Original Article

Moringa Oleife Attenuates Testicular Damage Induced by High Fructose Diet in Albino Rats: Histological Study

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ABSTRACT

Introduction: High fructose diet is an important factor that causes insulin resistance and leads to damage of the testicles and infertility. Moringa oleifera leaves used for medicinal purposes can improve testicular damage induced by high fructose diet.

Aim of the Work: To examine the effects of a high-fructose diet (HFD) on testicular structures and to evaluate the potential role of Moringa oleifera leaf extract on serum level of insulin, glucose and testosterone with subsequent effect on histological structure of the testes of adult albino rats.

Materials and Methods: The animals were divided into group I (fed standard diet), group II (fed a 60 g/100 g of high-fructose diet) and group III (HFD group treated with Moringa 300 mg/kg per day). Paraffin sections were stained by H&E and PAS and examined by light microscope. In addition, ultra-thin sections and semi-thin sections stained with toluidine blue were examined by electron and light microscope. The results were statistically analyzed.

Results: In HFD, a significant decrease in the level of testosterone and an increase in the level of insulin and glucose in the blood were detected. Also, a significant decrease in the weight of testes and diameter of the seminiferous tubule was recorded. The histological structure showed vacuolations of epithelial lining the seminiferous tubules &exfoliation of germinal cells inside the lumen of tubule. Interstitial cells of Leydig had numerous autophagic vacuoles and electron dense bodies in their cytoplasm. There was a significant decrease in the PAS positive reaction in the tubules and interstitium. Administration of Moringa extract, significantly lowered elevated insulin level and glucose levels. Sertoli cells and germinal epithelium cells showed moderate recovery.

Conclusion: Moringa leaf extract can attenuate testicular toxicity induced by high fructose diet. Therefore, we recommend using Moringa leaves, especially for patients with insulin resistance resulting from excessive fructose use.

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Key Words: Fertility; high fructose diet; insulin resistance; moringa oleifera; sertoli cells.

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INTRODUCTION

Recently, commercial fructose has been widely used in the industry as a sweetener in food, beverage and medical products[1]. In contrast to natural fructose, enzymatic isomerization of starch yields commercial fructose (corn syrup), which is preferred in industry. However, high fructose consumption in our daily diet may cause the development of insulin resistance (IR), which leads to a variety of metabolic disorders[2-4]. IR occurs when our body cells fail to respond normally to insulin and can't absorb glucose for energy production. Pancreatic β -islets counteract insulin insensitivity by producing a large amount of insulin to manage blood glucose levels resulting in hyper-insulinemia. Furthermore, when the body develops insulin resistance, blood sugar levels rise, leading eventually to the development of type-2 diabetes (T2D)[5]. Insulin signaling is critical for lowering blood glucose levels, stimulating protein, fatty acid and glycogen production, promoting mitochondrial function and decreasing apoptosis[6]. As a result of defect in insulin signaling there is a high probability for developing IR and triggering a variety of metabolic abnormalities.

In humans, IR development is associated with a variety of health problems, including type 2 diabetes and infertility[7-8]. Although it is known that IR interferes with various biological functions, including defects within eukaryotic cells, the relationship between IR and male infertility is not fully understood. According to Mohamed *et al*.[9], a high fructose diet generating IR may be involved in enhancing oxidative damage to cellular components and promoting male infertility. Oxidative stress has a negative feedback mechanism on the hypothalamic-pituitary-gonadal (HPG) axis that causes an imbalance in the regulatory activity of gonadotropin- releasing hormones (GRH), which negatively affects both Leydig and Sertoli cells[10]. Oxidative stress activates inflammatory mechanism and cellular death in the levels of plasma testosterone, sperm count, Leydig and Sertoli cells that leads to infertility[11]. Therefore, IR is also associated with male sexual disfunction.

Moringa oleife (family Moringaceae), plant utilized as a medicinal herb for the treatment of some chronic diseases[10]. One possible alternative option for reducing IR and infertility is to use Moringa oleife. The leaves of

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Moringa contain a variety of bioactive compounds such as beta-carotene, vitamins (B, C and E), polyphenols, alkaloids, tannins, saponins, oxalates, phenolic acids, phytates and antioxidants that help in the prevention of oxidative damage to body tissues and DNA[11-12]. M. oleifera has been used to improve male sexual functions such as libido, sexual desire, erectile dysfunction and sperm quality[13-15], as well as, improve testicular regulatory proteins. The present study aimed to investigate the effects of daily intake of Moringa oleifera on the structure of the testes in HFD rats.

MATERIALS AND METHODS

Plant extraction

Moringa oleife was generously provided by the Agriculture Research Center (ARC) in Giza, Egypt. The aqueous extract of M. oleifera was prepared as previously described[16]. Mixing 100 g dried leaves with 1L boiling water for 5 minutes[17]. The mixture was then filtered and kept at 4 ºC for a week.

Diet content

The standard and high fructose (60 g/100g) diets were prepared as previously described in Rajasekar and Anuradha[18].

Experimental animals

Adult males of Sprague Dawley rats weighing 140–270 g were bought from the Egyptian Organization for Biological Products and Vaccines' breeding unit in Helwan, Egypt. After a week of acclimatization, rats were housed in metallic cages (4 rats per cage) under continuous environmental conditions of light (12 h light/dark), temperature (25C°) and humidity (50%). Water was provided ad libitum. All animals received care approved by the local committee at the Faculty of Science, Al-Azhar University, Egypt.

Study groups

The experimental animals (male Albino rats) were divided into 3 groups (8 rats each) as follows:

Group I (Control group): healthy animals fed standard diet.

Group II (HFD group): Rats fed on high fructose diet (HFD).

Group III (HFD + Mo group): The aqueous extract of Moringa oleife (at a dose level of 300 mg/kg)[19] was administered orally to rats fed a high-fructose diet. The experimental duration was for 4 weeks.

Body weight and Blood collection

Initial and final body weights of each rat in all three groups were recorded. Fasting blood glucose levels were measured using ELITE glucometer device, and blood was taken from the rats' retro-orbital venous plexus. Insulin concentration in serum samples was measured using rat-specific ELISA kit (Glory science Co., LtD, USA). Testosterone levels were determined using rat-specific ELISA kits (MyBioSource, Inc.). The measurements were taken at Al-Azhar University's Oncology Research Unit.

Histological and histochemical studies

The testes were removed and weighted following dissection. The samples were washed with PBS (pH 7.4) and then fixed in 10% neutral buffer formol. The samples were dehydrated in ethanol and then embedded in paraffin. Sections were cut at a thickness of 5µ and stained with hematoxylin and eosin and periodic acid Schiff (PAS) for glycogen[20]. Image Analysis software (IPWIN 32image analysis) was used to examine the optical density and assess the metabolic changes of glycogen density in tissue.

Ultra-structural examination

Small pieces (0.5 mm) of testes from all groups were immediately fixed in 4% glutaraldehyde in 0.2M cacodylate buffer (pH 7.2) for 24h at 4°C. Specimens were then post-fixed in 1% OsO4 in cacodylate buffer and embedded in Epon[21]. For light microscope, semithin sections were prepared and stained with toluidine blue. Ultrathin sections were also prepared and stained with uranyl acetate and lead citrate for transmission EM investigation (Jeol-JEM) at the EM unit, Ein Shams University.

Statistical analysis

Data were expressed as mean ± standard error of mean (SEM) and statistically analyzed using one-way ANOVA followed by Tukey's multiple comparisons test (Tukey's MCT). A difference was considered significant at $p< 0.001$ 0r $p< 0.05$.

