**Semen characteristics, reproductive hormones and testicular histology of male rabbits fed dietary supplemental levels of dried date palm (*Phoenix* *dactylifera*) fruit meal**

**ABSTRACT**

*The testis is the primary sex organ in the male reproductive system that is responsible for the production of semen. This study investigated the effects of dietary supplementation with dried date palm fruit meal (DDFM) on semen characteristics, reproductive hormone profiles, and testicular histology in male rabbits. Thirty-six grower rabbit bucks aged 8–10 weeks old used for the study were randomly assigned to four dietary treatments in a completely randomized design as follows; T1 (0.00% DDFM), T2 (0.50% DDFM), T3 (1.00% DDFM), and T4 (1.50% DDFM). Each treatment was replicated thrice with 3 rabbits per replicate in a study that lasted 24 weeks. At the end of the experiment, semen samples, blood and testicular samples were collected for laboratory examinations. Results indicated that dietary inclusion of DDFM significantly improved semen volume, sperm concentration, percentage of live sperm cells, and total sperm count per ejaculate compared to the control. Although sperm motility was not significantly influenced (P>0.05), morphological abnormalities decreased in DDFM-supplemented groups. Rabbit bucks in T2, T3 and T4 had higher similar sperm concentration values of 86.67, 92.00, and 92.33 x 106/ml, respectively, than in T1 (77.00 x 106/ml). Hormonal analysis showed increased (P=0.05) follicle-stimulating hormone (FSH) and luteinizing hormone (LH) levels with supplementation, whereas testosterone levels varied among treatments. Testicular histology revealed no pathological changes in the control, while seminiferous tubules in treated groups exhibited varying degrees of hypertrophy, vacuolation, and sporadic germinal epithelial degeneration, particularly at higher supplementation levels. These findings suggest that moderate inclusion of DDFM (1.00%) enhances semen quality and reproductive hormone profiles in rabbit bucks but may induce mild histological changes at higher doses.*

**Keywords:** Date palm fruit, rabbit bucks, semen quality, reproductive hormones, testicular histology, sperm motility, fertility.

1. **INTRODUCTION**

The testis in vertebrates is composed of two primary compartments namely, the tubular compartment and the intertubular (or interstitial) compartment (Schulz *et al.* 2010). The tubular compartment is made up of the seminiferous epithelium, which contains two cell types, the somatic Sertoli cells and the germ cells (spermatogenic cells), which are present at various stages of development (Matta *et al.* 2002). The intertubular compartment houses the steroidogenic Leydig cells, blood and lymphatic vessels, macrophages, mast cells, and neural and connective tissue cells. The intertubular compartment is continuous with the tunica albuginea (Koulish *et al.* 2002; Nobrega and Quagio-Grassiotto, 2007). Surrounding the testicular lobule is the tunica propria, which consists of the basal lamina and peritubular myoid cells (Schulz *et al.* 2010). The testis is the primary sex organ in the male reproductive system that is responsible for the production of semen.

Semen, according to Frandson *et al.* (2009), is composed of spermatozoa suspended in the secretions of the male accessory sex glands. The fluid component of semen, known as seminal plasma, serves as a medium for sperm transport and contains various essential substances, including electrolytes, fructose, citric acid, and sorbitol. Fructose, a sugar molecule, provides a source of energy for spermatozoa. Semen analysis is an essential tool in evaluating male fertility; however, no single semen characteristic is universally accepted as a definitive predictor of fertility (Frandson *et al.* 2009). Seminal plasma also contains microparticles of varying sizes that influence sperm function during their journey through the female reproductive tract (Castellini, 2008). The concentration of spermatozoa per milliliter varies between species and is a critical parameter in semen evaluation (Frandson *et al.* 2009). Semen analysis has been extensively utilized in the selection of breeding males for both natural and assisted reproductive techniques. Abd El-Azim and El-Kamash (2011), further reported that rabbit breeds exhibit significant differences in reaction time, semen pH, semen density, semen color, mass motility, and progressive motility.

