned to four treatment diets Prior to the commencement of the experiment, prophylactic measures were taken to control internal and external parasites through subcutaneous administration of ivermectin injection (0.1 ml/rabbit). Additionally, a broad-spectrum antibiotic, [Oxytetracycline L.A (0.2 ml/rabbit)], was administered to minimize bacterial load. The rabbits were managed under intensive conditions and housed in wired wooden rabbit hutches within an open-ended rabbit house to ensure adequate ventilation. Throughout the 168-day (24-week) experimental period, the rabbits were provided with feed, water, and forages ad libitum. Weekly body weights were taken to monitor growth progress.

**2.4 Sourcing and Processing of Test Materials**

Dried date palm fruit were procured from a local market in the Itu Local Government Area, Akwa Ibom State. The fruit were subjected to air drying and subsequently milled using an electric grinding machine to obtain dried date palm fruit meal (DDFM).

# 2.5 Proximate analysis of dried date palm fruit meal and experimental diets

Dried date palm fruit meal (DDFM) and the four experimental diets were analyzed according to the method of AOAC (2010) to determine the dry matter, crude protein, crude fibre, ether extract, ash and nitrogen free extract (NFE) contents.

# 2.6 Experimental Diets

The four experimental diets were formulated to contain varying levels of DDFM: 0.00% (control), 0.50%, 1.00%, and 1.50%, designated as T1, T2, T3, and T4, respectively. All the diets were fortified with bone meal, vitamin premix, and salt.

 **Table 1: Composition of the Experimental Diet**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Ingredients  | T1(0.00% DDFM) | T2(0.50% DDFM) | T3(1.00% DDFM) | T4(1.50% DDFM) |
| Maize | 45.00 | 45.00 | 45.00 | 45.00 |
| Soybean cake  | 21.00 | 21.00 | 21.00 | 21.00 |
| Wheat Offal  | 17.10 | 17.10 | 17.10 | 17.10 |
| Rice offal | 5.00 | 5:00 | 5:00 | 5:00 |
| Palm Kernel Cake | 8.00 | 8.00 | 8.00 | 8.00 |
| Bone meal | 3.00 | 3.00 | 3.00 | 3.00 |
| Common salt | 0.25 | 0.25 | 0.25 | 0.25 |
| Vit-Premix | 0.25 | 0.25 | 0.25 | 0.25 |
| Lysine  | 0.20 | 0.25 | 0.25 | 0.25 |
| Methionine  | 0.20 | 0.25 | 0.25 | 0.25 |
| TOTAL | 100.00 | 100.00 | 100.00 | 100.00 |
| Calculated Composition |  |  |  |
| Metabolizable Energy (Kcal/Kg) | 2806.30 | 2806.30 | 2806.30 | 2806.30 |
| Crude Protein (%) | 17.15 | 17.15 | 17.15 | 17.15 |
| Crude fibre (%) | 5.56 | 5.56 | 5.56 | 5.56 |
| Ether Extract (%) | 6.87 | 6.87 | 6.87 | 6.87 |

# 2.7 Data Collection

**2.7.1 Measurement of Growth Parameters**

Live body body weight: the weekly live body body weight was measured for each doe in each group using a generic electronic weighing scale (SF – 400A) with a sensitivity of 1g.

**Feed intake:** Feed intake was evaluated by subtracting the quantity of leftover feed from the quantity offered the previous day in a 24-hour cycle.

**Total body weight gain:** Total body weight gain was calculated as the difference between the final and the initial body body weight.

Total body body weight gain (g) = final body body weight – Initial body weight

**Daily body weight** **gain** was obtained by dividing the total body weight gain by the total number of experimental days as follows:

Daily body weight gain (g) = $\frac{Total weight gain }{168 days}$

**Total feed intake**: Total feed intake was calculated by summing the total amount of feed consumed by the animals for 168 days of the experiment.

