



GONADAL SPERM RESERVES AND TESTOSTERONE PROFILE OF WISTAR RATS TREATED WITH TAURINE FOLLOWING CYPERMETRIN TOXICITY

Ubah, S. A¹.; Abah, K. O¹.; Abalaka, S. E².; Idoko, I. S².; Akande, M. G³.; Okoronkwo, S³.; Akumka, D³.; Mohamed, A³.; and Hassan, R¹*.

¹Department of Theriogenology, Faculty of Veterinary Medicine, University of Abuja, Nigeria. ²Department of Veterinary Pathology, Faculty of Veterinary Medicine, University of Abuja, Nigeria. ³Department of Veterinary Pharmacology and Toxicology, University of Abuja, Nigeria. *Corresponding author: Email: hraheelah@gmail.com; Tel No: +234 803 647 9918.

ABSTRACT

This study aimed to investigate the impact of Taurine (TAU) on sperm/spermatid reserves and testosterone profile of Wistar rats exposed to Cypermethrin (CYP) toxicity. Male rats weighing between 150 - 200 g age 10-11 weeks old were used. The experiment was divided into 7 groups, which included; Group A distilled water, Group B soya oil at 2 ml/kg, Group C TAU 50mg/kg, Group D TAU 100mg/kg, Group E CYP at 20 mg/kg Group F TAU at 50 mg/kg with CYP at 20 mg/kg and Group G TAU at 100 mg/kg with CYP at 20 mg/kg respectively. The treatments were administered once daily by oral gavage for 60 days. At termination, the rats were decapitated. Sera samples were obtained. The epididymis was separated into head, body and tail, testicular and epididymal filtrate volumes were measured. Paired gonadal and epididymal sperm/spermatid reserves were determined using a haemocytometer and light microscope. Testosterone assay was done with testosterone ELISA Kits. Results showed that testicular sperm/spermatid reserves of groups A and B were $11.50 \pm 0.87^b \times 10^6$ /g of testes and $16.00 \pm 3.08^a \times 10^6$ /g which were significantly higher than the rest groups ($p < 0.05$). Sperm reserves of the tail epididymis was significantly higher in groups A, B, E and F ($p < 0.05$). The values were $15.75 \pm 2.95^a \times 10^6$ /g, $15.25 \pm 2.81^a \times 10^6$ /g, $11.50 \pm 1.50^a \times 10^6$ /g and $10.0 \pm 0.0^a \times 10^6$ /g respectively, Sperm reserves of the head epididymis was significantly higher in groups D and E ($p < 0.05$). The values were $10.25 \pm 3.68^a \times 10^6$ /g $9.25 \pm 1.89^a \times 10^6$ /g. It was concluded that taurine at 50mg and 100 mg/kg did not show any significant positive effect on serum testosterone, testicular sperm/spermatid reserves, tail and body epididymal sperm reserves. Taurine effect may be dose dependent and influenced by osmoregulation. It was recommended that higher doses of taurine be tested.

Keywords: Sperm reserves, Testosterone, Rats, Taurine, Cypermethrin, Toxicity.

INTRODUCTION

Taurine (TAU), 2 - aminoethane sulfonic acid, is the richest free amino-acid found in tissues and cells of mammals, it also plays a major role in many important biological processes in the body. It is credited as a neurotransmitter, osmo-regulator and antioxidant in most tissues. Taurine is vital for reproduction, development of the central nervous system, the retina and calcium modulation (Ebtehal, 2018). In addition, it is necessary in cell membrane stabilization in the heart, muscle, retina, CNS and immune system (Harris, 2012). Taurine acts as an endogenous antioxidant and this is related to TAU's scavenging mechanism and reducing cell apoptosis (Niittynen *et al.*, 1999, Abbasoglul *et al.*, 2001 Bhavsar *et al.*, 2010). Taurine has been detected in Leydig cells, vascular endothelial cells, and some other interstitial cells of testes and epithelial cells of efferent ducts in male reproductive system of rats (Lobo *et al.*, 2000). Taurine can be biosynthesized by male reproductive organs (Li *et al.*, 2006). Most importantly taurine has been identified as the major free amino acid of sperm cells and seminal fluid (Hinton, 1990; Holmes *et al.*, 1992a; Holmes *et al.*, 1992b; Guérin *et al.*, 1995). It has been documented that taurine may function as an antioxidant (Alvarez and Storey, 1983), a capacitating agent (Meizel *et al.*, 1980; Meizel, 1985), membrane-stabilizing factor (Mrsny, 1985) and motility factor (Boatman *et al.*, 1990) of sperm. It has also been reported that taurine can stimulate testosterone secretion both in vivo and in vitro (Yang *et al.*, 2010b). Taurine have been demonstrated in spermatozoa and seminal fluid of numerous species and it is known to enhance mammalian sperm characteristics (Holmes *et al.*, 1992a; van der Horst and Grooten, 1966) It was reported that taurine plays important roles in the