Studies in male rats revealed that the date fruit can improve the process of spermatogenesis, the concentration of testosterone, FSH and LH and sperm (Adaay and Mattar, 2012; Saryono, *et al.*, 2016). Baliga *et al.* (2011) noted that carbohydrates constitute the primary chemical constituents of dates, encompassing both reducing sugars such as glucose and fructose, as well as non-reducing sugars such as sucrose, along with minor amounts of polysaccharides, including cellulose and starch. A publication by Premium Times (2016), noted that eating dates will promote sperm quality and quantity as it is one of the best natural fruit used for human male fertility and increases the size of testes in men. The article also explained that dates contained high level of flavonoid which aid sperm motility and increase sperm count, help to improve sexual activities and increase the production of sex hormones. Khalifa *et al.* (2018) in their study, observed that administration of date fruit extracts at 10 and 20 mL decreased nitric oxide and glutathione, increased lipid peroxidation, ascorbic acid and testosterone level and concluded that aqueous extract of date palm could enhance the rabbit buck’s fertility and its health performance. Earlier reports (Arfat, 2014; El-Kashlan, 2015) have demonstrated that date palm pollen can increase in the level of sex hormones like testosterone, FSH, LH as well as estradiol in experimental subjects by giving DPP to them. Saryono and Rahmanti (2018), stated that date fruit extracts contain a variety of components that work as potent antioxidants such as flavonoids, phenolic, vitamin C, E, and A, which can protect the sperm cell membranes against lipid peroxidation, thus decreasing the percentage of dead sperm and maintain normal sperm morphology.

Hence, this study was designed to evaluate the effect of dried date palm fruit meal on semen quality, testosterone, follicle stimulating hormone (FSH), luteinizing hormone (LH) and testicular histology in male rabbits fed dietary supplemental levels of dried date palm fruit meal.

**2. MATERIALS AND METHODS**

**2.1 Experimental Site**

The study was conducted at the Rabbitry Unit of the Teaching and *Res.* farm, of Department of Animal Science*.*, University of Uyo, Akwa Ibom State. Uyo, the State capital, is located on latitude 4º 591 and 5º 041 N and longitude 7º 531 and 8º 001 E, with an elevation of about 60.96m above the sea level, according to Solomon *et al.* (2024), with a bi-modal rainfall pattern and mean annual rainfall of 2190mm and mean relative humidity of 81%.

**2.2 Sourcing and Processing of Test materials**

Dried date palm fruit were purchased from a local market in Itu Local Government Area of Akwa Ibom State, Nigeria, and used for the study. The dried date fruit were air dried, milled using an electric grinding machine, and used in this study as dried date palm fruit meal (DDFM).

**2.3 Experimental Animals and Management**

A total of thirty-six male grower rabbits, aged 8 – 10 weeks, were used for the study. The rabbit bucks were allowed for two weeks of acclimatization period, during which they were fed with formulated ration and *Calapogonium* *mucunoides* leaves. Prior to the commencement of the experiment, the rabbits were treated against internal and external parasites by administering ivermectin injection at 0.1ml/rabbit subcutaneously. A broad-spectrum antibiotic (Oxytetracycline L.A) was also administered intramuscularly at 0.2 ml/rabbit to check bacterial load. The rabbits were managed intensively in a wired wooden hutch, located inside an open-ended rabbit house for proper ventilation. The rabbits were provided with feed, water and forages *ad-libitum* for 168-days (24 weeks) of the experimental period. They were weighed at the beginning of the experiment and subsequently on a weekly basis.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 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 |

**Table 1: Composition of Experimental Diet**

**2.4 Experimental Diet**

Four experimental diets were formulated to contain dietary supplemental levels of dried date palm fruit meal (DDFM) at 0.00% (control), 0.50%, 1.00% and 1.50% and coded as T1, T2, T3 and T4 respectively. T1 contained 0.00% of the test ingredients and hence, serve as the control diet.