**Daily feed intake**: This was computed by dividing the total feed consumed per each doe during the experiment by 168 days as follows:

Daily feed intake (g) = $\frac{Total Feed Intake }{168 days}$

**Feed conversion ratio (FCR)**: Feed conversion ratio was computed by dividing the total feed intake by total body weight gain during the study as follows:

Feed Conversion Ratio = $\frac{Total feed intake}{Total body weight gain}$

**2.7.2 Haematological Parameters**

At the conclusion of the 24-week experimental period, blood samples were collected from one randomly selected doe within each replicate in each treatment group. Blood collection was performed via an external ear vein between 7:00 and 8:30 AM using a sterile disposable syringe and needle. Prior to collection, sterile universal bottles containing Ethylenediaminetetraacetic acid (EDTA) anticoagulant were labeled for sample identification. Following blood collection, the puncture site of each animal was disinfected with a cotton swab soaked in methylated spirit to prevent infection.

The following hematological parameters were assessed: packed cell volume (PCV), red blood cells (RBC), white blood cells (WBC), hemoglobin (Hb), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), mean corpuscular volume (MCV), neutrophils, and lymphocytes were assessed using an automated analyzer ((Sysmex kx-21n).

# 2.8 Statistical Analysis

# The experimental data were subjected to analysis of variance (ANOVA) procedure in a completely randomized design, using IBM Statistical Package for Social Science (SPSS) version 21. Differences between treatment means were separated using Duncan multiple Range Test of the software.

# The statistical model adopted was:

# Yіј = μ+Tі +eіј

# Where Yіј = a single observation, μ = overall mean, Tі = Treatment effect, eіј = Random error

associated with the jth observation in the ith treatment.

**3. RESULTS**

**3.1 Growth Performance of Rabbit Does Fed Diets Containing Dietary Supplemental Levels of Dried Date Fruit Meal**

Growth performance of the rabbit does fed diets containing varying levels of the dried date fruit ~~s~~ meal (DDFM) is presented in Table 2. The results revealed significant differences *(P=.05)* in the final body weight, total body weight gain, daily body weight gain, and feed conversion ratio of the does across the treatments. The highest final body weight was recorded in the does fed diet T3 (1887.39 g), which was significantly greater than the final body weight of the does fed diets T1 (1629.39 g) and T2 (1741.00 g) but similar for those fed diet T4 (1847.33 g). The lowest final body weight was recorded for the does on the control diet (T1). Similarly, total body weight gain was significantly highest for the animals fed diet T3 (1138.28 g), followed by those fed diets T4 (1099.11 g), T2 (993.78 g) with the lowest for the rabbits fed the control diet (T1) (886.39 g). Daily body weight gain followed a similar trend, with the does fed diet T3 showing the highest value (6.78 g), followed by those fed diets T4 (6.54 g), T2 (5.92 g), and T1 (5.28 g).

No significant differences (P>0.05) were observed in total feed intake and daily feed intake of the does across all the treatments. However, while total feed intake varied slightly at 13392.90 g, 13548.00 g, 13530.67 g, and 13530.67 g for the rabbits fed diets T1, T2, T3, and T4, respectively, daily feed intake increased marginally in the does fed diets T1, T2, T3 but slightly decreased in those fed diet T4. Feed conversion ratio (FCR) was significantly the best (lowest) in the does fed diet T3 (11.89), followed by those fed diets T4 (12.31), T2 (13.63), and T1 (15.11).