maintenance, stimulation of sperm motility as well as stimulation of capacitation and acrosome reactions in vivo and in vitro (Meizel *et al.*, 1980). It has been demonstrated that taurine could significantly increase the motility of sperm in adult rats, but has no obvious effects on the other semen parameters (Yang *et al.*, 2010a). Cypermethrin is a synthetic pyrethroid. It is used as an insecticide, many commercial acaricides contain cypermethrin. There has been reports of cardiotoxicity (Ghazouani *et al.*, 2020), kidney toxicity (Priyanka *et al.*, 2023), hematological, hepatic and gonadal toxicity in mature male rats exposed to cypermethrin (Tuhina *et al.*, 2017). Several investigations have reported that pesticides adversely affect testicular functions in experimental animals and function as potent endocrine disrupters (Priyanka *et al.*, 2023). Systematic toxicity of cypermethrin and alterations in behavior of Albino rats has also been reported (Ghazouani *et al.*, 2020). Other effects were, genotoxicity (Vilena *et al.*, 2022), immunotoxicity, degeneration of the reproductive system, histological alteration, and DNA damage (Anupam, *et al.*, 2022;; Vilena *et al.*, 2022). A significant reduction in the relative weights of the testes, epididymis, seminal vesicle and prostate glands that, consequently, disrupts the normal androgen status and androgenesis have also been reported (Ubah *et al.*, 2021) high abnormal sperm cell morphology, lowered motility and mass activity were also attributed to cypermethrin toxicity (Ubah *et al.*, 2021) Considering the reproductive potential of taurine in male reproduction, including potential to stimulate the secretion of Luteinizing hormone and Testosterone, increase the levels of testicular

marker enzymes, elevate testicular antioxidation and improve sperm quality. This study was designed to investigate the impact of taurine on sperm reserves and testosterone profile of Wistar rats exposed to cypermethrin toxicity.

MATERIALS AND METHODS

The study was carried out in Physiology and Pharmacology Laboratory of Faculty of Veterinary Medicine, University of Abuja which is situated within the Federal Capital Territory (FCT), Abuja. (longitude 7009'54''E and 7010'38''E and latitude 8059'13''N and 8059'49''N (Dikedi, 2012; WMO, 2012).

EXPERIMENTAL ANIMALS

The animals were handled in accordance with the guidelines of the National Institute of Health Guide for Care and Use of Laboratory animals (Garber *et al.*, 2011). Approval for the animal use was obtained from the University of Abuja Animal Care and Ethics Committee (UAACEC 2019/166/21). Sexually mature adult male Wistar rats weighing between 150 - 200 g and 10 weeks of age were used. They were obtained from the Department of Physiology, Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria, Kaduna State, Nigeria. They were acclimatized for a period of two weeks before the commencement of the research. They were housed in cages under standard environmental conditions (23–25°C, 12hrs/12hrs light/dark cycle). The experimental animals had access to standard rat chow and tap water *ad libitum*. 5% solution of Cypermethrin (CYP) (EC) was reconstituted from Cypro-10[®] which was a 100% solution containing 100 mg/ml of CYP. It was prepared by reconstitution in soya oil (SO, Grand Cereals and Oil Mills Limited, Jos, Nigeria). An analytical grade of Taurine (TAU)

