Assessment of the potential effect of detarium senegalense aqueous leaf extract on sperm parameters in diabetic male wistar rat

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ABSTRACT

The aim of this study is to determine the potential of the *Detarium Senegalense aqueous* leaf extract in improving sperm quality of Streptozotocin (STZ) induced diabetic male rat. Following one week acclimatization period, a total of 30 male rats were randomly shared into six groups as follows; Group A: Treatment control received 40 mg/kg body weight STZ and 100 mg/kg b.w metformin. Group B: Received 40 mg/kg b.w STZ and 200 mg/kg b.w Aqueous Extract *Detarium Senegalense*. Group C: Received 40 mg/kg b.w STZ and 400 mg/kg b.w AEDS. Group D: Received 40 mg/kg b.w STZ and 600 mg/kg b.w AEDS. Group E: Positive control (diabetic control) received 40 mg/kg b.w STZ, distilled water and animal feed every day. Group F: Negative control (normal control) received distilled water and animal feed only. The results obtained from the study indicated that treatment with *Detarium Senegalense* aqueous leaf extract was observed to improve the percentage of active motility and decreased the percentage of sluggish motility, and also showed a significant reduction in headless tail morphology, bent mid-piece and coiled mid piece morphology in the experimental groups B, C and D. Also, the treatment with the extract reduced the sperm count in Group B, C and D. These findings suggest that *Detarium Senegalense* aqueous leaf extract may be beneficial in improving sperm quality and male infertility in diabetic males.

Keywords : Detarium Senegalense; Diabetes; Sperm; Infertility; Streptozotocin; Wistar Rat.

1. INTRUDUCTION

Diabetes is a long-term metabolic disorder defined by hyperglycemia and a number of comorbidities brought on by deficiencies in insulin action and/or secretion (Balaji et al., 2019). There are three main forms of diabetes mellitus: type 1 diabetes mellitus (T1DM), type 2 diabetes mellitus (T2DM), and gestational diabetes mellitus (GDM) (Goyal and Jialal, 2018). Due to the pancreatic cells being destroyed by a cellular mediated autoimmune process, T1DM results in a total lack of insulin. In T2DM, Insulin resistance and a relative insulin deficiency are both present. Also, GDM refers to any level of glucose intolerance that is identified during pregnancy (Goyal and Jialal, 2018). DM affects more than 463 million people worldwide, and by 2045, that number is expected to rise to 700 million, according to the most recent data (Ahmed et al., 2022).

The development of diabetes mellitus has been linked to free radical production. Excessive amounts of free radical formation combined with low levels of endogenous antioxidants cause damage to cellular organelles, excessive lipid peroxidation, and loss of pancreatic beta-cells, oxidative stress, and the onset of diabetes (Darenskaya et al., 2021). A number of pathological disorders, such as diabetic nephropathy, retinopathy, and neuropathy, eventually occur as the comorbidities of diabetes progress (Park et al., 2021).

An important complication of diabetes is the disturbance in the male reproductive system. Glucose metabolism is an important event in spermatogenesis (Agbaje et al., 2019).

The impact of diabetes on male fertility is an area of growing interest, with research suggesting that diabetes can have a negative effect on male reproductive health. Male infertility is multifactorial. A total of 60% of all male infertility cases are caused by sperm dysfunction (Wright et al., 2019). Poor sperm quality and reduced sperm count are the major factors in male infertility. Sperm quality can be assessed by three primary endpoints, that is, sperm concentration, morphology, and motility (Buhling et al., 2019). Male infertility may be caused by urogenital infections, chromosomal abnormalities, urogenital carcinoma, alteration in genital hormones, and unhealthy lifestyle (Daumler et al., 2016). In 30–80% of cases, sperm damage is postulated to have resulted from oxidative stress caused by reactive oxidative species (ROS). This oxidative stress damages the DNA of sperms which ultimately decreases sperm motility, damages the membrane of the acrosome, and decreases the ability of the sperm to fertilize the oocyte (Barati et al., 2020).