**Table 2: Growth performance of rabbit does fed diets containing dietary supplemental levels of dried date fruit meal**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Parameters | T1(0.00% DDFM) | T2(0.50% DDFM) | T3(1.00% DDFM) | T4(1.50% DDFM) | SEM |
| Initial body weight (g) | 743.00 | 747.22 | 749.11 | 748.22 | 81.24 |
| Final body weight (g) | 1629.39b | 1741.00ab | 1887.39a | 1847.33a | 51.90 |
| Total body weight gain (g) | 886.39b | 993.78ab | 1138.28a | 1099.11a | 94.71 |
| Daily body weight gain (g) | 5.28a | 5.92c | 6.78a | 6.54b | 0.18 |
| Feed intake (g) | 13392.90 | 13548.00 | 13530.67 | 13530.67 | 48.02 |
| Daily feed intake (g) | 95.66 | 96.77 | 96.86 | 96.65 | 0.34 |
| Feed Conversion Ratio | 15.11a | 13.63b | 11.89d | 12..31c | 0.38 |

SEM – Standard error of mean, means without letters were not significant (p>0.05), SEM – Standard Error of Means

**3.2 Haematological Indices of Rabbit Does Fed Diets Containing Dried Date Fruit Meal**

The WBC count ranged from 4.80 × 10⁹/dL in T4 to 5.67 × 10⁹/dL in T2, with T1 (5.27 × 10⁹/dL) and T3 (5.47 × 10⁹/dL) showing intermediate values. The similarity in WBC counts across the groups indicates that the DDFM supplementation did not significantly affect the WBCs. The RBC counts were 4.37 × 10¹²/L in T1, 4.33 × 10¹²/L in T2, 4.90 × 10¹²/L in T3, and 5.17 × 10¹²/L in T4. While there was a trend towards higher RBC counts in T3 and T4, the differences were not significant. Similarly, MCV values were 69.33 fl in T1, 71.00 fl in T2, 75.67 fl in T3, and 69.67 fl in T4, showing no significant effect of DDFM on the average volume of red blood cells. MCH values, which reflect the amount of haemoglobin per red blood cell, were 21.33 pg in T1, 23.33 pg in T2, 23.67 pg in T3, and 22.67 pg in T4. The MCHC values, which indicate the concentration of haemoglobin in a given volume of packed red blood cells, were 31.33% in T1, 33.33% in T2, 31.33% in T3, and 33.00% in T4, with no significant differences observed across the treatments. These parameters suggest that the DDFM supplementation did not significantly alter the general characteristics of red blood cells or their haemoglobin content.

**Table 3: Haematological indices of rabbit does fed diets containing dietary supplemental levels of dried date fruit meal**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Parameters | T1 | T2 | T3 | T4 | SEM |
| Packed Cell Volume (%) | 30.33b | 30.67b | 36.67a | 36.33a | 1.01 |
| White Blood Cells (×109/dL) | 5.27 | 5.67 | 5.47 | 4.80 | 0.39 |
| Platelet | 123.33c | 154.00b | 197.67a | 139.67bc | 21.91 |
| Red Blood Cells (×1012/L) | 4.37 | 4.33 | 4.90 | 5.17 | 0.14 |
| MCV (fl) | 69.33 | 71.00 | 75.67 | 69.67 | 1.21 |
| MCH (pg) | 21.333 | 23.33 | 23.67 | 22.67 | 0.52 |
| MCHC (%) | 31.33 | 33.33 | 31.33 | 33.00 | 0.64 |
| Haemoglobin (g/dL) | 9.33b | 10.13ab | 11.57a | 11.70a | 10.68 |
| Lymphocytes (%) | 60.00 | 70.00 | 62.33 | 63.33 | 1.80 |
| Eosinophil (%) | 4.67 | 4.67 | 4.00 | 4.00 | 0.19 |
| Monocytes (%) | 3.67 | 3.00 | 3.00 | 2.67 | 0.19 |
| Neutrophils (%) | 31.33 | 22.00 | 30.33 | 29.67 | 1.71 |
| Basophil (%) | 0.33 | 0.33 | 0.33 | 0.33 | 0.14 |

MCV - mean corpuscular volume, MCH – mean corpuscular haemoglobin, MCHC – Mean corpuscular haemoglobin concentration, SEM – Standard error of means; Means with different superscripts are significant *(P=.05)*