**2.5 Experimental Design**

The four treatment groups were assigned to the four experimental diets in a completely randomized design (CRD). Each treatment was replicated three times with nine (9) rabbits per treatment and three (3) rabbits per replicate. Each replicate received an assigned diet for twenty-four (24) weeks. The statistical model is used is as follows:

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 Semen Collection and Evaluation**

**2.6.1.1 Semen Collection**

Semen collection was done using a specially designed artificial vagina for rabbits. To collect the semen from the bucks, a rabbit doe was introduced to the buck’s cage to serve as a teaser. The buck was watched closely and as it mounts the doe, the AV was placed gently at the vulva of the doe, so as to direct the penis into the AV for penetration and eventual ejaculation.

**2.6.1.2 Semen Evaluation**

The ejaculates obtained were evaluated according to the method of Zemjanis (1970) adopted by Shinkut (2015). This include visual or gross evaluation of the ejaculate soon after collection for volume and colour as well as microscopic examination for motility, concentration, percentage live spermatozoa and morphological abnormalities.

**2.6.2 Testicular Histology**

The testes of rabbit bucks from each treatment was removed with the aid of local anesthetic, weighed and fixed in 10% formalin solution for histopathological examination at the Department of Chemo Pathology, University of Uyo. The method of Ewuola (2009) was followed for tissue processing. After fixation, the tissues were dehydrated, infiltrated with liquid paraffin, embedded in paraffin blocks, and sectioned at a thickness of 5 microns. Each section was stained with hematoxylin and eosin (H&E) using standard staining procedures. The slides were examined under a light microscope.

**2.6.3 Hormonal assay**

Blood sample was taken through the jugular vein from three (3) bucks per treatment into heparinized tubes then centrifuged at 3000 rpm for 15minutes. Serum was separated and stored at -4oC for analyses. Testosterone, FSH and LH concentration was determined by Enzyme Linked Immunoassay (ELISA) according to the method of (Adeyemi 2014).

**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.

**3. RESULTS**

**3.1 Hormonal profile of rabbit bucks fed diets supplemented with dried dates fruit meal**

Fig 1-3. Hormonal profile of rabbit bucks fed diets supplemented with dried dates fruit meal

The results one the hormonal profile of rabbit bucks fed diets supplemented with DDFM are presented in figures 1, 2, and 3 respectively. These results revealed significant variations in the reproductive hormones evaluated. The result on follicle stimulating hormone showed relative increase in bucks fed T2, and T3 with similar values of 0.50 and 0.50 respectively. These values were however not significantly different (p<0.05) from T1. The FSH value in T1 (0.40) differed from T4 (0.20). The mean values of luteinizing hormone increased significantly (p<0.0) with DDFM supplementation in the bucks’ diets. The mean values observed in the study in bucks with DDFM in their diets were 4.20, 4.20, and 4.40 for bucks in treatments 2, 3, and 4 respectively, bucks in T1 had mean LH value of 3.60. Lower (p<0.05) testosterone was observed in T3 (16.50) and T4 16.60, which differed from T2 (18.00). Treatment 1 had mean testosterone value of 17.80

**3.2 Semen characteristics of Rabbit bucks fed diets supplemented with dried dates fruit meal**

The results on Table 2 showed that dried dates fruit significantly influenced all semen parameters evaluated except, sperm motility. Semen volume significantly increased (p<0.05) with DDFM supplementation in the bucks’ diets. The mean values in bucks fed 0.50 and 1.00% DDFM 0.73 ml and 0.87 ml. The highest (0.90 ml) semen volume was observed in bucks fed diet containing 1.50% DDFM, while the control group without DDFM in their diet recorded the least mean semen volume of 0.50 ml. There was no significant variation (p>0.05) in the semen colour in the study, as the semen colour was milky in all treatment groups. Sperm motility was also not affected (p>0.05) by DDFM supplementation in the bucks’ diets. The values observed were 75.67, 84.33, 83.67 and 84.00% for T1, T2, T3, and T4 respectively.