Currently, diabetes is treated by a synthetic drug such as metformin to prevent diabetes complications, but the treatment does not significantly improve sperm quality parameters and somehow it reduces sperm quality parameters (Bertoldo et al., 2019). Growing attention has been seen in medicinal plants recently, which are thought to be possible sources of more economical, secure, and effective antidiabetic medications (Salleh et al., 2021). This concept originated from traditional medicine's past usage of medicinal plants to treat diabetes (Yatoo et al., 2017). According to reports, a number of plants are used in folk medicine to treat diabetes and have been sufficiently scientifically validated in both in vitro and in vivo diabetic models (Ullah et al., 2018). One of such plant is Detarium Senegalense.

The plant Detarium Senegalense is a member of the subfamily Detarioideae of the Leguminoseae family (Nwachukwu et al., 2022). It is a kind of tree that is indigenous to tropical Africa and grows up to around 36 meters in height with a buttressed bole. Its common names include tallow tree, detar, and in Eastern Nigeria (Igbo tribe), it is called Ofo, Taura' in Hausa and it is called 'Ogbogbo' in Yoruba (Dossa et al., 2020). The tree is valuable for a number of reasons, including its nutritious fruit, local prominence in traditional medicine, and its ability to produce high-quality wood (Nwachukwu et al., 2022). The plant has been found to have various pharmacological activities, including antioxidant, anti-inflammatory, and hypoglycemic effects (Sanni et al., 2018). The leaves are consumed as a vegetable in soups and are also used locally as an eye wash for conjunctivitis and as an enema for diarrhea. The study will explore the effect of the plant extract on sperm quality in diabetic rats.

Fig 1: Leaf and seedpod of *Detarium Senegalense*

The findings of this study could provide a new therapeutic approach for maintaining male reproductive health. Furthermore, the study will contribute to the existing literature on the pharmacological properties of Detarium Senegalense and its potential as an alternative treatment for sperm dysfunction.

This study aims to investigate the impact of Detarium Senegalense, an African medicinal plant, on sperm parameters in male diabetic rats and to assess whether the plant extract has the potential to improve sperm quality in diabetic rats, which may have implications for male fertility.

2. MATERIALS AND METHODS

2.1. COLLECTION OF PLANT MATERIAL

Mature fresh leaves of *Detarium Senegalense* were obtained from a remote farmland in the rural area of Uli in Ihiala LGA, Anambra State, Nigeria. Leaves were authenticated through the kind assistance of a botanist at University of Nigeria Nsukka, Enugu State Nigeria.

2.2 PREPARATION OF PLANT AND AQUEOUS EXTRACTION PROCEDURE

The plant leaves were washed and air-dried at room temperature. The air-dried leaves were ground to powder. Exactly 80 g of the sample was soaked in 1000mL of distilled water for 48 hours. It was then filtered using a Whatmann filter paper (No.1). The filtrate was allowed to dry overnight on a water bath set at a temperature of 50 ˚C to obtain the aqueous crude extract and the extract was stored in the fridge at 4 ˚C until needed.

2.3 CHEMICALS

Trichloroacetic acid (TCA), Thiobarbituric acid (TBA), DPPH (2,2-diphenyl-1-picrylhydrazyl) radical, Tannic acid, Quercetin, Ascorbic acid, Mannitol, Folin-Ciocalteau, Metformin, D-glucose, sodium citrate, citric acid and streptozotocin were purchased from Sigma-Aldrich (St-Louis, MO, USA). All other needed chemicals and reagents were of analytical grade.

2.4 ACCLIMATIZATION OF THE EXPERIMENTAL ANIMALS

Thirty (30) male *Wistar* albino rats of 120–160 g were obtained from the ABUAD animal care facility and maintained under standard conditions. All animals were given free access to standard laboratory food and water for a week (7 days) before and during the period of experiment. All animals were fed with pelletized diet and water and libitum.

2.5 INDUCTION OF TYPE 2 DIABETES MELLITUS

Type 2 diabetes mellitus was induced in the experimental rats through intraperitoneal injection of 40 mg/kg body weight streptozotocin (STZ) dissolved in ice-cold 0.1 M citrate buffer (pH 4.5), after administration of 10% D-glucose in their drinking water for 7 days. Blood samples were taken by tail vein puncture and glucose levels were monitored using test fine glucometer, type 2 diabetes mellitus was confirmed after 72 hours and animals with blood glucose level ≥ 250 mg/dL were considered diabetic and were used for the study.