For the differential white blood cell counts, there was no significant difference (p>0.05) in the percentage of monocytes; however, rabbits fed diet T2 (3.00%) had the highest percentage count compared to the other treatments. Similarly, no significant differences (P>0.05) were recorded in the percentage ~~s~~ concentration of Lymphocytes, Eosinophils, Neutrophils, and Basophils of rabbits fed the various treatment diets.The percentage of Lymphocytes ranged from 60.00% in T1 to 70.00% in T2, with T3 and T4 showing 62.33% and 63.33%, respectively. Eosinophil percentages were 4.67% in T1 and T2, and 4.00% in T3 and T4, indicating that the DDFM had little effect on this parameter in the does. Neutrophil percentages ranged from 22.00% in T2 to 31.33% in T1, with T3 and T4 showing values of 30.33% and 29.67%, respectively. Basophil percentages remained consistent across all treatments at 0.33%.

Overall, while significant differences were observed in PCV, Platelet count, and Haemoglobin concentration, the majority of haematological indices, including WBC count, RBC count, MCV, MCH, MCHC, and differential white blood cell counts, showed no significant differences across the treatments.

**4. DISCUSSION**

**4.1 Growth performance of rabbit does fed diets containing varying levels of dried date fruit meal**

Results on the growth performance of rabbit does fed diets containing varying levels of dried date fruit ~~s~~ meal (DDFM) reveal significant improvements in the final body weight, total body weight gain, daily body weight gain, and feed conversion ratio (FCR), aligning with findings in existing literature on the effects of plant-based feed additives growth performance. The significantly higher final body weights recorded for the animals fed diets T3 and T4 compared to those fed on T1 are consistent with the observations of Reece *et al.* (2015) and Malik *et al.* (2022) who reported improved body weight in animals supplemented with nutrient-rich plant-based feeds. DDFM contains ~~a~~ high nitrogen-free extract (78.81%) and minerals such as calcium and iron and would likely enhance ~~d~~ energy availability and skeletal development which might result to the increases in the growth traits ~~,~~ as was noted by Etim *et al.* (2014) ~~,~~ who emphasized the role of dietary minerals in growth performance.

The significantly higher total body weight gain and daily body weight gain noted in the rabbits fed on dietsT3 and T4 than those fed on the control diet T1 suggests that DDFM improved nutrient assimilation and feed utilization in the animals. This finding supports the report of Omoikhoje *et al.* (2024) who noted increased weight gain in animals fed diets supplemented with Jatropha leaf meal. Similarly, Essien *et al.* (2024) attributed improved growth to phytochemical and energy composition of plant-based supplements, which enhance protein synthesis and metabolic activity.

Total feed intake and daily feed intake did not vary significantly in the rabbits does across the treatments. However, the similarity of their values aligns with the findings of Malik *et al.* (2022)~~,~~ who reported no significant differences in feed intake among broilers fed plant-based diets. This suggests that the DDFM did not influence feed palatability for increased consumption but enhanced ~~s~~ growth of the rabbits by improving their nutrient conversion efficiency~~,~~ as evidenced by the significantly better FCR detected for the animals fed on diet T4 (12.85) and T3 (13.01) compared to those fed on the control diet T1 (18.30). The improved FCR detected in this study indicates more efficient feed utilization with higher DDFM inclusion. This is consistent with the findings of Abdul Ameer *et al.* (2022) who have reported enhanced FCR in rabbits fed diets containing bioactive-rich plant extracts. The rich phytochemical composition of DDFM which includes flavonoids and saponins, may have contributed to better nutrient absorption and gut health, as was reported by Soetan *et al.* (2013).

**4.2 Haematological indices of rabbit does fed diets containing dietary supplemental levels of dried date fruit meal**

Hematological indices according to Okorie *et al.* (2011), are means of conducting clinical investigations on the existence of various metabolites and other components in an animal, and they can also be used as crucial tools for determining the health status of an individual as well as in the diagnosis of various pathological and metabolic problems (Afolabi *et al.,* 2011). The haematological findings in this study align with established literature, showcasing the potential of dried date fruit meal (DDFM) to improve certain blood parameters while maintaining the overall blood health of rabbits. Packed cell volume (PCV), an important marker of oxygen-carrying capacity, was significantly elevated in the rabbits fed diets T3 and T4 which is consistent with the reports of Reece *et al.* (2015) and the Merck Veterinary Manual (2012), which identified PCV values of 30–50% as optimal for health of rabbits. This suggests that DDFM supplementation could support efficient oxygen transport, a critical condition that is needed for growth and metabolism.