**Table 2: Semen characteristics of Rabbit bucks fed diets supplemented with dried dates fruit meal**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Parameters | T1  (0.00% DDFM) | T2  (0.50% DDFM) | T3  (1.00% DDFM) | T4  (1.50% DDFM) | SEM |
| Volume (ml) | 0.50c | 0.73b | 0.87ab | 0.90a | 0.07 |
| Colour | Milky | Milky | Milky | Milky |  |
| Motility (%) | 75.67 | 84.33 | 83.67 | 84.0 | 2.15 |
| Concentration  (x 106/ml) | 77.00b | 88.67ab | 92.00a | 92.33a | 2.50 |
| Normal cells (%) | 79.00b | 92.33a | 92.00a | 92.33a | 2.34 |
| Abnormal cells (%) | 21.00a | 7.67b | 8.00b | 6.67b | 2.34 |
| Live cells (%) | 78.33b | 85.33ab | 89.33a | 91.00a | 1.90 |
| Dead cells (%) | 21.67a | 14.67ab | 10.67b | 9.00b | 1.90 |
| Total cells/ejaculate) (X 106/ml) | 38.07b | 63.87ab | 79.60a | 83.43a | 6.78 |

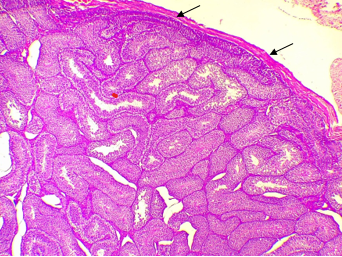
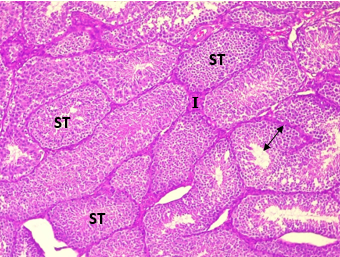
a b c – Means in the same row with different superscript are significantly different (P< 0.05); DDFM – Dried dates fruit meal; SEM – Standard error of mean.

The supplementation of DDFM significantly increased (p<0.05) the sperm concentration in the rabbit bucks. Rabbit bucks in T2, T3 and T4 had higher similar sperm concentration values of 86.67, 92.00, and 92.33 x 106/ml, respectively, than in those of bucks in T1 with mean value of 77.00 x 106/ml, which was statistically similar to T2. The percentages of normal sperm cells in the semen of the bucks were lower (p<0.05) in the control group (79.00%) without DDFM in their diet, when compared to those with 0.50, 1.00, and 1.50% DDFM in their diets, with mean percentages of 92.33, 92.00 and 92.33% respectively. The mean percentages of abnormal sperm cells took similar pattern.

There was significant variation (p<0.05) in the percentage of live sperm cells. Bucks in T1, and T2 recorded similar means of 78.33, and 85.33% respectively, which were lower than those in T3, and T4 respectively with mean values of 89.33 and 91.00%. Dead sperm cells percentage were significantly reduced (p<0.05) with DDFM supplementation in comparison with those of bucks without the test material. Total sperm cells per ejaculate differed significant (p<0.05) among treatment groups. The mean values were higher in bucks in T3 (79.60 x 106/ml), and T4 (83.43 x 106/ml), which were similar to those in T2 (63.87 x 106/ml), but differ from T1 (37.07 x 106/ml).

**4.3: Testicular histology of Rabbit bucks fed diets supplemented with dried dates fruit**

**meal**

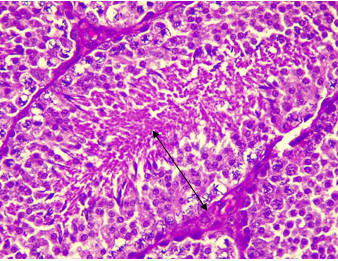


Plate-1 T1: Section of testicular tissue showing tunical albuginea (thin arrow), seminiferous tubules (ST) and the interstices (I). The seminiferous tubules were lined by germinal epithelium (double head arrow). No pathologic changes seen. H&E stain, x40, x100 and x400 magnification.

