# Serum biochemistry, lipid profile and serum antioxidant indices of Rabbit Does fed dietary supplementation of dried dates (*Phoenix* *dactylifera*) fruit meal

**ABSTRACT**

*Antioxidants exert a wide range of beneficial effects, contributing to the prevention of disease onset. This study assessed the impact of dietary supplementation with dried date fruit meal (DDFM) on serum biochemical indices, lipid profile, and antioxidant status in Rabbit Does. A total of thirty-six female growing rabbits (8–10 weeks old) were randomly allocated to four dietary treatments containing DDFM at 0.00% (control), 0.50%, 1.00%, and 1.50%, respectively. The experiment followed a completely randomized design (CRD) with three replicates per treatment and lasted for 24 weeks. Serum biochemical parameters, lipid profile, and antioxidant indices were analyzed post-experiment using standard laboratory procedures. Results revealed that total protein, albumin, and globulin concentrations were significantly higher (p<0.05) in the control group (T1) and declined with increased DDFM inclusion. However, urea, glucose, and liver enzyme activities (AST, ALT, and ALP) remained unaffected. Total protein levels were highest in T1 (76.50 g/dL) and significantly higher compared to T2 (70.50 g/dL), T3 (54.50 g/dL), and T4 (57.00 g/dL). Lipid profile analysis indicated significant reductions in total cholesterol and LDL levels in treatments receiving 1.00% and 1.50% DDFM, suggesting improved lipid metabolism. The lowest LDL value was found in T4 (0.80 g/dL), which was significantly lower than the other treatments, which had comparable values: T1 (1.25 g/dL), T2 (1.50 g/dL), and T3 (1.50 g/dL) Antioxidant indices, including catalase (CAT), superoxide dismutase (SOD), and glutathione (GSH), exhibited significant increases in higher DDFM treatments, indicating enhanced oxidative defense. GSH concentrations were highest in T4 (18.52 µg/mL) and T3 (18.38 µg/mL), followed by T2 (17.22 µg/mL), and the lowest value in T1 (16.78 µg/mL). These findings suggest that while DDFM inclusion at higher levels may reduce serum protein indices, it enhances antioxidant status and improves lipid metabolism, making it a potentially beneficial feed additive for rabbit production.*

**Keywords:** Dried date fruit, Serum biochemistry, Lipid profile, Antioxidant indices, Rabbit Does

1. **INTRODUCTION**

Antioxidants are extensively investigated across various disciplines, including biology, medicine, food science, and nutrition (Kotha *et al.*, 2022). These compounds mitigate or decelerate cellular damage induced by free radicals—unstable molecules generated in response to environmental and physiological stressors (Kotha *et al.*, 2022). Oxidative stress arises from an imbalance between reactive oxygen/nitrogen species (ROS/RNS) and the body's antioxidant defense mechanisms, leading to pathological consequences when ROS/RNS exceed the system's neutralizing capacity (Kotha *et al.*, 2022). Antioxidants exert a wide range of beneficial effects in various disease conditions, contributing to the prevention of disease onset. Antioxidant potential of dates has been attributed to their rich composition of phenolic compounds, including p-coumaric, ferulic, and sinapic acids, as well as flavonoids and procyanidins (Rahamani *et al.*, 2014). Studies by Gu *et al.* (2003) and Hong *et al.* (2006) have identified thirteen flavonoid glycosides—such as luteolin, quercetin, and apigenin—at different maturity stages of date fruit. Additionally, the glucose content of dates ranges from 81.9% to 91.2% (Al-Tamim, 2014), with essential minerals such as Cu, Na, Ca, Mg, P, K, Zn, and Fe, which are vital for metabolic functions (Hafez and El-Sohaimy, 2010). Furthermore, date fruits provide significant amounts of vitamins (B1, B2, B3, B6, and C), dietary fiber (16.2%), protein (5.22%), carbohydrates (62.5%), and fats (8.49%) (Vyawahare *et al.*, 2009). The protein content includes albumin, globulin, prolamin, and gluten, with soluble proteins constituting approximately 5–6%. The fatty acid profile encompasses capric, lauric, myristic, palmitic, stearic, linoleic, linolenic, and arachidonic acids (Boukouada and Yousfi, 2009). Additionally, dates exhibit a high polyphenol levels (50.2 mg/g), primarily epicatechin and catechin, which contribute to their antioxidative properties (Saryono *et al.*, 2016).