2.6 EXPERIMENTAL DESIGN

The rats were randomly shared into six (6) groups containing five rats each and were treated as follows:

Group A: Treatment control received 40 mg/kg b.w STZ and 100 mg/kg b.w metformin

Group B: Received 40 mg/kg b.w STZ and 200 mg/kg b.w AEDS

Group C: Received 40 mg/kg b.w STZ and 400 mg/kg b.w AEDS

Group D: Received 40 mg/kg b.w STZ and 600 mg/kg b.w AEDS

Group E: Positive control (diabetic control) received 40 mg/kg b.w STZ, distilled water and animal feed.

Group F: Negative control (normal control) received distilled water and animal feed only.

The animals were maintained at room temperature of 22±20ºC with 12 hours light/dark cycle. Animals used in this present study were maintained under the principles and guidelines of the Nigeria Council on Animal Care as outlined in Guide for the care and use of Laboratory Animals'. (AEDS= Aqueous Extract of *Detarium Senegalense*, STZ= Streptozotocin).

All animals were monitored throughout the period for clinical observations. Twenty-four hours after the last treatment (Day 14), rats were immobilized by cervical dislocation, and blood was collected from the retro-orbital venous plexus. Plasma samples were separated from blood cells by centrifugation at 3000g for 10 min and stored at 8°C until the determination of hormone concentrations, hematological parameter, kidney function, and liver function tests.

2.7 SPERM QUALITY ANALYSIS

Sperm analysis was done include live-dead count, motility, sperm morphology and concentration. Sperm count was assessed using a haemocytometer based on WHO protocol. The sperm sample was pipetted on the middle grid of the haemocytometer, and counted at 10 boxes of that particular grid under light microscope with 100× magnification. Sperm count was recorded in millions. Then, the same haemocytometer was used in sperm motility determination. Sperm motility was presented in percentage values in accordance to the grade determined by WHO. Next, based on the motility of the sperm, sperm viability was assessed by using the following formula:

$$\frac{\text{Viable sperm (P and NP)}}{\text{200 sperm}} \times 100\% \qquad (i)$$

Lastly, for normal sperm morphology analysis, the sperm sample was pipetted on the glass slide, and smeared over the slide surface. The smeared slide was then dried and stained using Giemsa staining before being observed under a light microscope.

3 RESULT

3.1 THE EFFECT OF AQUEOUS EXTRACT OF *DETARIUM SENEGALENSE* ON PERCENTAGE ACTIVE MOTILITY (A.M %) IN THE EXPERIMENTAL RATS

The activities of the percentage active motility in the experimental groups are illustrated in fig 2 There was a significant difference in percentage active motility (A.M %) in the experimental rats. Groups B, C, D, E, had higher percentages of active motility compared to group F (the negative control group) having the highest percentage of active motility. The lowest percentage active motility (A.M %) was observed in group A which was treated with metformin (100 mg/kg body weight).

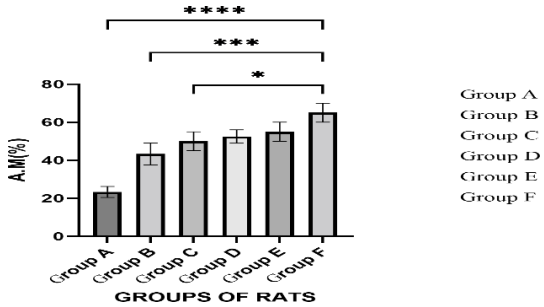

Figure 2: Effect of Aqueous extract of *Detarium Senegalense* on percentage active motility (A.M %) in the sperm of *Wistar* rats. Group A: (100 mg/kg b.w metformin), Group B: (200 mg/kg b.w AEDS), Group C: (400 mg/kg b.w AEDS), Group D: (600 mg/kg b.w AEDS), Group E: Positive control (diabetic control): (distilled water and animal feed), Group F: Negative control (normal control) received distilled water and animal feed only.

3.2 THE EFFECT OF AQUEOUS EXTRACT OF *DETARIUM SENEGALENSE* ON PERCENTAGE SLUGGISH MOTILITY (S.M %) IN THE EXPERIMENTAL RATS

The activities of percentage sluggish motility in the experimental groups are illustrated in fig 3. There was a significant difference in percentage sluggish motility (S.M %) in the experimental rats. Group A, B, C, and E showed similar high percentage sluggish motility, while Group D showed a slightly lower percentage. In contrast, the positive control (diabetic control) group E showed the highest percentage of sluggish motility among all the groups, with the lowest percentage sluggish motility observed in group F (Negative control).