RESULTS

Physiological analysis and organ weights

HFD group demonstrated significant increase in fasting blood glucose and insulin levels in HFD (P *value* < 0.001) compared to control rats. Administration of M. oleifera significantly (P *value* < 0.001) decreased insulin levels. Blood glucose levels was not significantly reduced when compared to HFD group. HFD rats showed significant decrease in testosterone levels compared to control rats (P *value* < 0.001). However, Moringa oleife extract showed significant increase in testosterone level (P *value* < 0.001) compared to HFD rats (Table 1).

Table 2 indicated that there was no significant difference in the body weights among the experimental groups. However, HFD group had significantly lower testis weight (P *value* < 0.05) than the control animals (Table 2). Moringa oleife extract showed significant increase in testis weight compared to control rats (P *value* < 0.05). The diameter of the seminiferous tubules in HFD group was significantly decreased (P *value* < 0.001) as compared to the control group (Table 2). However, M. oleifera extract showed significant increase in tubular diameter (P *value* < 0.001) compared to HFD rats.

The mean density of PAS positive reaction showed a significant decrease ($P < 0.001$) in testes of HFD group compared to control animals (Histogram 1). However, M. oleifera extract showed significant increase in PAS density ($P < 0.001$) compared to testes of HFD rats (Histogram 1).

Histological observations

A- Light microscopy examination

Sections of testes from the control rats stained with H&E revealed closely packed seminiferous tubules enclosed by thin regular basement membrane (Figure 1 A). Each tubule appeared lined by germ cells and Sertoli cells. Germinal epithelium included spermatogonia resting on basement membrane, primary spermatocytes, rounded and elongated spermatids (Figure 1B). The interstitial tissues between tubules contained Leydig cells around blood capillaries (Figures 1 A-C). Sections of testes from the HFD rats, revealed disorganized seminiferous tubules, and some tubules were devoid of sperms. Also, apparent decrease in the diameter of tubules and thickness of germinal epithelium was seen (Figure 2A). Some tubules showed multiple vacuolations with separation of basal compartment of tubules from adluminal compartment (Figure 2B). Other tubules showed exfoliated germ cells inside the lumen, as well as, reduction in the interstitial cells (Figure 2C). HFD+Mo group showed no detectable structural abnormalities (Figures 3 A-C). The seminiferous tubules were apparently resuming their normal architecture (Figure 3 A), and most tubules contain spermatozoon with normal morphological appearance (Figure 3 B). The interstitial tissue formed by Leydig cells and blood capillaries were normal (Figures 3 B,C).

Semithin sections stained with toluidine blue demonstrated normal structure of tubules of the control group (Figure 4A) Group II revealed vacuolations of germinal epithelium with accumulation of immature cells and residual bodies inside the lumen of tubules (Figure 4 B). The interstitium contained few Leydig cells & spindle-shape cells. Group III showed normal structure (Figure 4 C).

B- Ultra-structural observations

The control group had normal seminiferous tubules (Figures 5A,B). Each tubule appeared surrounded by a thin basal lamina contained flat nucleus of myoid cell. The tubule was lined by normal spermatogonia, spermatocytes, spermatids and Sertoli cells (Figure 5A). Each tubule lumen contained a varied number of mature spermatozoa with normal morphology embedded in the Sertoli cell process (Figure 5B). In addition, normal Sertoli cell processes filling the narrow spaces between the germ cells were seen (Figures 5A,B). Sertoli cells have euochromatic nucleus with a prominent nucleolus. Organelles such as mitochondria, endoplasmic reticulum and free ribosomes were present in the cytoplasm (Figure 5 A). Interstitial or Leydig cells surrounding the tubules of the control group are large with indented nucleus (Figure 5C). The cytoplasm contains smooth endoplasmic reticulum, numerous fat globule and mitochondria vary in size and shapes.

In group II (HFD), the tubule was enclosed by corrugated basement membrane. Germ cells were widely separated. Large vacuoles were present in Sertoli cell processes. Apoptotic changes were detected in some germ cells (Figure 6A). Sertoli cells exhibited multiple lipid vacuoles and distorted mitochondria (Figure 6B). Abnormal shape of sperm head (globular head) was detected (Figure 6C). Rounded spermatids showed apoptotic nucleus and abnormal distribution of their mitochondria (Figure 6C). Leydig cells of HFD group appeared with clumps of heterochromatin in their nucleus. Also, their cytoplasm contained autophagic vacuoles, electron dense bodies and small empty vacuoles (Figure 6 D).

Testicular tissue of HFD +Mo group recovered dramatically from injury caused by IR (Figures 7 A-C). The lumen contains mature Spermatozoon of normal morphological appearance (Figure 7B), as well as numerous normal spermatids. The Leydig cells appeared normal with large nucleus (Figure 7C).

C- Histochemical reaction

(Figure 8A) showed strong PAS positive reaction in the boundaries of the seminiferous tubules, inter-tubular connective tissue of the control group. Group II showed weak positive PAS reaction in basement membrane of tubules, while mild reaction in iterstitium and degenerated germ cells (Figure 8B). However, group III showed moderate PAS reaction in basement membrane of tubules, interstitium and elongated spermatids (Figure 8C).