Date fruit works as an antioxidant to stop the chain reaction due to oxidative stress. The antioxidant content of the date fruit has been widely demonstrated (Nehdi *et al.*, 2010; Saafi *et al.*, 2011; Saryono *et al.*, 2015, Saryono and Rahmawati, 2016). High polyphenol content in the date fruit (50.2 mg/g), especially epicatechin, and catechin determine antioxidant activity, both in vivo and in vitro. Thus, this study seeks to determine the influence of dried date fruit meal on the biochemical indices, lipid profile, and serum antioxidant activities in Rabbit Does.

# 2. MATERIALS AND METHODS

**2.1 Experimental** **Site**

The research was carried out at the Rabbitry 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 Sourcing and Processing of Test Materials**

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

**2.3 Experimental Animals and Management**

Thirty-six female growing mongrel (New Zealand x Chinchilla) rabbits aged between eight and ten weeks were utilized for the study. A two-week acclimatization period was implemented, during which the rabbits received a formulated ration. Subsequently, the rabbits were randomly assigned to four treatment groups, each receiving a diet containing varying levels of DDFM: 0.00% (control), 0.00%, 0.50%, 1.00 and 1.50%, respectively. Prior to the commencement of the experiment, prophylactic measures were taken to address 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.

# 2.4 Experimental Diets

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. The control diet (T1) served as a baseline, containing no DDFM.

 **Table 1: Composition of 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 |

DDFM: dried dates fruits meal

**2.5 Experimental Design**

A completely randomized design (CRD) was employed to allocate the four treatment groups to the respective experimental diets. Each treatment group consisted of three replicates, with each replicate comprising three rabbits. This resulted in a total of nine rabbits per treatment. The experimental feeding period for each replicate was twenty-four weeks (168 – days).

 The statistical model adopted was:

Yіј = μ+Tі +eіј

Where:

Yіј = single observation μ = overall mean

Tі = Treatment effect

eіј = Random error associated with the jth observation in the

 ith treatment

**2.6 Data Collection**

**2.6.1 Serum Biochemistry**

Blood sample (3ml) was collected from a random doe in each replicate using sterile needle and syringe through the external ear vein into labeled sterile universal bottles without anticoagulant for serum biochemical analysis. The parameters that were evaluated include blood glucose, total protein, albumin, globulin, urea, cholesterol, alkaline phosphatase (ALP), alanine amino transferase (AST) and Aspartate amino transferase (ALT). The levels of AST, ALT, and ALP were determined using kinetic kits according to a method by Ahmed (2010); moreover, protein concentration was determined using a method by Pilaski (1972). Furthermore, Patton's method (Weiss and Wardrop, 2011) was used to determine urea, whereas creatinine was calculated using a method by Provan *et al.* (2009). The sera were thawed, the ALT, AST and ALP where assayed using the Audiocomb Serum Auto-analyser (Bayer Express Plus, Bayer Germany, Serial Number 15950 in the Chemical Pathology Laboratory, University of Uyo Teaching Hospital (UUTH), Uyo.

**2.6.2 Lipid profile**

At the end of the finding trial, 3ml blood was collected aseptically using a sterile syringe and needles from the ear veins in a bottle with ethylene diamine tetra-acetic acid (EDTA) to prevent clotting. Serum samples from blood were separated by centrifugation of 4000rpm for 5min at 20oC. Samples were analyzed at University of Uyo Teaching Hospital for triglycerides, total cholesterol, high density lipoprotein and low-density lipoprotein using biochemical autoanalyzer (Cobas Mira Plus, Roche Diagnostics).

**2.6.3 Determination of antioxidants**

Blood samples (5ml) were collected from one Doe per replicate into plain sample bottles. The serum was obtained by centrifuging the blood at 3,000 rpm for 10 min at 4ºC as described by Skowron *et al.* (2018). The blood haemolysate was prepared from centrifuged blood cells after centrifugation as earlier stated. The sediment of erythrocytes was rinsed three times with saline and then haemolysed with deionised water. The activities of Catalase (CAT), and and glutathione peroxide (GSH) were determined in blood haemolysate. The activities of superoxide dismutase (SOD) were determined according to the method of Oyanagui method and adopted by Skowronm *et al.* (2018). The activity of CAT was determined by the kinetic method of Aebi and adopted by Skowronm *et al.* (2018) while GSH activity was determined by the kinetic method described by Paglia and Valentine and adopted by Skowronm *et al.* (2018).