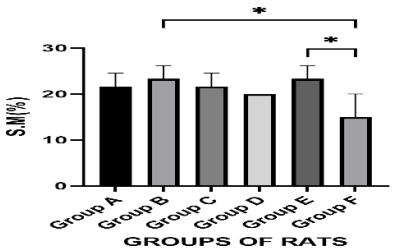

Figure 3: Effect of Aqueous extract of *Detarium Senegalense* on percentage sluggish motility (S.M %) in the sperm of *Wistar* rats. Group A: (100 mg/kg b.w metformin), Group B: (200 mg/kg b.w AEDS), Group C: (400 mg/kg b.w AEDS), Group D: (600 mg/kg b.w AEDS), Group E: Positive control (diabetic control): (distilled water and animal feed), Group F: Negative control (normal control) received distilled water and animal feed only.

3.3 THE EFFECT OF AQUEOUS EXTRACT OF *DETARIUM SENEGALENSE* ON PERCENTAGE NON-MOTILE (N.M %) IN THE EXPERIMENTAL RATS

The activities of the percentage non-motile in the experimental groups are illustrated in fig 4. There was a significant difference in percentage non-motile (N.M %) in the experimental rats. AEDS-treated groups (B, C and D) had a decreased level in percentages of non-motile sperm compared to the negative control group (Group F) which also had a decreased level in percentages of non-motile sperm. However, there is a significant difference in group A which has the highest percentage of non-motile sperm compared to the negative control group (Group F).

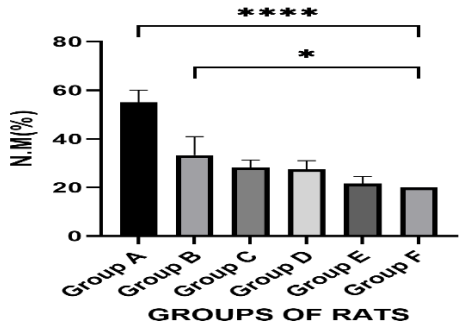

Figure 4: Effect of Aqueous extract of *Detarium Senegalense* percentage non-motile (N.M %) in the sperm of *Wistar* rats. Group A: (100 mg/kg b.w metformin), Group B: (200 mg/kg b.w AEDS), Group C: (400 mg/kg b.w AEDS), Group D: (600 mg/kg b.w AEDS), Group E: Positive control (diabetic control): (distilled water and animal feed), Group F: Negative control (normal control) received distilled water and animal feed only.

3.4 THE EFFECT OF AQUEOUS EXTRACT OF *DETARIUM SENEGALENSE* ON ROUND HEAD R.H (N) IN THE EXPERIMENTAL RATS

The activities of the Round Head in the experimental groups are illustrated in fig 5. There was a significant difference in sperm cells with round-shaped heads R.H (n) in the experimental rats. Groups A, B, C, showed similar increase in prevalence of sperm cells with round-shaped heads R.H (n) compared to group F (the negative control group) which had a slight decrease. Group E showed the lowest prevalence of sperm cells with round-shaped heads R.H (n) compared to AEDS-treated groups (group B, C, and D).

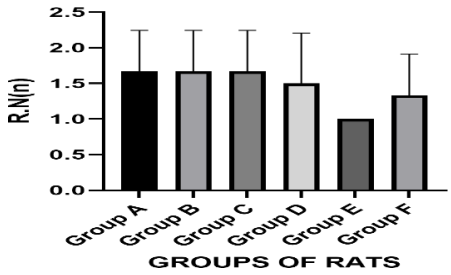

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Figure 5: Effect of Aqueous extract of *Detarium Senegalense* on Round Head R.H (n) in the sperm of *Wistar* rats. Group A: (100 mg/kg b.w metformin), Group B: (200 mg/kg b.w AEDS), Group C: (400 mg/kg b.w AEDS), Group D: (600 mg/kg b.w AEDS), Group E: Positive control (diabetic control): (distilled water and animal feed), Group F: Negative control (normal control) received distilled water and animal feed only.