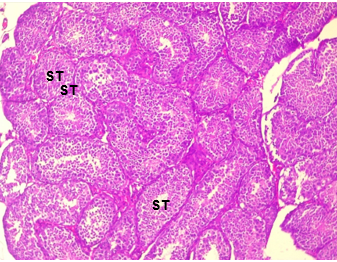
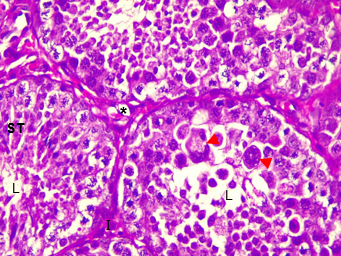
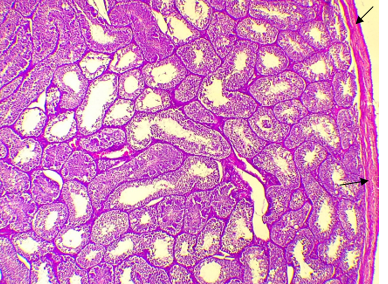
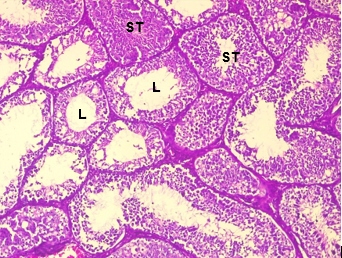
 

Plate 2 -T2: Section showed seminiferous tubules (**ST**) and the interstices(**I**). The seminiferous tubules showed lumen (**L**) partly &completely filled with both developing and mature germinal epithelial cells. Also seen were hypertrophic and multinucleated cells (red arrowhead) germinal cells. There was focal vacuolation (asterisk) in the interstices. Haematoxylin and Eosin (H&E) stain, x100& x400 magnification

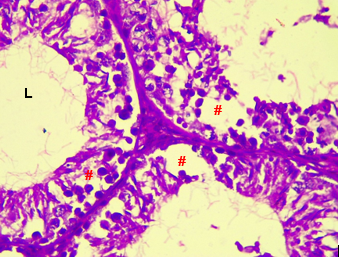
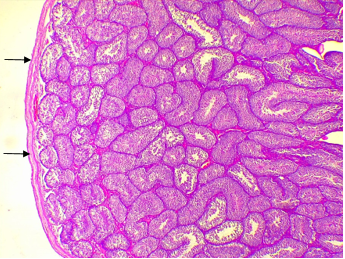
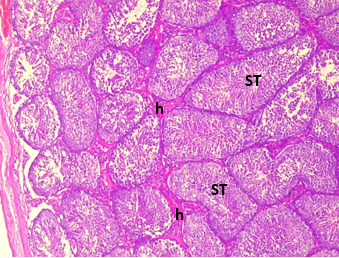


Plate -3 T3: Photomicrograph of testes showing tunica albuginea (**Thin arrow)** and seminiferous tubules with wide lumen (**L**), showing and degenerated germinal epithelium layer (**#**). Haematoxylin and Eosin (H&E) stain, x40, x100 and x400 magnification

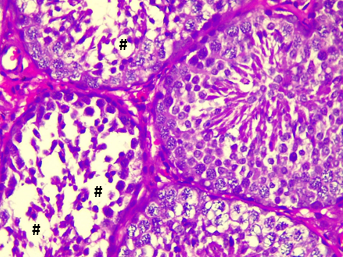


Plate -4 T4: Section of testicular tissue showing tunical albuginea (**thin arrow**), seminiferous tubules (**ST**) and the interstices (**I**). There are sporadic germinal epithelial degeneration (**#**) in the germinal epithelium of some seminiferous tubule. There were edema in the interstices (**h**). H&E stain, x40, x100 & x400 magnification.