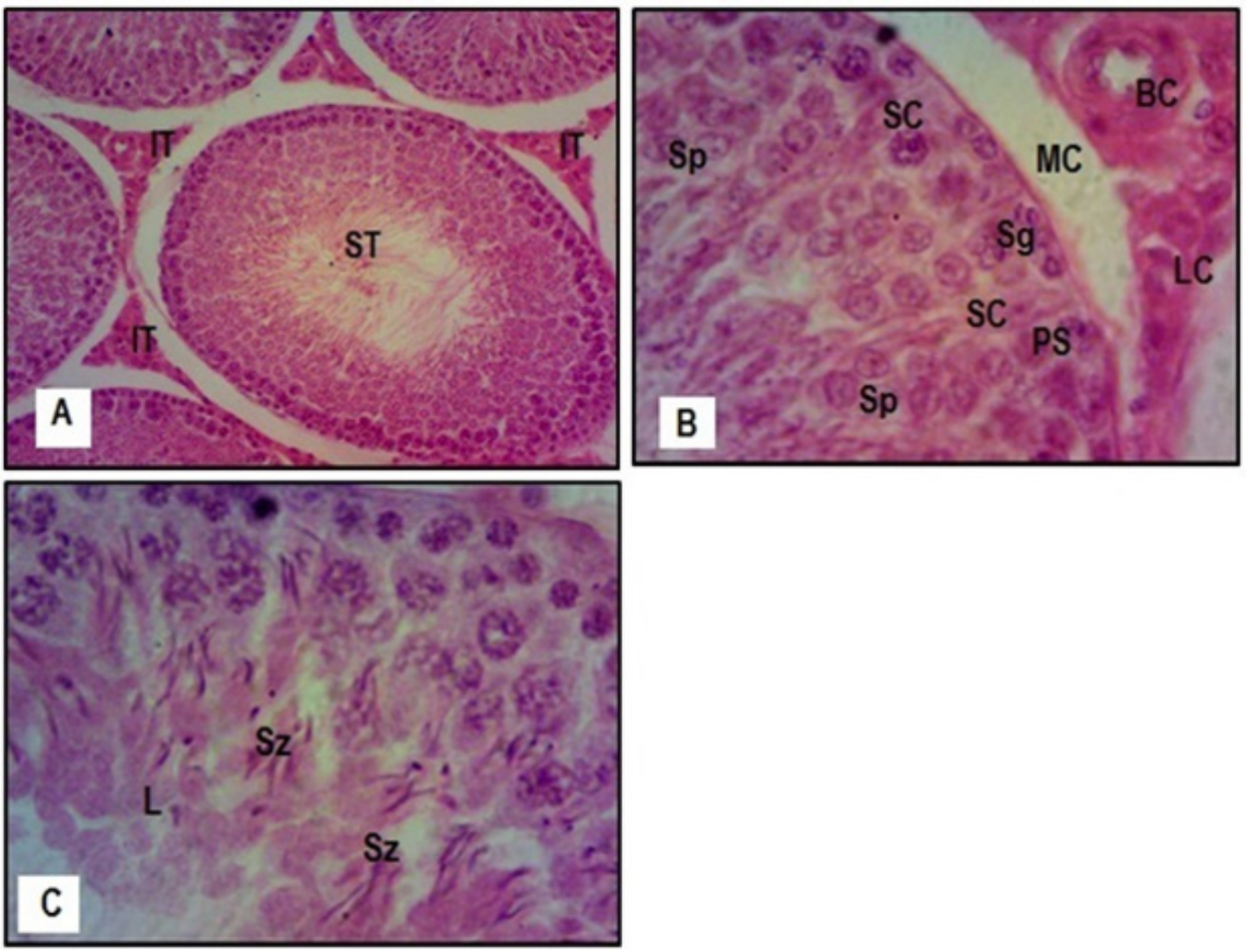


Fig. 1: Micrographs of cross sections of testicular tissue of adult albino rats of group I (Control) showing A, the seminiferous tubules (ST) lined by germinal epithelium with sperm inside their Lumina. Interstitial tissues (IT) between seminiferous tubules (Hx. & E. at 100 X). B, seminiferous tubule surrounded by basement membrane containing myoid cells (MC). The tubule is lined by germinal epithelium and normal Sertoli cells (SC). The germinal epithelium consists of spermatogonia (Sg) lying on thin basement membrane, primary spermatocytes (PS) and spermatids (Sp). The Interstitial tissues contain Leydig cells (LC) and blood capillaries (Hx. & E. at 400 X). C, the lumen (L) of the seminiferous tubule filled with normal elongated spermatozoa (Sz) (Hx. & E. at 400 X).

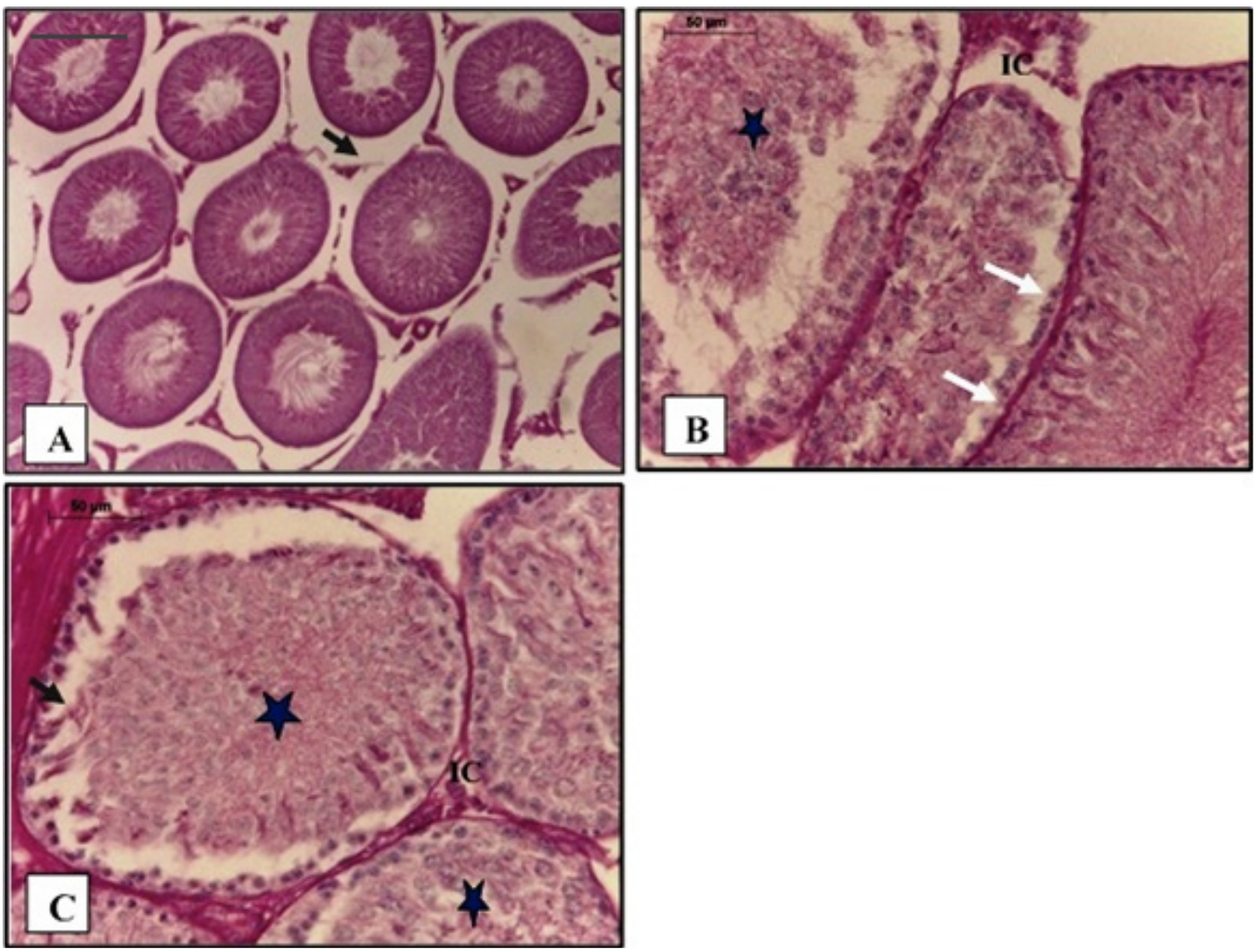


Fig. 2. Micrographs of cross sections of testicular tissue of adult albino rats of group II (HFD) showing A, apparent decrease in tubular diameter and widening of interstitium (Arrow) (Scale Bar 200 µm). B, Vacuolation between basal and adluminal compartment of one tubule (White Arrows). Other tubule shows sloughing of germinal epithelium inside the lumen with absence of mature sperms (Star). C, Separation of basal compartment of tubules from adluminal compartment (Arrow). The lumen of tubule contains exfoliated cells (Stars). Notice reduction in interstitial cells (IC). (Hx. & E. stain) (scale bar = 200 & 50µm).