**2.7 Statistical Analysis**

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

**2.8 Ethical Issues**

The Does were kept in the most humane way possible, in accordance with the ethical issues governing the use of animals in research. Every effort was made to ensure that all animals used in the study received equal treatment.

**3. RESULTS**

**3.1 Serum Biochemistry of Rabbit Does Fed Diets Containing Dried Date Fruits Meal**

The serum biochemistry of Rabbit Does fed diets containing varying levels of dried date fruits meal (DDFM) is presented in Table 2. Significant differences (p<0.05) were observed in Total Protein, Globulin, Albumin, and ALP (Alkaline Phosphatase) concentrations. Total protein levels were highest in T1 (76.50 g/dL) and significantly higher compared to T2 (70.50 g/dL), T3 (54.50 g/dL), and T4 (57.00 g/dL). The lowest values were observed in T3 and T4, which had comparable levels, indicating that the inclusion of DDFM, particularly at higher levels, may reduce total protein content in the blood.

Globulin levels were also significantly affected by DDFM supplementation, with T1 showing the highest value (39.00 g/dL), followed by T2 (36.50 g/dL), and significantly lower values in T3 and T4 (23.50 g/dL each). The decreased globulin concentrations in T3 and T4 could suggest a potential impact of DDFM on immune function or protein synthesis. Similarly, Albumin concentrations were highest in T1 (37.50 g/dL), followed by T2 (34.00 g/dL), and lower in T3 (31.00 g/dL) and T4 (33.50 g/dL), with the latter two treatments being significantly lower than T1.

No significant differences were observed in Urea, Glucose, and the liver enzymes (AST, ALT, and ALP) across the treatments. Urea concentrations were similar in T1 (5.15 mmol/L), T2 (5.35 mmol/L), and T3 (5.05 mmol/L), with the lowest value found in T4 (4.80 mmol/L). Glucose levels were also not significantly different across the treatments, with values of 3.10 g/dL in T1, 2.90 g/dL in T2, and 3.00 g/dL in T3 and T4.

Regarding liver enzyme activities, AST (Alanine Aspartate Aminotransferase) activity showed no significant differences among the treatments, with values ranging from 44.50 µ/L in T1 to 64.00 µ/L in T2. Similarly, ALT (Alanine Aminotransferase) activity was relatively stable across the groups, with T1 showing 19.00 µ/L, T2 showing a significantly higher value of 18.50 µ/L, and T3 (17.50 µ/L) and T4 (20.50 µ/L) showing values similar to T1. ALP levels were significantly affected by DDFM, with the highest level recorded in T2 (32.00 µ/L), followed by T4 (21.00 µ/L), and the lowest values observed in T1 and T3 (19.00 µ/L each).

**Table 2: Serum biochemistry of Rabbit Does fed diets containing dietary levels of dried date friuts meal**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Parameters | T1(0.00%DDFM | T2(0.50%DDFM | T3(1.00%DDFM) | T4(1.50%DDFM) | SEM |
| Total protein (g/dL) | 76.50a | 70.50b | 54.50c | 57.00c | 2.81 |
| Globulin  | 39.00a | 36.50a | 23.50b | 23.50b | 2.23 |
| Albumin | 37.50a | 34.00b | 31.00b | 33.50b | 0.75 |
| Urea (mmol/L) | 5.15ab | 5.35a | 5.05ab | 4.80b | 0.07 |
| AST ((µ/L) | 44.50 | 64.00 | 53.00 | 58.50 | 3.51 |
| ALP ((µ/L) | 19.00b | 32.00a | 19.00b | 21.00b | 1.81 |
| ALT ((µ/L) | 19.00 | 1850 | 17.50 | 20.50 | 0.50 |
| Glucose (g/dL) | 3.10 | 2.90 | 3.00 | 3.10 | 0.04 |

a b c – Means in the same row with different superscript are significantly different (P< 0.05); AST - Alanine aspartate aminotransferase; ALP – Alanine amino phosphatase; ALT - Alanine aminotransferase; SEM – Standard error of means; DDFM – Dried dates fruit meal.