3.5 THE EFFECT OF AQUEOUS EXTRACT OF *DETARIUM SENEGALENSE* ON PIN HEAD - P.H (N) IN THE EXPERIMENTAL RATS

The activities of the Pin Head in the experimental groups are illustrated in fig 6. There was a significant difference in Pin Head - P.H (n) in the experimental rats. Group A, C, and E (Positive control) showed similar increase in proportion of sperm cells with pin head abnormality. In contrast, Group B and the Negative control (Group F) showed a slightly lower proportion, with the lowest proportion of sperm cells with pin head abnormality observed in group D

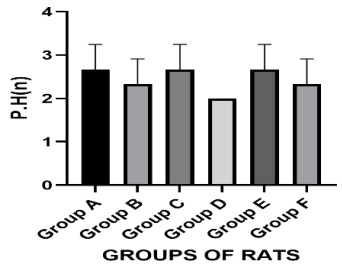

Figure 6: Effect of Aqueous extract of *Detarium Senegalense* on Pin-head P.H (n) in the sperm of *Wistar* rats. Group A: (100 mg/kg b.w metformin), Group B: (200 mg/kg b.w AEDS), Group C: (400 mg/kg b.w AEDS), Group D: (600 mg/kg b.w AEDS), Group E: Positive control (diabetic control): (distilled water and animal feed), Group F: Negative control (normal control) received distilled water and animal feed only

3.6 THE EFFECT OF AQUEOUS EXTRACT OF *DETARIUM SENEGALENSE* ON HEADLESS TAIL -H.T (N) IN THE EXPERIMENTAL RATS

The activities of the HT in the experimental groups are illustrated in fig 7. There was a significant difference in Headless Tail H.T (n) in the experimental rats. AEDS-treated groups (B, C, D) have lower percentages of headless tail morphology compared to Group E which has a slight increase in the percentage. However, there is a significant difference in group A which has the highest percentage compared to the negative control group (Group F) which has the lowest percentages of headless tail morphology.

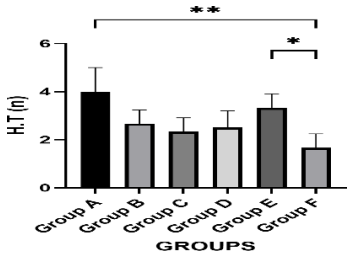

Figure 7: Effect of Aqueous extract of *Detarium Senegalense* on Headless Tail H.T (n) **s**in the sperm of *Wistar* rats. Group A: (100 mg/kg b.w metformin), Group B: (200 mg/kg b.w AEDS), Group C: (400 mg/kg b.w AEDS), Group D: (600 mg/kg b.w AEDS), Group E: Positive control (diabetic control): (distilled water and animal feed), Group F: Negative control (normal control) received distilled water and animal feed only

3.7 THE EFFECT OF AQUEOUS EXTRACT OF *DETARIUM SENEGALENSE* ON BENT MID-PIECE BMP (N) IN THE EXPERIMENTAL RATS

The activities of the BMP (n) in the experimental groups are illustrated in fig 8. There was a significant difference in bent mid piece morphology BMP (n) in the experimental rats. Groups (A, B, C, and E) showed similar percentage of bent mid piece morphology. However, Group D has the lowest percentage compared to the negative control group (Group F) which has the highest percentage of bent mid piece morphology.

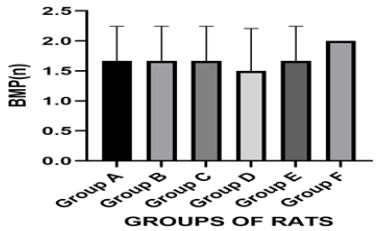

Figure 8: Effect of Aqueous extract of *Detarium Senegalense* on bent mid piece BMP (n) in the sperm of *Wistar* rats. Group A: (100 mg/kg b.w metformin), Group B: (200 mg/kg b.w AEDS), Group C: (400 mg/kg b.w AEDS), Group D: (600 mg/kg b.w AEDS), Group E: Positive control (diabetic control): (distilled water and animal feed), Group F: Negative control (normal control) received distilled water and animal feed only

3.8 THE EFFECT OF AQUEOUS EXTRACT OF *DETARIUM SENEGALENSE* ON COILED MID PIECE - C.M.P (N) IN THE EXPERIMENTAL RATS

The activities of the C.M.P (n) in the experimental groups are illustrated in fig 9. There was a significant difference in coiled mid piece - C.M.P (n) in the experimental rats. In the AEDS-treated groups C and D compared to Group F, both have similar percentage of coiled mid piece morphology. Also, Group E has a slight decrease in the percentage compared to group F. However, there is a significant difference in group A which has the highest percentage compared to Group B which has the lowest percentages of coiled mid- piece morphology.