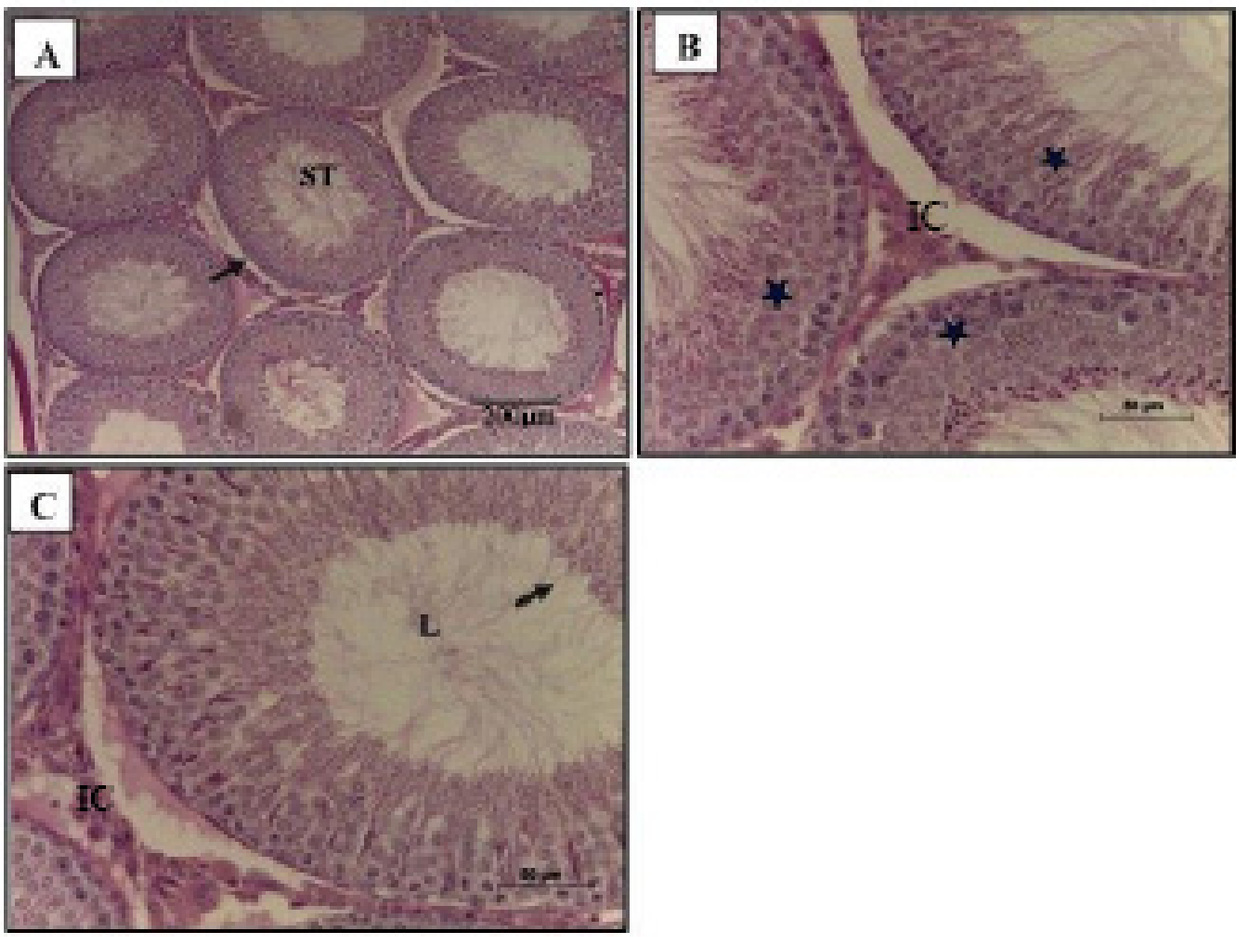


Fig.3: Micrographs of cross sections of testicular tissue of adult albino rats group III (HFD+ Mo) Showing A, normal diameter of seminiferous tubules (ST) and their lumen contains mature sperm. The tubule is enclosed with normal thin basement (Arrow). B, the tubules are lined with closely arranged germinal epithelium (Stars). Interstitial Leydig cells (IC) and blood capillaries appear normal. C, the lumen (L) of most tubules contain mature Spermatozoon of normal morphological appearance and their wavy-like tails filed the lumen (Arrow). (Hx. & E. stain) (scale bar = 200 & 50µm).

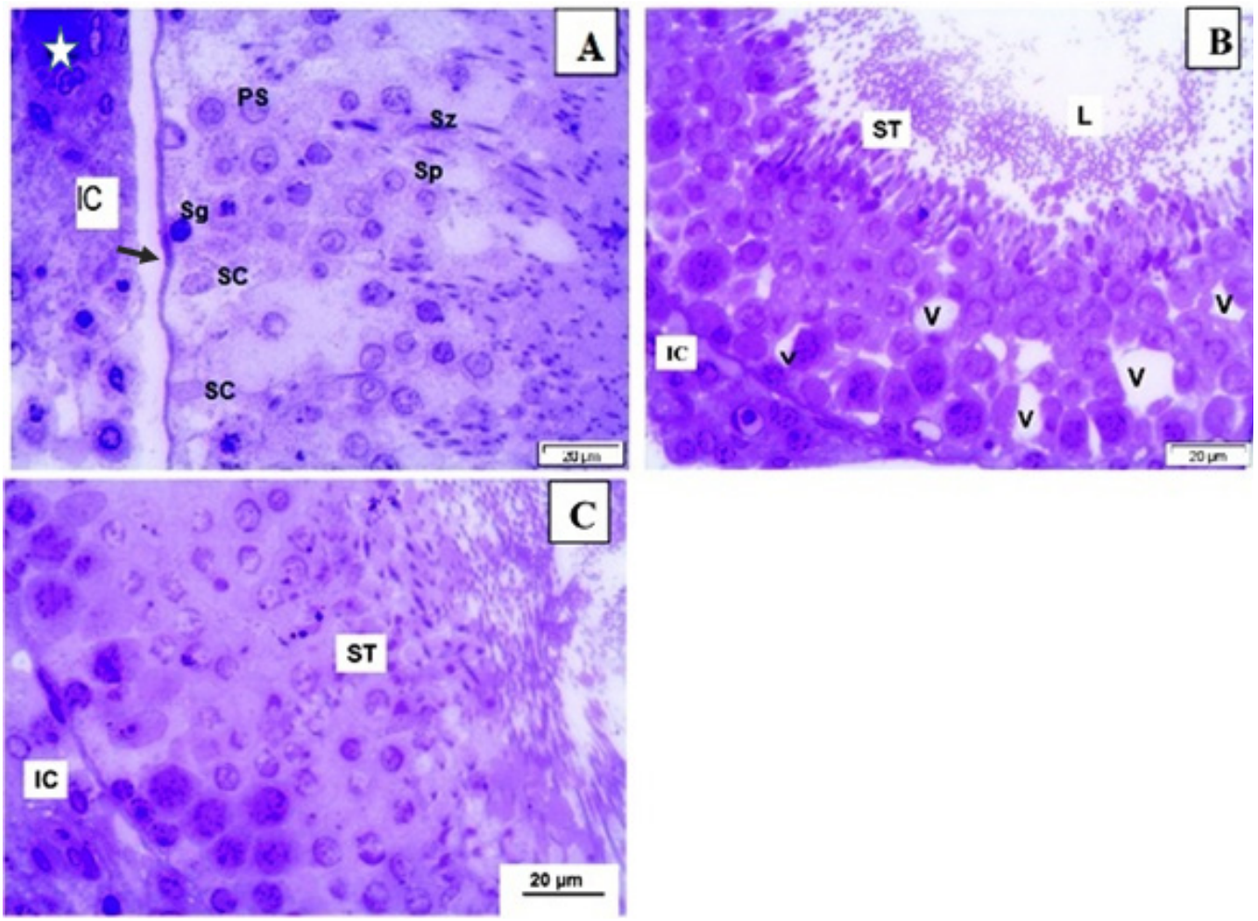


Fig. 4: Micrographs of semi-thin sections of the seminiferous tubules (ST) of different groups. A- Group I showing part of seminiferous tubule enclosed by basement membrane that contains flat nuclei of myoid cells (Arrow). The tubule is lined by different types of germinal epithelium and bunch of sperm attached to the apex of Sertoli cells (SC). The interstitial cells (IC) and blood capillaries (star) are normal. Notice presence of spermatogonia (Sg), primary spermatocytes (PS), spermatids (Sp) and Spermatozoa (Sz). B- Part of tubule of group II with multiple vacuoles (V) in germinal epithelium. Lumen (L) of the tubule contains many residual bodies and immature germ cells. Few small & spindle shaped Interstitial cells (IC) are present. C- The tubule (ST) and interstitium (IC) of group III appear similar to control group. (Toluidine blue stain) (scale bar = 20 µm).