**4. DISCUSSION**

**4.1 Hormonal profile of rabbit bucks fed diets supplemented with dried dates fruit meal**

Supplementing rabbit bucks’ diets with dried dates fruit meal significantly increased the luteinizing hormone (LH), follicle stimulating hormone (FSH) and testosterone at 0.50% DDFM supplementation in the study. This result is similar to the report of Zargar *et al.* in Khalifa *et al.* (2018) who found that date extract increased the level of follicle stimulating hormone, luteinizing hormone and testosterone in rats.Khalifa*et al.* (2018) also observed increase in testosterone level in the blood using date palm extract than those of rats in the control. This observation is similar to the report of Kostyuk *et al.* in Khalifa *et al.* (2018), who found an increase in plasma levels of testosterone on eating date palm. Orabi and Shawky (2014) also recorded significant increase in blood testosterone in rats when compared with the control. Pecora *et al.* (2023) noted that LH acts on the Leydig cells, while FSH acts on the Sertoli cells. Saryono, *et al.* (2016) explained that Leydig cells are the primary source of testosterone and androgens which have a crucial role in fertility, including sperm production and spermatogenesis, controlling sexual development, and maintaining secondary sexual characteristics and behaviors. Previous studies (Adaay and Mattar, 2012; Saryono, *et al.* 2016, Zare *et al.* 2019 and Ubah *et al.* 2021) in male rats have demonstrated the ability of date fruit to improve the process of spermatogenesis, the concentration of testosterone, FSH and LH and sperm concentration.

**4.2 Semen characteristics of Rabbit bucks fed diets supplemented with dried dates**

Gross appearance of ejaculated semen is used to evaluate semen quality (Bearden *et al.* 2004). The significant increase observed with the supplemental levels of DDFM in the rabbit bucks’ diets is in variance with the findings of Khalifa *et al.* (2018), who reported non-significant difference in semen volume in male New Zealand white rabbits administered dates water extract at 10 and 20 ml respectively. The semen volume observed were higher than those reported by Solomon *et al.* (2024) for mongrel rabbit bucks fed diets containing garlic meal. This shows the ability of DDFM to increase ejaculate volume. Earlier report (Campos *et al.* 2014), put the normal range of semen volume between 0.3-0.6 ml, which are below the values observed in the study. The supplemental levels of DDFM however, did not have significant effect on semen colour, which were similar to the reports of Solomon *et al.* (2024) and Solomon *et al.* (2022). Good quality semen should, according to (George *et al.,* 2017), have a uniformly milky appearance which gives the indication of high sperm concentration. Hafez and Bearden *et al.*  in Ezike (2010) noted that samples with low sperm concentration will appear watery or less opaque.

Semen motility, though did not vary significantly, marginally increased in the DDFM group when compared with the control group, demonstrating the potential of dates to increase semen motility. Sperm cells need energy to swim through the female reproductive tract to the site of fertilization, therefore, the sugars present in dates may have the potential to increase the sperm energy to increase motility. This claim was supported by Shehzad *et al.* (2021), who stated that the glucose present in dates provides energy, corroborating with the statement of Saryono *et al*. (2016) who started that date fruit contains 50 - 57% glucose. The report of Ubah *et al.* (2021) on sperm motility in rats administered dates extract also supported the findings in this study. Khalifa *et al.* (2018), who also observed significant improvement in sperm motility in their study stated that sperm motility depends on the synchronized actions of proteins, sugars, ions and small organic molecules, which they said is one of the main factors that facilitate the journey of sperm toward the egg and the subsequent fertilization process. The sperm concentration of rabbit bucks administered supplemental levels of DDFM showed superiority at 1.00 and 1.50% DDFM over the control group, which was however, similar to those of bucks administered 0.50% DDFM in their diet. Sperm concentration is a crucial parameter in semen quality assessment because, high concentration will increase the number of sperm cells that can fertilize an ovum. This is important because Durape (2007) suggested that though it takes one single sperm to fertilize an ovum, adequate number of spermatozoa must be available at the site of fertilization to ensure high fertility.