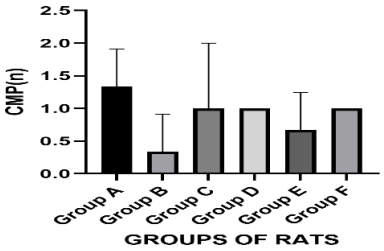

Figure 9: Effect of Aqueous extract of *Detarium Senegalense* on coiled mid piece BMP (n) in the sperm of *Wistar* rats. Group A: (100 mg/kg b.w metformin), Group B: (200 mg/kg b.w AEDS), Group C: (400 mg/kg b.w AEDS), Group D: (600 mg/kg b.w AEDS), Group E: Positive control (diabetic control): (distilled water and animal feed), Group F: Negative control (normal control) received distilled water and animal feed only.

3.9 THE EFFECT OF AQUEOUS EXTRACT OF *DETARIUM SENEGALENSE* ON LOOPED TAIL -L.T (N) IN THE EXPERIMENTAL RATS

There was a significant difference in looped tail L.T (n) in the experimental rats. Groups A and C shows increase in prevalence of the looped tail defect compared to Group B and E which has the decrease in the prevalence of the looped tail defect. Also, Group D and F has no cells with the looped tail defect.

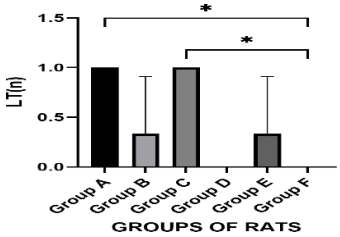

Figure 10: Effect of Aqueous extract of *Detarium Senegalense* on bent looped tail L.T (n) in the sperm of *Wistar* rats. Group A: (100 mg/kg b.w metformin), Group B: (200 mg/kg b.w AEDS), Group C: (400 mg/kg b.w AEDS), Group D: (600 mg/kg b.w AEDS), Group E: Positive control (diabetic control): (distilled water and animal feed), Group F: Negative control (normal control) received distilled water and animal feed only.

3.10 THE EFFECT OF AQUEOUS EXTRACT OF *DETARIUM SENEGALENSE* ON COILED TAIL -C.T (N) IN THE EXPERIMENTAL RATS

The activities of the C.T (n) in the experimental groups are illustrated in fig 10. There was a significant difference in coiled tail - C.T (n) in the experimental rats. Groups (A, B, C, and F) are all on the same level showing that they have similar increase in the frequency of coiled tail morphology. However, Group D treated with 600mg/dl of AEDS has the lowest percentage of coiled tail Morphology compared to the negative control group (Group F).

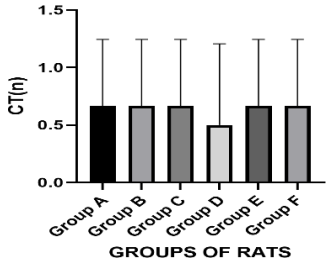

Figure 11: Effect of Aqueous extract of *Detarium Senegalense* on coiled tail C.T (n) in the sperm of *Wistar* rats. Group A: (100 mg/kg b.w metformin), Group B: (200 mg/kg b.w AEDS), Group C: (400 mg/kg b.w AEDS), Group D: (600 mg/kg b.w AEDS), Group E: Positive control (diabetic control): (distilled water and animal feed), Group F: Negative control (normal control) received distilled water and animal feed only.

3.11 THE EFFECT OF AQUEOUS EXTRACT OF *DETARIUM SENEGALENSE* ON COUNT X10^6 IN THE EXPERIMENTAL RATS

There was a significant difference in sperm count x10^6 in the experimental rats. The negative control group (Group F) had a higher sperm count value compared to the AEDS-treated groups (Group B, C, D), with the lowest sperm count value observed in the group treated with metformin (Group A).