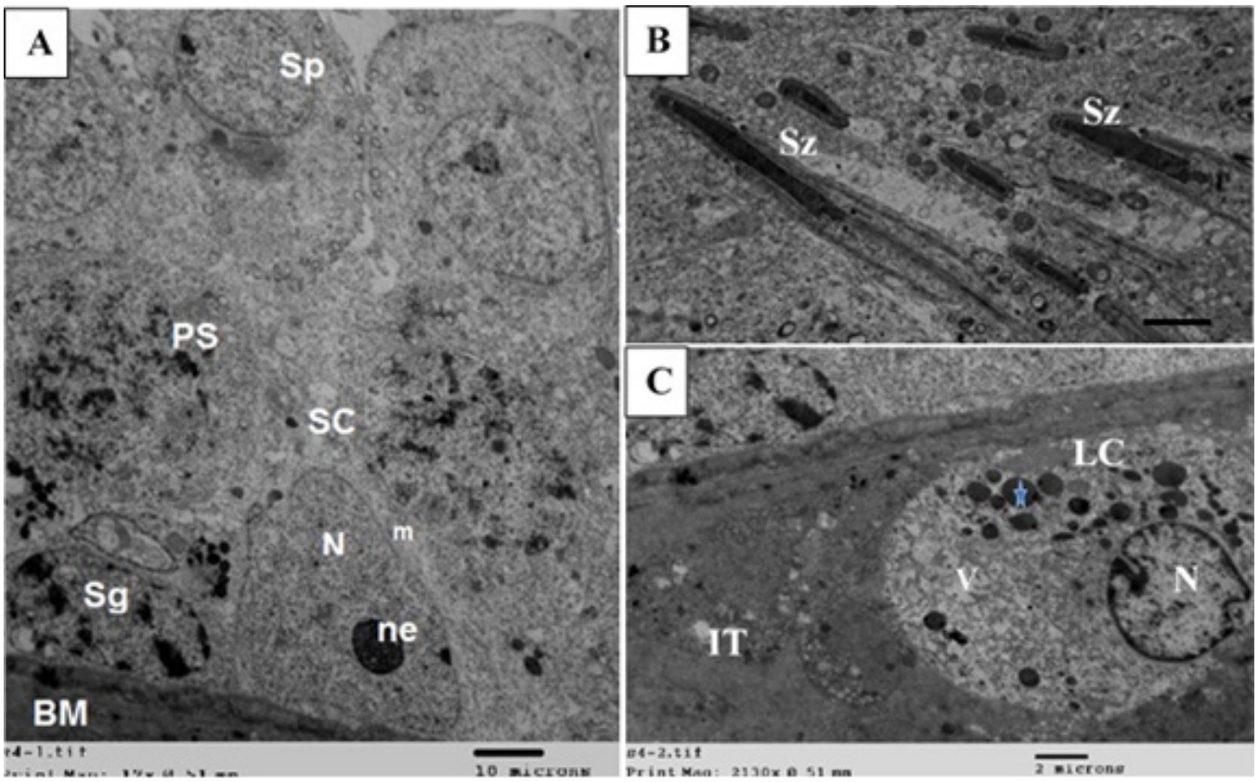


Fig.5: T.E. T.E. micrograph of the seminiferous tubules of group I (control rats) showing A, the seminiferous tubule containig Sertoli cell (SC) with large nucleus (N), prominent nucleolus (ne) and numerous mitochondria (m). Lying on the basement membrane (BM) containing myoid cell nucleus. Notice presence of spermatogonia (Sg), primary spermatocytes (PS) and spermatids (Sp). B, numerous spermatozoa (Sz) of normal morphological appearance embedded in SC processes. C, interstitial tissue (IT) containing Leydig cells (LC) with indented nucleus (N) and its cytoplasm contain many vacuoles (V) and electron dense bodies (Stars). (scale bar = 10 and 2 µm).