was obtained from Sigma Aldrich[®] (Steinheim, Germany). Prior to daily administration, 100 mg of (TAU) was reconstituted in distilled water to obtain 100 mg/ml suspension. The median lethal dose (LD₅₀) of CYP was not determined in this study. Rather, an oral LD₅₀ value of 200 mg/kg was selected for CYP based on the range of oral LD₅₀ of rats reported as 150 – 500 mg/kg by USEPA (1989). The dose of CYP used in this investigation was 0.1 LD₅₀ CYP i.e. 20 mg/kg. The male Wistar rats were weighed and divided into seven different groups of five rats each. The groups included (A-G) and received the following treatments (A) Distilled water, (B) Soya oil at 2 ml/kg, (C) Taurine 50mg/kg, (D) Taurine 100mg/kg, (E) Cypermethrin at 20 mg/kg, (F) Taurine at 50 mg/kg and CYP at 20 mg/kg and (G) Taurine at 100 mg/kg and CYP at 20 mg/kg respectively. The treatments were administered once daily by oral gavage for 60 days. The animals were observed for clinical signs of toxicity during the study. At the end of the study, the rats were euthanized by decapitation (Leary *et al.*, 2013) and 3 ml of blood samples were collected into centrifuge tubes via the media cantus of the eyes. The blood samples were incubated at room temperature for 30 min and then centrifuged at 1000 × g for 5 min to obtain sera samples. Five rats each from groups A, B, C, D, E, F and G were humanely euthanized by cervical dislocation and the gonads collected intact then cleaned of any extraneous tissue by dissection. The testes were weighed using a sensitive scale (Electronic compact, BL20001) and testicular volume was estimated by water displacement method using a 10ml measuring cylinder. The fibrous capsule (tunica albuginea) was separated using a scapel blade, the left and right epididymis were weighed using a sensitive

scale (Electronic compact, BL20001) while the length was measured with a flexible tape and were separated into caput, corpus and cauda grossly. The tissues were then placed in normal saline for onward estimation of epididymal sperm reserves. Testicular and epididymal sperm reserves were determined according to modified method of Jennifer *et al.*, (1997), Alabi, (2005) and Ubah *et al.*, (2016). Briefly, the testicular parenchyma was sliced and pounded in a mortar with pestle then homogenized for two minutes with 10 ml of normal saline containing antibiotics (sodium penicillin G, 100 iu/ml and streptomycin sulphate, 1mg/ml) to prevent bacterial growth and a drop of eosin-nigrosin stain for visual clarity. The epididymal sperm reserves were determined by isolating the caput, corpus and cauda epididymis, these were minced with a pair of scissors separately in 10ml of normal saline solution. All tissues were homogenized within 6 hours after collection, testicular homogenates and epididymal samples were stored in the fridge overnight. After 24 hours the samples were filtered through gauze and the testicular filtrate and epididymal filtrate volumes were measured. Testicular filtrates were diluted in half while 1ml of epididymal filtrate was diluted with 2ml of Saline. Sperm reserves of the gonads as well as epididymal sperm reserves were determined using a haemocytometer and light microscope, according to the method of Kwari and Waziri (2006). Serum samples were used for testosterone assay. The assay was done in the Endocrinology laboratory of NAPRI. Rat testosterone (T) ELISA Kits (Cusabio[®], China) were used. Details of the assay procedure was as described by the manufacturer: (Biocompare, 2020). Data obtained were analyzed using descriptive statistics and one way analysis of variance (ANOVA) using IBM SPSS Statistical package, version 23. and expressed as mean \pm

standard error of mean (SEM). Values of $p < 0.05$ were considered statistically significant.

RESULTS

Paired testicular sperm reserves of groups A and B (distilled water and soya oil) were $11.50 \pm 0.87^b \times 10^6$ /g and $16.00 \pm 3.08^a \times 10^6$ /g. The values were significantly higher than the rest groups ($p < 0.05$). Paired testicular sperm reserves of group D (taurine 100mg/kg) was different from taurine 50mg/kg and the cypermethrin groups although it was not significant ($p > 0.05$) (Fig.1).