**3.2 Lipid Profile of Rabbit Does Fed Diets Containing Dietary Levels of Dried Date Fruits Meal**

The lipid profile of Rabbit Does fed diets containing varying levels of dried date fruits meal (DDFM) is presented in Table 3. Significant differences (p<0.05) were observed in triglyceride, total cholesterol, and LDL concentrations. Triglyceride levels were highest in T2 (1.05 g/dL) and significantly higher than those in T1 (0.80 g/dL), but comparable to T3 (0.95 g/dL) and T4 (1.00 g/dL). The total cholesterol levels were highest in T2 (3.00 g/dL) and T1 (2.90 g/dL), which were significantly higher than T3 (2.15 g/dL) and T4 (2.35 g/dL). The lowest LDL value was found in T4 (0.80 g/dL), which was significantly lower than the other treatments, but had comparable values: T1 (1.25 g/dL), T2 (1.50 g/dL), and T3 (1.50 g/dL). However, no significant differences were observed in HDL and VLDL levels across all treatments, with values of 1.15, 1.05, 1.00, and 1.05 for T1, T2, T3, and T4, respectively, and 0.50 and 0.45 for VLDL in T1, T2, T3, and T4, respectively.

**Table 3: Lipid profile of Rabbit Does fed diets containing dietary levels of dried date fruit meal**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Parameters | T1(0.00%DDFM | T2(0.50%DDFM | T3(1.00%DDFM) | T4(1.50%DDFM) |  | SEM |
| Triglyceride | 0.80b | 1.05a | 0.95ab | 1.00a | 0.03 |
| Total cholesterol | 2.90a | 3.00a | 2.15b | 2.35b | 0.11 |
| HDL | 1.15 | 1.05 | 1.00 | 1.05 | 0.03 |
| VLDL | 0.50 | 0.45 | 0.50 | 0.45 | 0.01 |
| LDL | 1.25a | 1.50a | 1.50a | 0.80b | 0.09 |

a b – Means in the same row with different superscript are significantly different (P< 0.05); DDFM – Dried dates fruit meal; SEM – Standard error of mean.

**3.3 Antioxidant Indices of Rabbit Does Fed Diets Containing Dietary Levels of Dried Date Fruits Meal**

The antioxidant indices of Rabbit Does fed diets containing varying levels of dried date fruits meal (DDFM) are shown in Table 4. From the results, significant differences (p<0.05) were observed in CAT, SOD, and GSH concentrations. CAT levels were highest in T4 (1.93 µg/mL) and T3 (1.88 µg/mL), with the lowest value in T1 (1.66 µg/mL) and T2 (1.69 µg/mL).

**Table 4: Antioxidant indices of Rabbit Does fed diets containing dietary levels of dried date fruit meal**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Parameters | T1(0.00%DDFM | T2(0.50%DDFM | T3(1.00%DDFM) | T4(1.50%DDFM) |  | SEM |
| CAT (ug/ml) | 1.66b | 1.69b | 1.88a |  1.93a |  0.04 |
| SOD (ug/ml) | 5.72b | 6.08b | 7.12a |  7.23a |  0.21 |
| GSH (ug/ml) | 16.78b | 17.22b | 18.38a |  18.52a |  0.24 |

a b – Means in the same row with different superscript are significantly different (P< 0.05); DDFM – Dried dates fruit meal; SEM – Standard error of mean.

SOD activity was also highest in T4 (7.23 µg/mL) and T3 (7.12 µg/mL), followed by T2 (6.08 µg/mL), and the lowest value was observed in does fed T1 (5.72 µg/mL). GSH concentrations were highest in T4 (18.52 µg/mL) and T3 (18.38 µg/mL) groups respectively, and followed by Rabbit Does in T2 (17.22 µg/mL). The lowest value of GSH was observed in T1 (16.78 µg/mL).