The supplementation of DDFM in the diets of the bucks significantly influenced sperm morphology by increasing the percentage of morphologically normal sperm cells and reducing the percentage of normal cells. This result supports the report of Khalifa *et al.* (2018) who attributed the better result on sperm morphology in their study to the antioxidant properties of date extract which they said can prevent the superﬂuous generation of free radicals produced by sperm cells, claiming that their ﬁndings supported the obtained results concerning improvement in sperm motility in association with marked reduction in sperm abnormality without pronounced effect on sperm livability. According to Saryono and Rahmamati (2016), date fruit extracts contain a variety of components that work as potent antioxidants such as flavonoids, phenolic, vitamin C, E, and A which can protect the sperm cell membranes against lipid peroxidation, thus decreasing the percentage of dead sperm and maintaining normal sperm morphology. Date fruit works as an antioxidant to stop the chain reaction due to oxidative stress (Saryono and Rahmamati, 2016).

Live sperm cells percentage increased with DDFM supplementation in the rabbit bucks’ diets with a corresponding decrease in dead sperm cells at 1.00 and 1.50% DDFM supplementation. The results which are synonymous to the report of Ubah *et al.* (2021), demonstrates the potential benefit of dates on these parameters. This means that DDFM can improve fertility by increasing sperm concentration, percentage of viable (live) sperm cells and reducing the percentage of morphologically defected cells. Live sperm percentages recorded in this study ranged from 71.33 to 85.67% and were similar to those reported by Adeyemi (2014) and Shinkut (2015) for rabbit bucks. This is further supported by the higher significant increase in total sperm cells per ejaculate in the study at 1.00 and 1.50% DDFM supplementation respective. A publication by Premium Times (2016) explained that dates contained high levels of estradiol and flavonoid which aid sperm motility and increase sperm count, help to improve sexual activities and increase the production of sex hormones. Khalifa *et al.* (2018) concluded that aqueous extract of date palm could enhance the rabbit buck’s fertility and its health performance. Ezike (2010) reported that the volume of ejaculated semen is determined not only for use in processing but also to establish a pattern for individual male. Ejaculates with larger volume, higher concentration, and higher motility will have higher fertility in most cases and more breeding units can be prepared from an ejaculate, thus, reducing the processing time and cost per breeding unit (Ezike (2010)

**4.3 Testicular histology**

The results on histology showed no pathological changes in the control group. Bucks fed 0.50% DDFM (T2) showed lumen partly and completely filled with both developing and mature germinal epithelial cells. Photomicrograph of testes in T3 showed tunica albugineaand seminiferous tubules with wide lumen and degenerated germinal epithelium layer. Al Za’abi *et al.* (2022), observed that the histological structures of the seminiferous tubule in male mice fed dates were normal in all groups, with a complete spermatogenesis process, mature Sertoli cells, intact Leydig cells, and an appropriate percentage of mature spermatozoa. T4 showed sporadic germinal epithelial degeneration in the germinal epithelium of some seminiferous tubule. These findings suggest that higher dose of dates fruit may have slight degenerative effect on the germinal epithelium of some seminiferous tubule due to higher presence of phytochemicals that may have caused changes to the testicular tissues.

**5. CONCLUSION**

The inclusion of dried date palm fruit meal at 1.00% in rabbit diets can significantly improve key semen characteristics, including sperm concentration, viability, and total sperm count, while reducing sperm abnormalities. Hormonal profiles indicated that DDFM enhanced FSH and LH levels, which are essential for reproductive function. However, histological analysis revealed mild degenerative changes in the testes at higher supplementation levels, suggesting a potential threshold for optimal use.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

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

**COMPETING INTEREST**

Authors have declared that there is no competing interest among the authors.

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