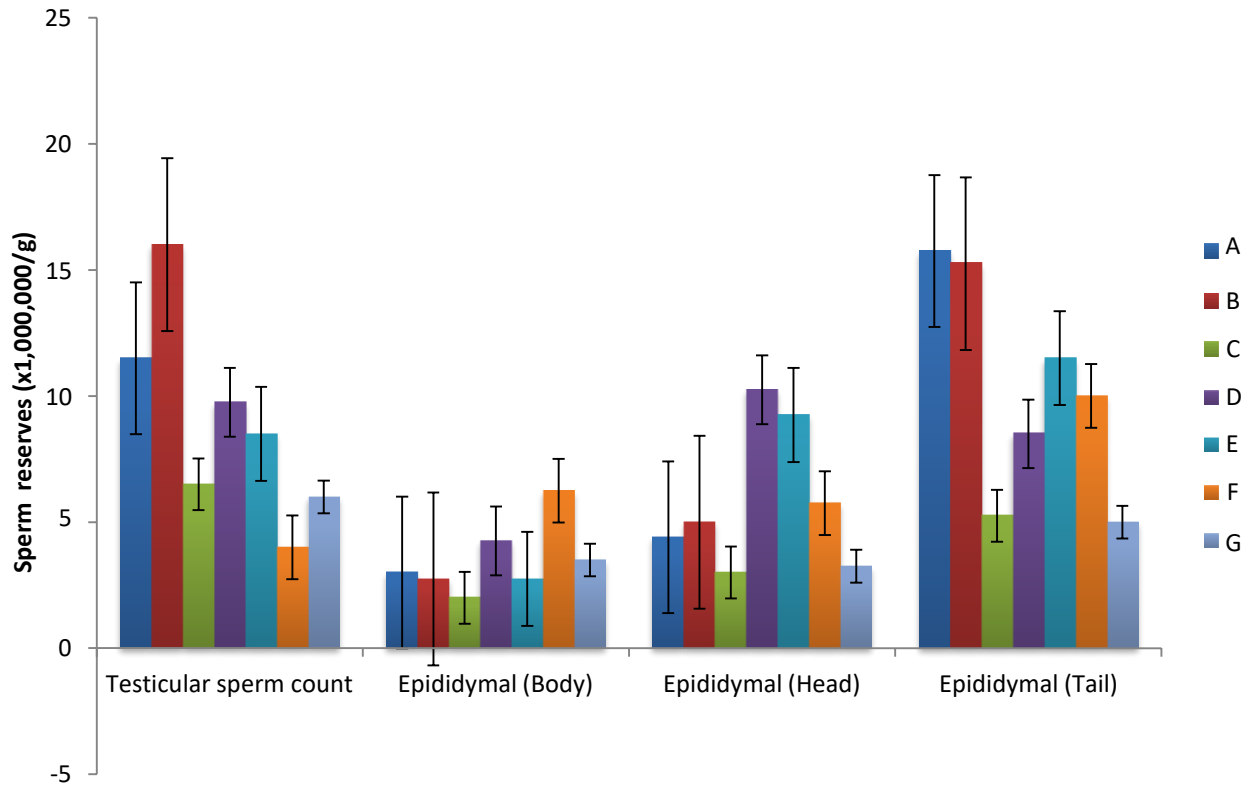


Fig.1: Paired sperm reserves of Wistar rats treated with Taurine 50mg/kg, 100mg/kg, Cypermethrin at 20mg/kg and combinations of Cypermethrin 20mg/kg with Taurine 50mg and 100mg/kg.

Key: A = Distilled water, B= soya oil at 2 ml/kg, C =Taurine 50 mg/kg, D = Taurine 100 mg/kg, E= Cypermethrinat 20 mg/kg, F= Taurine at 50 mg/kg and CYP at 20 mg/kg and G = Taurine at 100 mg/kg and CYP at 20 mg/kg.

Paired epididymal sperm reserves of the tail segment was significantly higher in groups A, B, E and F (Distilled water, Soya oil, Cypermethrin 20mg/kg and Cypermethrin with Taurine 50mg/kg) ($p < 0.05$). The values were $15.75 \pm 2.95 \times 10^6/g$, $15.25 \pm 2.81 \times 10^6/g$, $11.50 \pm 1.50 \times 10^6/g$ and $10.0 \pm 0.0^a \times 10^6 /g$ respectively, as compared to groups C, D and G (Taurine 50mg/kg, Taurine 100mg/kg and Cypermethrin at 20mg/kg with Taurine 100mg/kg) the values were $5.25 \pm 1.97^b \times 10^6/g$, $8.50 \pm 0.50^b \times 10^6/g$ and $5.00 \pm 1.73^b \times 10^6 /g$ respectively (Fig.1). Paired epididymal sperm reserves of the head segment

was significantly higher in groups D and E (Taurine 100 mg/kg and Cypermethrin 20 mg/kg) ($p < 0.05$). The values were $10.25 \pm 3.68^a \times 10^6 /g$ $9.25 \pm 1.89^a \times 10^6/g$ compared to A,B,C,Fand G (Distilled water, Soya oil, Taurine 50 mg/kg , CYP with Taurine 50 mg/kg and CYP with Taurine 100 mg/ kg, the values were $4.40 \pm 1.19^b \times 10^6/g$, $5.00 \pm 1.41^b \times 10^6 /g$, $3.00 \pm 0.71^b \times 10^6 /g$, $5.75 \pm 1.25^b \times 10^6/g$ and $3.25 \pm 0.75^b \times 10^6/g$ respectively (Fig.1) Paired epididymal sperm reserves of the body segment did not show any significant difference among the groups (Fig.1). There was no significant

difference in the Paired testicular filtrate and Paired epididymal filtrate volumes of the different segments among the groups (Fig.2)