**4. DISCUSSION**

**4.1 serum biochemical indices of Rabbit Does fed diets containing varying levels of dried date fruits meal**

The serum biochemistry of Rabbit Does fed diets containing varying levels of dried date fruits meal (DDFM) revealed significant differences in total protein, globulin, albumin, urea, and alkaline phosphatase (ALP), while aspartate aminotransferase (AST), alanine aminotransferase (ALT), and glucose levels remained statistically the same. Total protein values in the study were significantly higher in T1 (76.50 g/dL) and T2 (70.50 g/dL) compared to T3 (54.50 g/dL) and T4 (57.00 g/dL). This observation aligns with the findings of Essien *et al.* (2023), who reported improved serum protein concentrations in animals fed plant-based diets, emphasizing that higher protein levels reflect better protein metabolism and liver function. The decreased protein levels in T3 and T4, however, may indicate that excessive inclusion of DDFM could limit protein synthesis or increase protein utilization for growth, as noted by Malik *et al.* (2022). Globulin concentrations, an indicator of immune function, were significantly higher in T1 (39.00 g/dL) and T2 (36.50 g/dL) than in T3 (23.50 g/dL) and T4 (23.50 g/dL). This is consistent with the report of Omoikhoje *et al.* (2024), who observed that plant-based feed additives rich in bioactive compounds like flavonoids and saponins enhance immune response by supporting globulin synthesis. The reduced globulin levels in T3 and T4 could reflect increased nutrient partitioning towards growth rather than immune function. Albumin levels were significantly higher in T1 (37.50 g/dL) compared to T3 (31.00 g/dL) and T4 (33.50 g/dL). According to Reece *et al.* (2015), albumin is critical for maintaining osmotic pressure and transporting nutrients in the bloodstream, and its variation in this study highlights the influence of dietary DDFM on liver protein metabolism. Elevated albumin levels in T1 and T2 suggest better protein utilization and liver health, as also reported by Soetan *et al.* (2013).

Urea levels, which indicate nitrogen metabolism, were highest in T2 (5.35 mmol/L) and significantly greater than T4 (4.80 mmol/L), suggesting that dietary protein quality directly affects serum urea concentrations. The relatively lower urea levels in T3 and T4 may suggest improved nitrogen retention and reduced protein catabolism, supporting growth performance.

The ALP activity was significantly higher in T2 (32.00 µ/L) compared to T1 (19.00 µ/L), T3 (19.00 µ/L), and T4 (21.00 µ/L). ALP is associated with liver and bone metabolism, and its elevated levels in T2 may reflect increased bone activity or liver enzyme stimulation, as highlighted. Conversely, AST, ALT, and glucose levels remained within normal ranges and showed no significant differences across treatments, indicating that DDFM supplementation did not adversely affect liver integrity or glucose metabolism. These results align with Reece *et al.* (2015), who emphasized the stability of these parameters in healthy animals.

**4.2 Lipid profile of Rabbit Does fed diets containing varying levels of dried date fruits meal**

The lipid profile of Rabbit Does fed diets containing dried date fruits meal (DDFM) demonstrated significant effects on triglyceride, total cholesterol, and low-density lipoprotein (LDL) levels, while high-density lipoprotein (HDL) and very-low-density lipoprotein (VLDL) remained unaffected. The observed increase in triglycerides in T2 (1.05 mmol/L) and T4 (1.00 mmol/L) compared to T1 (0.80 mmol/L) suggests enhanced lipid storage and energy availability. Triglycerides, the primary form of lipid storage, are transported as lipoproteins and play critical roles in energy metabolism (Frandson *et al.*, 2009). However, contrasting results from Awan *et al.* (2019) showed reduced triglycerides in rats fed dates, highlighting possible species-specific differences in lipid metabolism.

Total cholesterol levels were significantly lower in T3 (2.15 mmol/L) and T4 (2.35 mmol/L) compared to T1 (2.90 mmol/L) and T2 (3.00 mmol/L). This decline aligns with findings from Anhwange *et al.* (2019) and Sunil (2013), who reported that flavonoids and saponins in plant-based feed additives inhibit cholesterol biosynthesis by forming insoluble complexes with bile acids and cholesterol, thereby reducing its absorption. The hypocholesterolemic effects observed in T3 and T4 could enhance cardiovascular health, given that high cholesterol is associated with an increased risk of atherosclerosis and heart disease (Tehrani *et al.*, 2013).