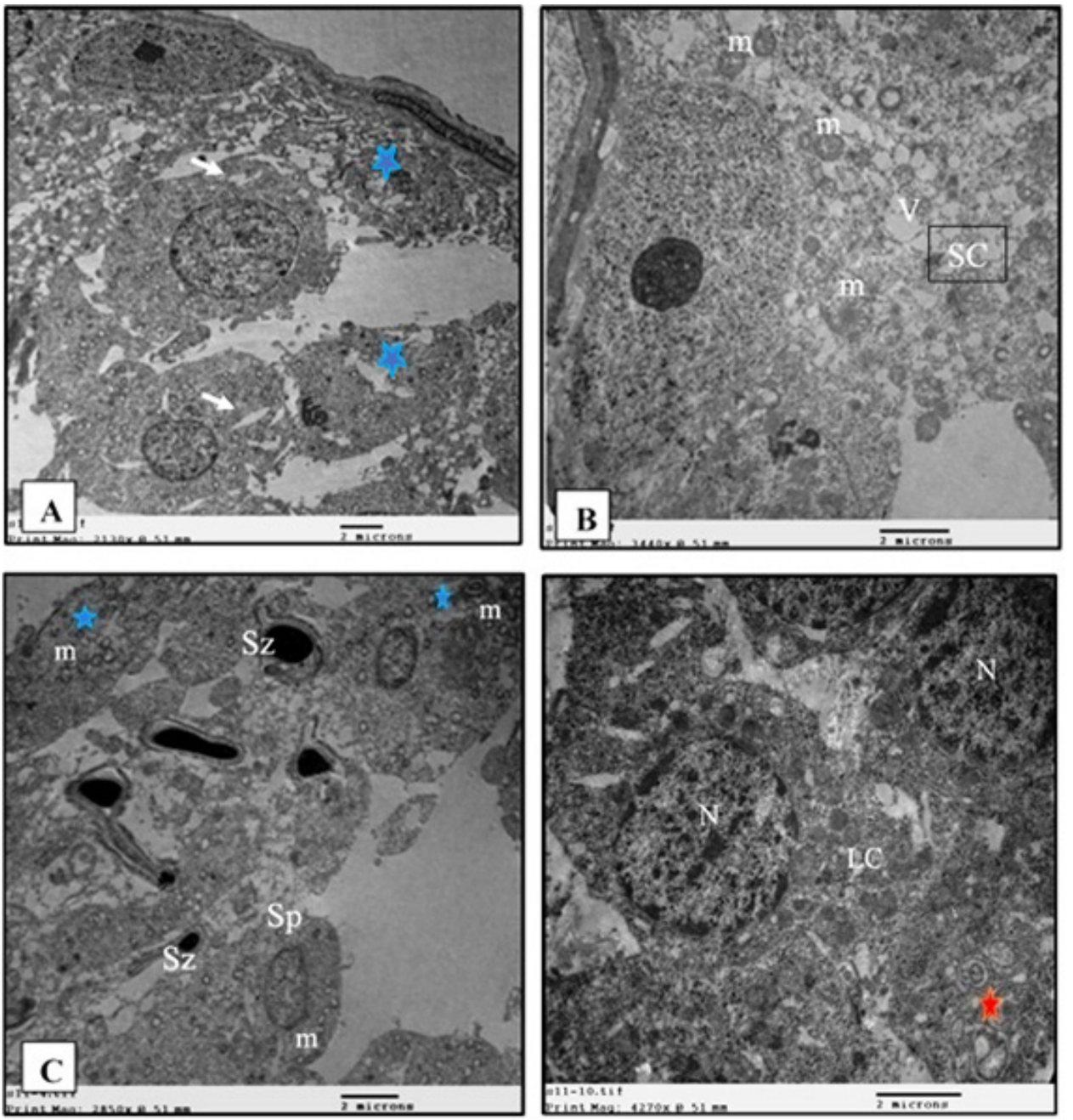


Fig. 6: T.E. micrograph of the seminiferous tubules group II (HFD) showing: A- multiple vacuoles inside germinal epithelium (Arrows) with separation of germ cells from each other. Some germ cells are apoptotic germ cells (ŝtar). B- multiple vacuoles (V) in the Sertoli cells process (SC) with mitochondrial damage (m). C- rounded spermatids (Sp) with abnormal distribution of mitochondria (m) and apoptotic nucleus (ŝtar). Abnormal heads of spermatozoa (Sz) (globular shape) surrounded by degenerated process of Sertoli cells. D-Nuclei (N) of Leydig cells (LC) containing clumps of heterochromatin. The cytoplasm of Leydig cell contains numerous autophagic vacuoles &electron dense bodies (ŝtar). (scale bar= 2 µm)

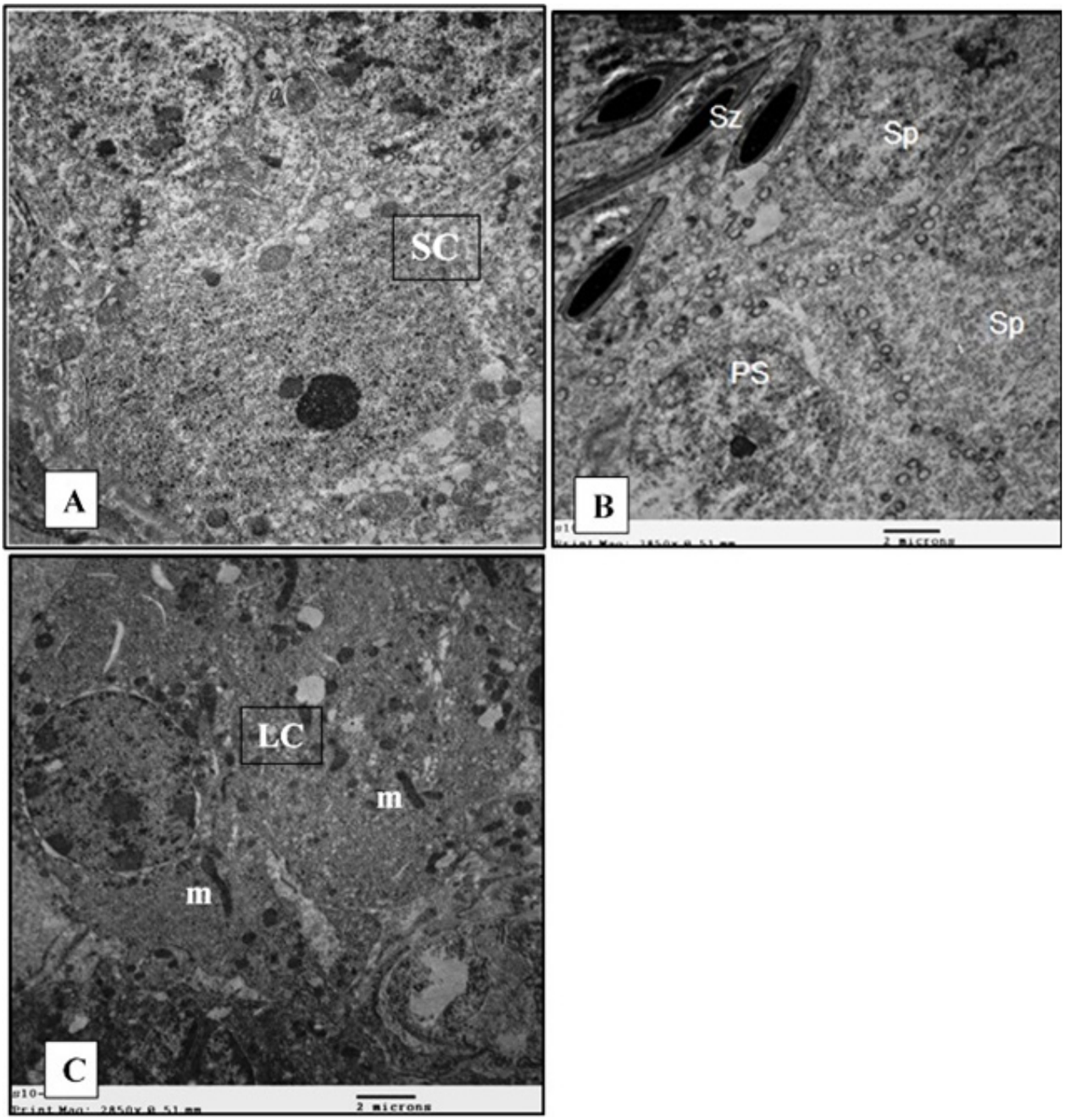


Fig. 7: T.E. micrograph of the seminiferous tubules of group III (HFD+Mo) showing: A, normal Sertoli cells processes (SC) . B, normal spermatocyte (PS), spermatid (Sp) & normal elongated head of mature Spermatozoon (Sz). C, Leydig cells (LC) cytoplasm with elongated mitochondria(m) and numerous smooth endoplasmic reticulum (scale bar= 2 µm).