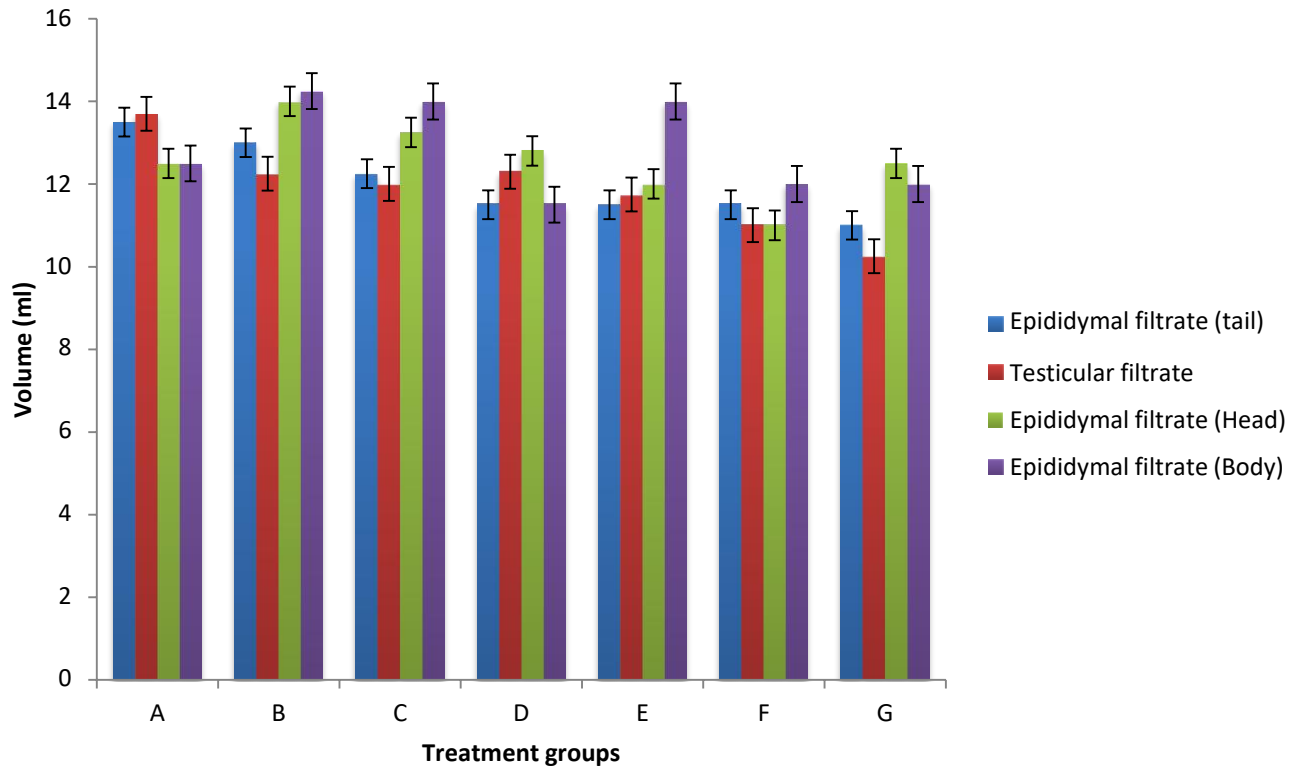


Fig.2: Paired testicular filtrate and epididymal filtrate volumes of Wistar rats treated with Taurine 50mg/kg, 100mg/kg, Cypermethrin at 20mg/kg and combinations of Cypermethrin 20mg/kg with Taurine 50mg and 100mg/kg.

Key: A = Distilled water, B = soya oil at 2 ml/kg, C = Taurine 50mg/kg, D = Taurine 100mg/kg, E = Cypermethrin at 20 mg/kg, F= Taurine at 50 mg/kg and CYP at 20 mg/kg and G= Taurine at 100 mg/kg and CYP at 20 mg/kg.