LDL, often referred to as “bad cholesterol,” was significantly reduced in T4 (0.80 mmol/L) compared to other treatments, reflecting an improved lipid profile and reduced risk of cardiovascular issues. This is consistent with observations by Odunitan-Wayas *et al.* (2018), who noted improved LDL levels in animals fed phytochemical-rich diets. The reduction in LDL levels may also be attributed to the antioxidant properties of flavonoids and phenols in DDFM, which protect against oxidative stress associated with LDL cholesterol (Thacker and Ram, 2024).

HDL levels, known for their protective role against coronary heart disease, ranged from 1.00 mmol/L to 1.15 mmol/L across treatments, with no significant differences. This stability may indicate that DDFM inclusion does not adversely affect HDL production, which aligns with findings by Ansari *et al.* (2020), who observed consistent HDL levels in animals fed plant-based supplements. Similarly, VLDL levels showed no significant variations, suggesting that DDFM does not alter the transport of triglycerides in the blood.

**4.3 Effect of dried dates fruits meal on antioxidant profile in Rabbit Does**

The significant variation observed in glutathione observed in the current study agrees with the findings of Khalifa *et al.* (2018) who observed significant reduction in the antioxidant in New Zealand rabbits administered dates fruits aqueous extract, which differs from the significant increase recorded in the study. Vyawahare *et al.* (2009) stated that dates can be a source of antioxidants through several mechanisms, such as neutralizing and destroying free radicals (NO, OH, and H2O2) and its precursors, preventing lipid peroxidation and stimulating antioxidant enzymes activity. Glutathione was higher at 1.00% DDFM (18.38 ug/ml) and 1.50% DDFM (18.52 ug/ml) supplementation. Superoxide dismutase (SOD), was significantly increased in Rabbit Does fed T3 (7.12 ug/ml), and T4 (7.23 ug/ml) diets respectively, which were significantly higher than those of does fed T1 (5.72 ug/ml) and T2 (6.08 ug/ml) diets respectively. Fathy *et al.* (2018) reported that the significant decrease of NO in the liver tissue of the dates extract treated groups as compared with the control group in their study might be the result of its interaction with superoxide to form peroxynitrite, which they said can react with cellular lipids, proteins, and DNA, and accelerates cell toxicity. The Rabbit Does fed T3 (1.00% DDFM), and T4 (1.50% DDFM) recorded similar values of 1.88 and 1.93 ug/ml respectively, which were significantly higher than those of T1 (0.00% DDFM) and T2 (0.50 DDFM) which had statistically similar values of 1.66 and 1.69 ug/ml respectively. CAT is an antioxidant enzyme required for the breakdown of H2O2 into H2O and O2 (Abdeen *et al.*, 2021). The significantly higher values of antioxidants observed at higher doses of dates demonstrates the ability of dates fruit to scavenge free radicals that are capable of causing cellular damage as noted by Fathy *et al.* (2018) and Khalifa *et al.* (2018). According to Tang *et al.* (2022), CAT and GSH-Px functions as antioxidase to get rid of lipid oxides produced during cell metabolism, thus, preventing peroxide poisoning, adding that CAT and GSH-Px could act as major antioxidant regulators in the initial stage of folliculogenesis.

**5. CONCLUSION**

This study demonstrated that 1.00% dietary supplementation with dried date fruit meal (DDFM) significantly influences serum biochemical parameters, lipid metabolism, and antioxidant indices in Rabbit Does. While total protein, albumin, and globulin concentrations declined at higher inclusion levels, the lipid profile improved through reduced cholesterol and LDL concentrations. Furthermore, DDFM supplementation enhanced antioxidant status by increasing catalase, superoxide dismutase, and glutathione levels.

**Disclaimer (Artificial intelligence)**

Authors 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.

**REFERENCES**

Ahmed A., Amira, S., Ashraf, E., Mohamed, A., Ola A. H., Ahmed G., Walaa F. A., Omnia A., Heba A. E., Bodour B., Samah F. I. and Afaf A. (2021). The potential antioxidant bioactivity of date palm fruit against gentamicin-mediated hepato-renal injury in male albino rats. *Biomedicine & Pharmacotherapy*, 143: 1.13

Ahmed F, Ahmed AM, Darwish H. H. (2010). Hypoglycemic effect of an extract from date seeds on diabetic rats. *Saudi Medicine Journal*; 31:747-51. 15.