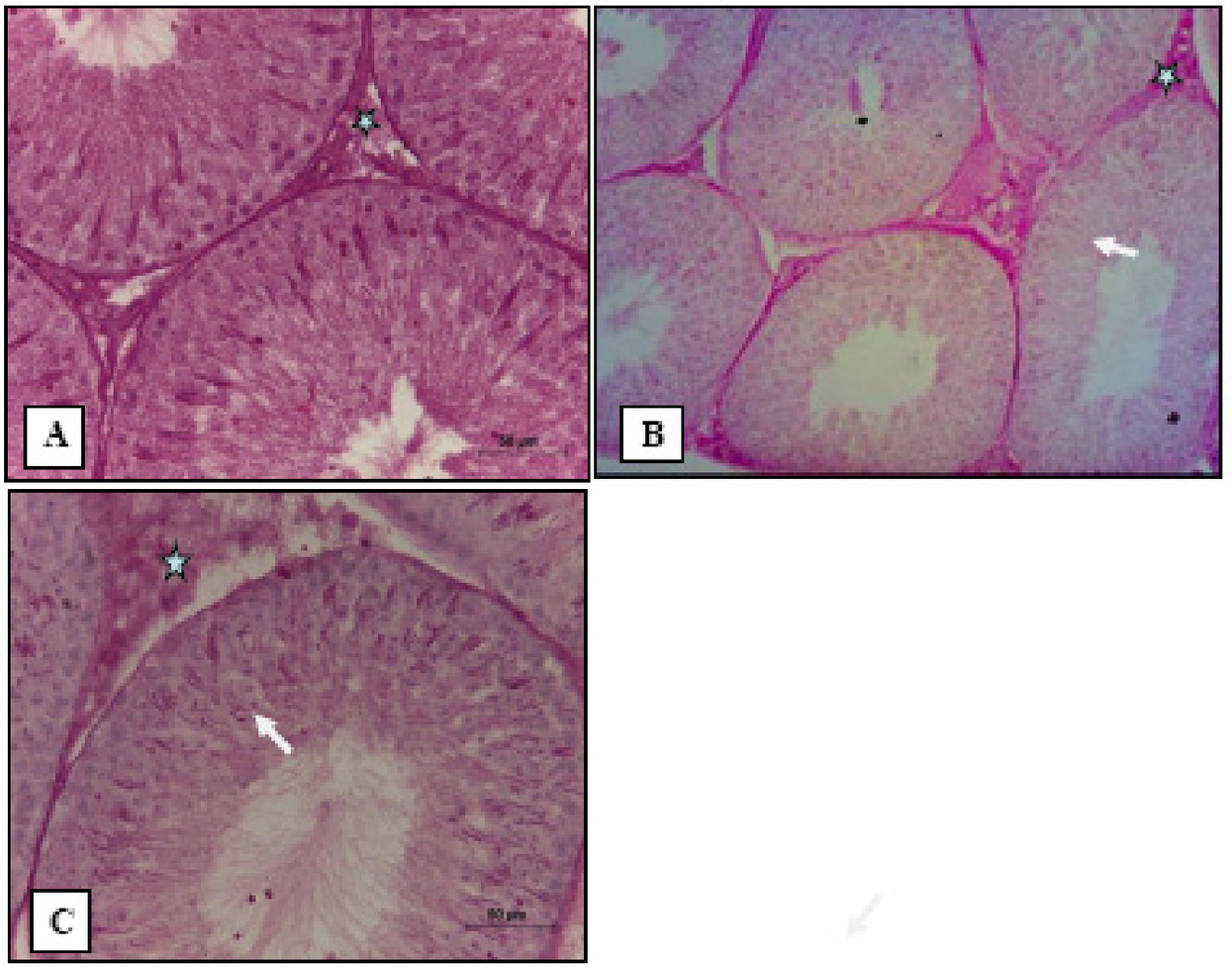


Fig. 8: Showing A (control group) – strong PAS positive reaction in basement membrane of tubules, interstitial tissue (Star) and elongated spermatids. B-group II strong positive PAS reaction in basement membrane of tubules, mild reaction in iterstitium (Star) and degenerated germ cells (White Arrow). C- group III moderate PAS reaction in basement membrane of tubules, interstitium (Star) and elongated spermatids (White Arrow).

Table 1: Serum level of glucose, insulin and testesterone in different groups

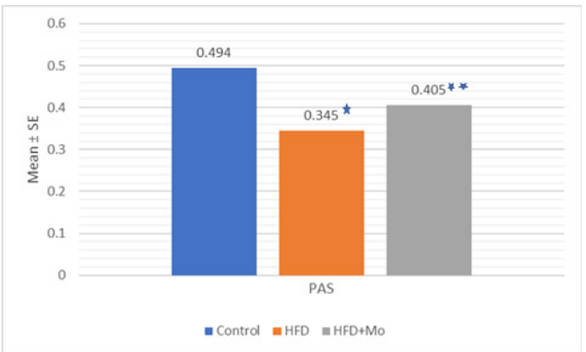
Groups	Control	HFD	HFD + Mo
Glucose (mg/dl)	95.167±4.1	132.5±6.45 [a]	128.94±4.11 [a]
Insulin (µU/ ml)	2.261±0.20	5.2±0.339 [a]	2.639 ± 0.18 [b]
Testosterone (ng/ml)	2.12±0.26	0.95±0.09 [a]	1.65±0.09 [a, b]

Data are presented as Mean ±SE and analyzed with One-way ANOVA followed by Tukey's MCT. a: Significant when compared to control group (*P value* < 0.001), b: Significant when HFD group compared to Moringa group (HFD +Mo) (*P value* < 0.001) (n=8 rats)

Table 2: Body weights, testes weights and diameter of seminiferous tubules in different groups

Groups	Control	HFD	HFD + Mo
Final BW (g)	278.1±40.5	246.1±42.7	267.1± 20.5
Testes weight (g)	2.85 ±0.42	2.18± 0.53 [a]	2.9 ± 0.29 [b]
Diametr of ST (µm)	302.5 ±10	208.12 ± 4.5 [a]	287.5 ± 8.86 [a, b]

Data are presented as Mean ±SE and analyzed with One-way ANOVA followed by Tukey's MCT. a: Significant when compared to control group (*P value* < 0.05), b: Significant when HFD group compared to Moringa group (HFD +Mo), (n= 8 rats)



Histogram 1: Mean density of PAS positive reaction in different groups. Data are presented as mean±SE and analyzed using ANOVA followed by MCT.: *Significant when compared to control group (*P value* < 0.05) ** Significant when group II compared to groupIII .

DISCUSSION

Moringa oleife is a phytochemical plant that has been used in the traditional medicine for centuries[22]. The current studies aimed to evaluate the protective effect of M. oleifera against insulin resistance impaired fertility in rats. Previous research found that rats fed on high-fructose diet developed a model of diet-induced insulin resistance[23]. The current work created a model of HFD-induced IR characterized by significantly higher glucose and insulin levels than control rats. IR is relatively the common cause of male infertility[24,25]. To validate Moringa oleife protective quality on male fertility in rats with IR, biochemical and histological examination were applied.

Moringa oleife treatment for 30 days (diet dose of 300 mg/Kg) significantly lowered insulin levels while having non-significant effect on blood glucose levels when compared to HFD group. The presence of IR promotes an increase in insulin synthesis and secretion, resulting in hyperinsulinemia[26]. This hyperinsulinemic condition can significantly enhance insulin resistance in peripheral tissues and different organs, reducing glucose absorption and leading to hyperglycemia, as seen in the HFD group. However, the protective properties of Moringa oleife have previously been demonstrated by lowering insulin levels and controlling blood glucose levels[27]. Moringa oleife affects pancreatic β-cells by either restoring their function or inhibiting their growth. Insulin sensitivity and glucose uptake and utilization in tissue are all factors to consider[28].

To investigate the possible effect of Moringa oleife on the body weight in HFD rat, body weight was measured to know if the effect of IR in rats was reversed after treatment. The present study observed a non-significant weight loss in Group II compared to group I, which might be related to metabolic abnormalities in structural proteins produced by hyperinsulinemia in IR, as previously documented[29]. Body weight of group III showed non-significant weight gain compared to group I. In agreement to this, previous study observed that oral treatment of Moringa oleife extract reduces weight loss in diabetics[30]. The weight gain observed in Group III might be attributed to M. oleifera's high concentration of essential amino acids and vitamins, as well as, antioxidants and antimicrobial compounds (phenols, tannins, alkaloids and cumarins) that act as growth promoters[31].

Assessing the weights of reproductive organ is one of the essential measurements for studying the effect of any pharmaceutical plants on reproductive organ and fertility. In the present study, Moringa oleife treatment to HFD rats resulted in a significant increase in testicular weight and width of seminiferous tubules compared to HFD rats. The mass of dividing germ cells and growing spermatids into spermatozoa determines the weight of the testes[32]. The significant decrease in testicular weight and diameter of tubules observed in Group II of the present study might be attributed to spermatogenic arrest and Leydig cells suppression of steroid hormones such as testosterone[33]. Leydig cells release testosterone in response to pituitary luteinizing hormone (LH).