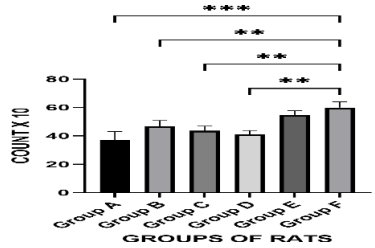

Figure 12: Effect of Aqueous extract of *Detarium Senegalense* on sperm count x10^6 in the sperm of *Wistar* rats. Group A: (100 mg/kg b.w metformin), Group B: (200 mg/kg b.w AEDS), Group C: (400 mg/kg b.w AEDS), Group D: (600 mg/kg b.w AEDS), Group E: Positive control (diabetic control): (distilled water and animal feed), Group F: Negative control (normal control) received distilled water and animal feed only.

4. DISCUSSION AND CONCLUSION

4.1 DISCUSSION

The study aimed to assess the potential effect of *Detarium Senegalense* aqueous leaf extract on sperm parameters in diabetic male Wistar rats. The study divided the rats into six groups, with Group A treated with 100 mg/kg b.w of metformin, Group B treated with 200 mg/kg b.w of aqueous leaf extract of *Detarium Senegalense*, Group C treated with 400 mg/kg b.w of the same extract, Group D treated with 600 mg/kg b.w of the same extract, Group E acting as the positive control (diabetic control), and Group F serving as the negative control group.

- **Percentage active motility:** This refers to the percentage of sperm cells in a sample that are actively moving forward. This parameter is important in assessing male fertility since it indicates the ability of sperm to swim and reach the egg for fertilization. Higher values of percentage active motility indicate better sperm quality. The results obtained from the study as shown in fig 3, indicated that treatment with *Detarium Senegalense* aqueous leaf extract resulted in Groups B, C, and D showing increased percentages of active motility than

the negative control group (Group F). This indicates improvement in sperm motility and a better sperm quality.

- **Percentage sluggish motility:** This refers to the percentage of sperm cells in a sample that are moving, but not in a forward direction or are moving slowly. Sluggish motility can be indicative of impaired sperm function and can reduce the chances of fertilization. Therefore, lower values of percentage sluggish motility are desirable. The results obtained from the study as shown in fig 4, indicated that Group F (normal control) had lower percentage of sperm cells with sluggish and the treatment with *Detarium Senegalense* aqueous leaf extract resulted in Groups B, C, and D showing lower percentages of sluggish motility than the diabetic control group (Group E). This indicates that the treatment reduced the number of sperm cells with sluggish motility and it also indicates better sperm quality.

- **Percentage non-motile:** This refers to the percentage of sperm cells in a sample that are not moving at all. This parameter is also important in assessing male fertility since it indicates the number of sperm that are incapable of fertilizing an egg. Higher values of percentage non-motile indicate lower sperm quality and can reduce the chances of conception. Therefore, lower values of percentage non-motile are desirable. The results obtained from the study in fig 5, indicated that Group F (normal control) showed lower percentage of non-motility and treatment with *Detarium Senegalense* aqueous leaf extract reduced the percentages of non-motile sperm in Groups B, C, and D which indicate better sperm quality.

- **Round head:** This refers to the shape of the head of the sperm. Normally, the head of the sperm is oval or elongated in shape, but in some cases, the head may be perfectly round. Abnormally round-shaped heads can result in poor sperm motility and fertilization rates. The results obtained from the study as shown in fig 6, indicated that the treatment with *Detarium Senegalense* aqueous leaf extract showed significant differences by increasing the number of sperm with rounded shaped head in the treated groups compared to the negative control group.

- **Pin head:** Pinhead sperm have a very small or tapered head, which can make it difficult for them to penetrate and fertilize the egg. Pinhead sperm are considered abnormal and can be associated with male infertility. The results obtained from the study in fig 7, indicated that Group F (normal control) showed increase in the percentage of sperm cells with pin head abnormality and treatment with *Detarium Senegalense* aqueous leaf extract reduced the percentages of sperm cells with pin head abnormality in Groups B and D which indicate better sperm quality.

- **Headless tail:** This refers to a sperm with a tail but without a head. Headless tails are considered abnormal and can be associated with poor motility and infertility. The results obtained from the study in fig 8, indicated that Group F (normal control) showed decrease in the percentage of sperm cells with headless tail morphology and treatment with *Detarium Senegalense* aqueous leaf extract reduced the percentages of sperm cells with headless tail morphology in Groups B, C and D which indicate better sperm quality.