White blood cell (WBC) count was not significantly different in the does across the treatment diets, but the values were maintained within the normal range (6.00–12.00 × 10⁹/dL) recommended by the Merck Veterinary Manual (2012). This indicates that the DDFM did not compromise the rabbits’ immunity. Similar findings were reported by Istifanus *et al.* (2022) who have highlighted the importance of WBC in combating infections and maintaining immunity. Moreover, Soetan *et al.* (2013) emphasized that, WBC plays a crucial role in antibody production and phagocytosis, and confirmed by the current findings, the DDFM supplementation has shown to support ~~s~~ these immune functions without any negative impacts. The WBC aids to protect the body from pathogen (Odunitan-Wayas *et al.,* 2018). White blood cell (WBC) count s typically increases in response to pathogens, enhancing the body’s defense mechanisms (Onyema *et al.,* 2024); thus the WBC counts recorded in the animals fed the various diets in the current work imply that the rabbit does were not exposed to pathogenic infections nor were their immune system compromised. The WBC differentials, including granulocytes (neutrophils, basophils, eosinophils) and non-granulocytes (lymphocytes, monocytes), provide specific insights into immune system activity (Onyema *et al.,* 2024). Lymphocytes, according to Afolabi *et al.* (2011), are the most common form of white blood cell, followed by heterophils, eosinophils, and monocytes. Since lymphocytes are reactive cells in inflammation and delayed hypersensitivity, they are involved in the manufacture of antibodies (Banks, 2014).

Red blood cell (RBC) counts, haemoglobin (Hb) levels, and other red cell indices (MCV, MCH, and MCHC) remained unaffected in the rabbits fed the experimental diets, with the values falling within the normal reference ranges for healthy rabbits reported by the Merck Veterinary Manual (2012) These align with the observations made by Abdul Ameer *et al.* (2022) and Istifanus *et al.* (2022) which indicate that stable RBC parameters reflect the absence of anemia and adequate oxygen-carrying capacity of the blood. The function of RBC as noted by (Onyema *et al.* (2024) is to transport oxygen from the lungs to tissues and remove carbon dioxide from the tissues to the lung in the body via haemoglobin. Therefore, the unaffected levels of RBC and Hb of the rabbis in all the treatment groups suggests that the DDFM supplementation did not impair erythropoiesis but affirms its safety and suitability in rabbit diets. The MCV is used to calculate the average erythrocyte size, the MCH measures the amount of haemoglobin per blood cell and the MCHC measures the amount of haemoglobin relative to the size of the cell per red blood cell (Odunitan-Wayas *et al.,* 2018). Results on MCV ~~,~~ and MCH in the current study indicate lack of macrocytic or hypochromic anemia in the rabbit does as supported by Onyema *et al.* (2024).

The study also recorded significant increases in platelet counts, particularly in the does fed diets T3 and T4; suggesting enhanced blood clotting potential of the animals, to prevent excessive blood loss during injuries according to Etim *et al.* (2014).

**5. CONCLUSION**

Findings of the study indicate that, DDFM at 1.00% can be supplemented in female rabbits’ diets to improve growth parameters without exhibiting any deleterious effect on the animals’ health.

Ethical Approval

The authors hereby declare that “Principles of laboratory animal care” (NIH Publication No. 85-23, revised 1985) and specific national laws were followed. All experiments have been examined and approved by the Ethics Committee of the Animal Science Department, University of Uyo, Nigeria.

**Disclaimer (Artificial intelligence)**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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