Previous results documented that oxidative stress in the testes disturbs both spermatogenesis and the testosterone synthesis[7]. The preset study revealed perinuclear aggregation of mitochondria in rounded spermatid (group II). Perinuclear clustering preceding mitochondrial ROS production and subsequent cell death by several hours[34]. Also, the hypothalamic – pituitary – testicular axis is disrupted by ROS[10].

Testosterone synthesis is crucial for the structural integrity and functional activity of accessory sex organs. Testosterone withdrawal causes premature release of spermatids from Sertoli Cells, providing that this hormone is critical for the attachment of germ cells with Sertoli Cells[35]. This was consistent with the current investigation, which found that rats in Group II had lower testosterone levels, vacuolation in the germinal epithelium layers, reduced sperm concentration, atrophic in the Leydig cells, as well as metabolic abnormalities in the glycogen contents of the testes.

Apparent decrease in interstitial cells with the presence of spindle shaped cells in group II of the present study denoted hypofunction of Leydig cells This was confirmed by decrease in PAS positive reaction in interstitium .In addition electron microscopic study revealed Leydig cell nuclei with clumps of heterochromatin and their cytoplasm contained autophagic vacuoles and electron dense granules resulting in poor steroidogenesis[35]. Further, autophagy induced apoptosis of Leydig cells[36].

Testosterone is also dependent on insulin level. In the reproductive system, insulin can increase testosterone synthesis, as well as activate the hypothalamic-pituitary-gonadal (HPG) axis, altering blood hormone levels critical for spermatogenesis[37]. Rats of group III were significantly increased in the serum testosterone levels. Previous study showed that Moringa oleife reduced the signs of testicular atrophy, cellular damage in rats with IR[38]. This was consistent with the present study that revealed testicular improvement in the PAS positive reaction. Improved

insulin secretion observed in group III may translated into improved testosterone production.

In control animals, Sertoli cells are important in testicular development and maturation because their normal structure controls the number of germ cells and spermatozoa differentiation during the spermatogenesis process. The interruption of Sertoli cell microtubule dynamics caused less basal & apical cytoplasmic processes related with germ cells[39]. Examination of Sertoli cells of Group II of the current study revealed destruction of their cellular processes, numerous vacuolization and electron-dense bodies, mitochondria swollen with ill-defined cristae. The significant decrease in tubular diameter seen in group II further supports the effect of HFD on Sertoli cells.

The epithelium basal compartment's structural integrity depends on either on the attachment of the SC to the peritubular tissue or on adhesion between the plasma membranes of adjacent SC[40]. In the current research, epithelial disarrangement and a decrease in both the epithelial and overall area of the tubular sections in HFD were caused by germinal epithelium & SC degeneration. This was linked to the disruption of Sertoli cytoskeleton with loss of attachment of germ cells to Sertoli cell processes .This led to decrease nutrition of germ cells and subsequent germ cell apoptosis as seen in group II of the present study[41].

However, Moringa treated group showed somewhat normal ultrastructure of the seminiferous tubules. In the current investigation, treatment of HFD rats with Moringa oleife resulted in the recovery of the damaged germ and Sertoli cells as well as substantial increases in testosterone levels as compared to control group. Moringa oleife extract contains specific plant pigments with antioxidant effect[42] that scavenges free radicals, decreases the harmful effect of oxidative stress and enhances antioxidant activity[43]. Bioactive compounds such as terpenoids, steroids, and phenolic compounds such as tannins, coumarins and flavonoids are found in Moringa leaf extract[44]. Researcher has demonstrated that the phytochemical composition of Moringa leaves has positive benefits attenuating the effects of oxidation on reproductive organ during IR, even if the precise phytochemical composition of the plant responsible for the observed results is not yet known.

CONCLUSION

Previous research revealed a link between high fructose consumption and the development of IR and infertility. This high level of fructose consumption may be a significant contribution to human reproductive dysfunction and should be investigated further. Moringa oleife has been shown to improve fertility through restoring the integrity and function of spermatogenesis and Sertoli cells, increasing insulin levels, improving glucose uptake from the testes.

CONFLICT OF INTERESTS

There are no conflicts of interest.

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الملخص العربى

المورينجا اوليفيرا تخفف من تلف الخصية الناجم من من النظام الغذاءي عالي الفركتوز في الجرذان البيضاء

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المقدمة: النظام الغذائي عالي الفركتوز هو عامل مهم يسبب مقاومة الأنسولين ويؤدي إلى حدوث تلف في الخصيتين والعقم. تستخدم أوراق المورينجا أوليفيرا لأغراض طبية ,يمكن لأوراق المورينجا تحسين تلف الخصية الناجم عن النظام الغذائي عالي الفركتوز.

. الهدف من البحث: دراسة آثار النظام الغذائي عالي الفركتوز (HFD) على خصوبة الفئران وتقييم الدور الوقائي المحتمل لمستخلص أوراق المورينجا أوليفيرا وإذا كان تناول مستخلص المورينجا أوليفيرا قد أثر على مستويات الأنسولين والجلوكوز وهرمون التستوستيرون في الدم ، , التأثير اللاحق على التركيب النسيجي في خصيتي الجرذان البيضاء البالغة.

المواد والطرق: تم تقسيم ذكور الجرذان البالغة بشكل عشواءى إلى المجموعة الأولى: (المجموعة الضابطة): تلقت نظاما غذاءئ، ,المجموعة الثانية: (تم إطعامها ٦٠ جم / ١٠٠ جم من نظام غذائي عالي الفركتوز لمدة اربع اسابيع) (مجموعة HFD) و (٣) والمجموعة الثالثة: (مجموعة HFD تعامل مع المورينجا ٣٠٠ مجم / كجم يوميا). بحلول الاسبوع الرابع تم وزن الجسم ثم التضحية بها ,تم ازالة للخصيتين وتم فحص قطاعات البرافين المصبوغة ب H&E و PAS بواسطة المجهر الضوئي وايضا فحص التركيب الدقيق باستخدام الميكروسكوب الالكتروني. تم تحليل النتائج إحصائيا.

نتائج البحث: حدث انخفاض كبير في مستوى هرمون التستوستيرون وزيادة في مستوى الأنسولين والجلوكوز في الدم. أيضا ، تم تسجيل انخفاض معنوي في وزن الخصيتين وقطر الاونبيبات المنوية في مجموعة HFD. أظهر التركيب النسيجي فجوات في البطانة الطلائية للاونبيبات المنوية ووتفكك الخلايا الجرثومية داخل تجويف الاونبيبات. تحتوي خلايا Leydig على العديد من الفجوات والأجسام ذات الكثافة الإلكترونية في السيتوبلازم. كان هناك انخفاض معنوي في PAS في الأنابيب والنسيج الخلالي. من ناحية أخرى ، أدى تناول مستخلص المورينجا إلى خفض مستوى الأنسولين المرتفع ومستويات الجلوكوز بشكل ملحوظ. أظهرت خلايا سيرتولي وا لخلايا الجرثومية تعافيًا معتدلًا بعد العلاج.

الخلاصة : يمكن لمستخلص أوراق المورينجا أن يخفف من سمية الخصية لمرضي مقاومة الانسولين و الناتجة عن نظام غذائي عالي الفركتوز.