- **Bent mid piece:** The mid-piece of the sperm is the part that connects the head to the tail. A bent mid-piece can result in abnormal sperm movement and reduced motility, which can affect fertilization. Bent mid-piece can be caused by genetic abnormalities or environmental factors such as exposure to toxins. The results obtained from the study in fig 9, indicated that Group F (normal control) showed increase in the percentage of sperm cells with Bent mid piece morphology and treatment with *Detarium Senegalense* aqueous leaf extract slightly reduced the percentages of sperm cells with Bent mid piece morphology in D while it increased the percentage of sperm cells with Bent mid piece morphology in Group B and C.

- **Coiled mid-piece:** The mid-piece of a sperm is the region between the head and the tail. Coiled mid-piece refers to a defect where the mid-piece of the sperm is twisted or coiled. This defect can also affect the sperm's ability to swim forward and may cause infertility. The results obtained from the study in fig 10, indicated that Group F (normal control) showed decrease in the percentage of sperm cells with Coiled mid-piece

morphology and treatment with *Detarium Senegalense* aqueous leaf extract reduced the percentages of sperm cells with Bent mid piece morphology in Groups B, C and D, with the lowest reduction seen in Group B. This indicates better sperm quality.

- **Looped tail:** This refers to a defect in the sperm tail where the tail is bent or twisted in a loop shape instead of being straight. This defect can affect the sperm's ability to swim forward and may cause infertility. The results obtained from the study in fig 11, indicated that Group F (normal control) showed no sperm cells with the looped tail defect and treatment with *Detarium Senegalense* aqueous leaf extract reduced the percentages of sperm cells with looped tail defect in Groups B (given 400mg/kg b.w AEDS) and D (given 600mg/kg b.w AEDS) and this indicates improved sperm quality.

- **Coiled tail:** This refers to a sperm tail that is abnormally coiled or twisted. Sperm with coiled tails can have reduced motility and difficulty swimming in a straight line, which can affect their ability to fertilize an egg. The results obtained from the study in fig 12, indicated that Group F (normal control) showed increase in the sperm cells with the coiled tail defect and treatment with *Detarium Senegalense* aqueous leaf extract reduced the percentages of sperm cells with coiled tail defect in Groups D (given 600mg/kg b.w AEDS) and this indicates improved sperm quality.

- **Count X10:** Sperm count is the concentration of spermatozoa in a given amount of semen. It is typically measured as the number of sperm in a milliliter of semen. Count X10 refers to the total number of spermatozoa in the entire ejaculate. The number is usually multiplied by 10 to estimate the total sperm count per milliliter of semen. Sperm count is an important parameter for assessing male fertility as low sperm count can reduce the chances of fertilization. The results obtained from the study in fig 13, indicated that Group F (normal control) showed higher sperm count and treatment with *Detarium Senegalense* aqueous leaf extract reduced the sperm count in Group B, C and D.

These findings suggest that *Detarium Senegalense* aqueous leaf extract may be beneficial in improving sperm quality and male infertility in diabetic males. Additionally, it is important to note that these results were obtained from a study using Wistar rats, and further studies are required to determine whether similar results can be obtained in human subjects. Overall, the study provides insight into a potential alternative treatment option for male infertility in diabetic patients, which is a significant issue that can arise due to the disease. The findings suggest that natural remedies, such as *Detarium Senegalense* aqueous leaf extract, may provide a cost-effective and safe treatment option for diabetic patients suffering from infertility.

4.2 CONCLUSION

Diabetes mellitus is a chronic metabolic disorder that affects various organs and systems in the body. One of the complications of diabetes is male infertility, which is characterized by poor semen quality and impaired sperm parameters. *Detarium Senegalense* is a plant commonly found in West Africa that has been used traditionally for the treatment of various diseases, including diabetes. *Detarium Senegalense* has potent antioxidant and anti-inflammatory properties, which may have a positive effect on sperm parameters in diabetic males. Based on the results obtained in this study, it can be concluded that *Detarium Senegalense* aqueous leaf extract has a potential positive effect on the sperm parameters of diabetic male Wistar rats. The extract was observed to improve the percentage of active motility, percentage of sluggish motility, and also showed a significant reduction in headless tail morphology in the experimental groups. However, the extract appeared to decrease the percentage of non-motile sperm cells and had a significant effect on coiled mid-piece morphology.

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