Al-Tamim, E., (2014). Comparative study on the chemical composition of Saudi Sukkari and Egyptian Swei date palm fruits*. Journal of American Science,* 10(6), pp.149–153.

Anhwange, B. A., Agbidye, I. G. Kyenge, B.A. and Ngbede P. O. (2019). Phytochemical Screening, Antimicrobial Activities and Nutritional content of *Jatropha tanjorensis* Leaves. *Nigerian Annals of Pure and Applied Science*, (2): 108-113

Ansari, R. A., Rabiu, K. M., Ayuba, V. and Omolabake, O. O. (2020). Review on *Jatropha tanjorensis* (Hospital too far); significance as an anti-anaemia plant. *International Blood Research and Review;* 11(4):1–7

Awan, K. A., Butt, M. S., Ashfaq, F., Munir, H. and Suleria, H. A. R. (2019). Effect of date fruit supplemented diet on serum lipidemic and oxidative stress biomarkers in rodent experimental modelling. I*nternational Food Research Journal* 26(4): 1143-1153

Boukouada, M. and Yousfi, M. (2009). Phytochemical study of date seeds lipids of three fruits (*Phoenix* *dactylifera* L.) produced in Ouargla region. *Ann. Fac. Sci. Sci. de’Ingénieur.* 1: 66–74.

Essien, C. A., Sam, I. M. and Okon, U. M. (2023). Effect of *Jatropha* *tanjeronsis* leaf meal on performance, carcass and internal organ characteristics of broiler finisher chickens. *Proceedings of 28th Annual Conference of ASAN 2023, Abuja, Nigeria;* 403-406

Fathy, A. H., Bashandy, M. A., Bashandy, S. A., and Mansour, A. M. (2018). The beneficial effect of natural antioxidants from olive oil with fig and date palm fruit extracts on biochemical and hematological parameters in rats during diethylnitrosamine-induced carcinogenesis. *FACETS* 3: 584–597. doi:10.1139/ facets-2017-0075

Frandson, R. D., Wilke, W. L. and Fails, A. D. (2009). Anatomy and physiology of farm animals seventh edition. *Wiley-Blackwell, John Wiley & Sons, Inc., Publication*

Gu, L., Kelm, M. A., Hammerstone, J. F., Beecher, G., Holden, J., Haytowitz, D. and Prior, R. L. (2003). Screening of foods containing proanthocyanidins and their structural characterization using LCMS/MS and thiolytic degradation. *Journal of Agriculture and Food Chemistry,*51: 7513–7521.

Hafez, E.E. and El-Sohaimy, S.A., (2010). Biochemical and Nutritional Characterizations of Date Palm Fruits (Phoenix dactylifera L*.). Journal of Applied Sciences Research,* 6(8), pp.1060–1067.

Hong, Y. J., Tomas-Barberan, F. A., Kader, A. A. and Mitchel, A. E. (2006). The flavonoid glycosides and procyanidin composition of Deglet Noor dates (*Phoenix* *dactyllifera*). *Journal of Agriculture and Food Chemistry.*54(6): 2405–2411.

Khalifa, A., Walaa H., El-Sisy, G. A., El-Nattat, W. S., Mourad, A. A. A., and Maghraby, N. (2018). Effect of water extract of dates palm (Phoenix dactylifera) on semen characteristics and oxidative status in serum of male New Zealand rabbits under heat stress. *Asian Paciﬁc Journal of Reproduction*, 7(1): 22-26. DOI: 10.4103/23050500.220981

Kotha, R.R.; Tareq, F.S.; Yildiz, E.; and Luthria, D.L. (2022). Oxidative Stress and Antioxidants—A Critical Review on In Vitro Antioxidant Assays. 11, 2388. https://doi.org/10.3390/ antiox11122388

Malik, A. A., Busari, L. B., Idundun, S. O., Adebowale, Z. A. and Okoye, A. O. (2022). Effect of feeding *Jatropha tanjorensis* leaf meal as a growth promoter on the performance, carcass characteristics and sensory properties of broiler chicken. *Nigerian Society for Animal Production;* 49(2): 140-149.https://doi.org/10.51791/njap.v49i2.3477