Paired length of the epididymal segments did not differ among the groups ($p>0.05$) (Table 1)

Table 1: Mean (\pm SEM) Paired length (cm) of epididymal segments of Wistar rats treated with Taurine 50mg/kg, 100mg/kg, Cypermethrin at 20mg/kg and combinations of Cypermethrin 20mg/kg with Taurine 50mg and 100mg/kg.

Groups	Head length (cm)	Body length (cm)	Tail length (cm)
Group A	1.05 \pm 0.05	1.78 \pm 0.11	1.38 \pm 0.08
Group B	1.63 \pm 0.13	1.55 \pm 0.06	1.50 \pm 0.07
Group C	1.20 \pm 0.14	1.80 \pm 0.18	0.75 \pm 0.05
Group D	1.53 \pm 0.10	1.43 \pm 0.11	1.28 \pm 0.03
Group E	1.25 \pm 0.12	1.95 \pm 0.10	1.33 \pm 0.05
Group F	1.50 \pm 0.00	1.85 \pm 0.09	1.40 \pm 0.06
Group G	1.38 \pm 0.10	1.98 \pm 0.12	1.20 \pm 0.00

Paired testes weight and volume did not differ among the groups as well as body weight of the rats ($p>0.05$) (Table 2).

Table 2: Mean (\pm SEM) body weight (g), Paired testicular weight (g) and volume (ml) of Wistar rats treated with Taurine 50mg/kg, 100mg/kg, Cypermethrin at 20mg/kg and combinations of Cypermethrin 20mg/kg with Taurine 50mg and 100mg/kg.

Groups	Testes weight (g)	Testes volume (ml)	Body weight (g)
Group A	0.90 \pm 0.06 ^a	0.90 \pm 0.06 ^a	137.00 \pm 18.5 ^a
Group B	1.20 \pm 0.04 ^a	1.15 \pm 0.05 ^a	165.60 \pm 15.4 ^a
Group C	0.70 \pm 0.07 ^a	0.75 \pm 0.05 ^a	138.0 \pm 28.1 ^a
Group D	1.15 \pm 0.05 ^a	1.20 \pm 0.00 ^a	159.4 \pm 28.0 ^a
Group E	1.13 \pm 0.16 ^a	1.00 \pm 0.00 ^a	175.8 \pm 24.0 ^a
Group F	1.30 \pm 0.03 ^a	1.30 \pm 0.06 ^a	170.0 \pm 29.9 ^a
Group G	1.20 \pm 0.40 ^a	1.15 \pm 0.05 ^a	194.4 \pm 34.3 ^a

^a Values down the column with the same superscript are significantly not different ($P>0.05$).

Mean testosterone profiles of the rats was significantly higher in group G (CYP with 100mg/kg Taurine) 3.28 ± 0.62^a ng/ml compared to the rest of the groups ($p < 0.05$) (Table 3).

Table 3: Mean (\pm SEM) Testosterone profiles (ng/ml) of Wistar rats treated with Taurine 50mg/kg, 100mg/kg, Cypermethrin at 20mg/kg and combinations of Cypermethrin 20mg/kg with Taurine 50mg and 100mg/kg.

Groups	Testosterone profile ng/ml
Group A	1.78 ± 0.33^b
Group B	1.25 ± 0.44^b
Group C	0.79 ± 0.50^b
Group D	0.95 ± 0.41^b
Group E	1.73 ± 0.41^b
Group F	0.42 ± 0.12^b
Group G	3.28 ± 0.62^a

^{a,b} Values down the column with different superscript are significantly different ($P < 0.05$)

Key: A = Distilled water, B= soya oil at 2 ml/kg, C =Taurine 50 mg/kg, D = Taurine 100 mg/kg, E= Cypermethrinat 20 mg/kg, F= Taurine at 50 mg/kg and CYP at 20 mg/kg and G = Taurine at 100 mg/kg and CYP at 20 mg/kg.