Odunitan-Wayas FI Kolanisi UI Chimonyo MI. (2018). Haematological and Serum Biochemical Responses of Ovambo Chickens Fed Provitamin A Biofortified Maize. *Brazilian Journal of Poultry Science;* 20(3): 425-434

Omoikhoje, S.O., Eguaoje, A.S., Iyiorobhe, P., Akangbe, E. and Aidelomon, E.O. (2024). Growth performance of broiler chickens on cold aqueous *Jatropha tanjorensis* leaf extracts. *Proceedings of 49th Conference of Nigerian Society for Animal Production: 24 – 27 March, 2024, Univ. of Ibadan, Nigeria*; 1298-1302

Pilaski J. (1972). Vergleichendauntersuchungenwher den hemoglobinehalfdeshuhner and putenblutes in abhangigkeit. *Voraiterundegshlecht Arch Eflugelkunde*; 37:70. 16.

Provan D., Singer, C. R., Baglin, T. and Dokal, I. (2009). Oxford handbook of clinical haematology: *Oxford University Press*

Rahmani, A. H., Aly, S. M., Ali, H., Babiker, A. Y., Srikar, S., and Khan, A. A. (2014). Therapeutic effects of date fruits (*Phoenix* *dactylifera*) in the prevention of diseases via modulation of anti-inflammatory, anti-oxidant and anti-tumour activity. *International journal of clinical and experimental medicine*, *7*(3): 483–491.

Reece, W. O., Erickson, H. H., Goff, J. P. and Uemura, E. E, (2015). Dukes' Physiology of Domestic Animals Thirteenth Edition. *Wiley Blackwell, John Wiley & Sons, Inc., Publication*

Saryono, E Rahmawati, E. (2016). Effects of dates fruit (phoenix dactylifera l.) in the female reproductive process. *International Journal of Recent Advances in Multidisciplinary Research;* 3 (7), 1630-1633,

Saryono, Rahmawati, E., Heryanto, Hapsari, ED., Hidayat, A., (2016). Antioxidant enzyme status on rat after date seeds (Phoenix Dactylifera) steeping treatment. *International Journal of Research in Medical Sciences*, 4(6), pp.1893– 1896

Saryono, Retnani, H. and Santoso, D., (2015). Date seeds (Phoenix Dactylifera) steeping can reduce malondialdehyde level for strengthen membrane sperm cells. *Ners* *Journal*, 10(2).

Soetan, K. O., Akinrinde, A. S., and Ajibade, T. O. (2013). Preliminary studies on the haematological parameters of cockerels fed raw and processed guinea corn (*Sorghum* *bicolor*). *Proceedings of 38th Annual Conference of Nigerian Society for Animal Production*. 49-52

Solomon, E., Solomon, I. P., Istifanus, E. F., Tom, E. T., Eyo, G., Ebe, A. I. (2024). Growth performance and semen characteristics of mongrel rabbit bucks fed dietary levels of garlic (*Allum sativum*) meal. *Journal of experimental and molecular biology*. 25 (3): 203-210

Sunil, K. (2013). Cardiac Glycosides as Anticancer Agent. *International Journal of Research in Pharmaceutical and Biomedical Sciences*; 4 (4): 1371- 1378

Tang, L., Bai, X., Xie, X., Chen, G., Jia, X., Lei, M., Li, C. and Lai, S. (2022). Negative effects of heat stress on ovarian tissue in female rabbit. Frontiers in Veterinary Science, 9:1009182. doi: 10.3389/fvets.2022.1009182

Tehrani, D. M., Gardin, J. M., Yanez, D., Hirsch, C. H., Lloyd-Jones, D. M., Stein, P. K. and Wong, N. D. (2013). Impact of inflammatory biomarkers on relation of high density lipoprotein-cholesterol with incident coronary heart disease: cardiovascular health study. *Atherosclerosis* 231(2): 246-251.

Thacker, H. and Ram, V. (2024). Medicinal properties of phytochemicals: A review. *Journal of Pharmacognosy and Phytochemistry*, 13(2): 78-82

Vyawahare S, Sitaula S, Martin S, Adalian D, Scherer A (2009). Electronic control of elastomeric microﬂuidic circuits with shape memory actuators. *Lab on a Chip Journal;* 8:1530–1535

Weiss, D. J. and Wardrop, K. J. (2011). Schalm's veterinary hematology: *John Wiley & Sons*;