DISCUSSION

Paired testicular sperm reserves of groups A and B (Distilled water and Soya oil) were significantly higher than the rest groups ($p < 0.05$). Paired testicular sperm reserves of group D (Taurine 100 mg/kg) was different from Taurine 50 mg/kg and the cypermethrin groups although it was not significant ($p > 0.05$) (Fig.1). This observation showed that taurine treatment 50 mg/kg and 100mg/kg were not better than the controls in terms of testicular sperm reserves. A closer observation however showed a dose dependent effect because 100 mg/kg was better than 50 mg/kg both were better than the cypermethrin treatments. It appears that dose of taurine or its tissue concentration is very important for its effect to take place. The current observation is contrary to the claim that reported that in aged rats, taurine could obviously increase the numbers and the motility of sperm, and the rate of live sperm, but has no significant effects on the rate of intact acrosome of sperm (Wallace and Dawson 1990, Coleman, 1977). It concluded that taurine can improve the semen quality in male animals especially in aged male animals (Wallace and Dawson 1990, Coleman, 1977). In our study there was no improvement in testicular sperm/spermatid reserves as a result of taurine treatment. The dose dependent effect observed maybe a signal that the current dose in this study might not be suitable to enhance testicular sperm reserves. It could be said that the current observation partially agreed with the report that taurine have been demonstrated in spermatozoa and seminal fluid of numerous species and it is known to enhance mammalian sperm characteristics (Vander Horst and Grooten, 1966; Holmes *et al.*, 1992 a and b). This partial agreement may be due to the differences observed between 50 mg/kg and 100 mg/kg, which means that the compound was present in the testes but had little effects probably

due to the dose used. The taurine treatments were obviously different from the cypermethrin treatments, showing that there were some biological activities. The results of the present study indicated that taurine did not have a positive effect on the paired sperm reserves of the tail segment of the epididymis. The controls (groups A and B) were significantly higher in paired sperm reserves compared to groups C and D (Taurine both at 50 mg/kg and 100 mg/kg) these two groups had values lower than the controls (Distilled water and Soya oil). Paired epididymal sperm reserves of the tail segment was significantly higher in groups A, B, E and F (Distilled water, Soya oil, Cypermethrin 20 mg/kg and Cypermethrin with Taurine 50 mg/kg) ($p > 0.05$). In the tail of the epididymis the taurine treatment further diminished sperm reserves even more than the cypermethrin treatment groups with the exception of group E (Cypermethrin with Taurine 50 mg/kg) as compared to groups C, D and G (Taurine 50 mg/kg, Taurine 100 mg/kg and Cypermethrin at 20 mg/kg with Taurine 100 mg/kg). It showed that the epididymal sperm reserves were worst decreased by taurine. The observation at the tail of the epididymis was at tandem with what was observed in the testis and similar physiology might be involved. The diminished sperm reserves observed may be attributed to the osmo-regulatory property of taurine. Taurine has been credited as a neurotransmitter, osmo-regulator and antioxidant in most tissues (Ebtehal, 2018). It has been reported as one of the osmolytes of semen that cause volume regulation. It can cause rapid and extensive volume increases (Yeung *et al.*, 2004). In view of this, physiological fluid dilution might be its mode of decreasing sperm reserves in the testes and in the cauda epididymis. The decreased sperm reserves in the testes and cauda epididymis were supported by the report of Yeung *et al.*,

(2004). According to him major epididymal secretions could serve as osmolytes in murine spermatozoa for volume regulation in response to physiological osmotic challenge in the normal fertile mice. The reduced sperm content of inositol and glutamate in the c-ros knockout mice might reflect maturational abnormalities in volume regulation (Yeung *et al.*, 2004). The current observations agreed with the report that stated that taurine is in high concentration in the male tract and acts as an organic osmolyte in somatic cells, the taurine transporter (TauT), taurine content and taurine channel phospholemman (PLM) in epididymis of mice. TauT and PLM may be involved in taurine regulation in the normal epididymis and the proximal accumulation of taurine in the infertile males (Xu *et al.*, 2003). Taurine has been associated with reduced sperm volume and infertility in mice (Yeung *et al.*, 2004). The present study showed that in the head segment of the epididymis taurine demonstrated a positive effect on paired sperm reserves at 100 mg/kg and this was in line with the document that reported that caput sperm did not respond to k (+) channel blocker quinine by swelling, demonstrating development of regulation during epididymal transit (Yeung *et al.*, 2004). Defective sperm volume regulation causes infertility in c-ros knockout (ko) mice lacking the initial segment (IS) of the epididymis (Yeung *et al.*, 2004). This goes to show that the head of epididymis is unique in its function of volume regulation and presents a different physiological response to osmotic challenge. In the present study there was abundant taurine in the male tract of the rats by virtue of dosing and body synthesis. It has been reported that taurine can be biosynthesized by male reproductive organs (Li *et al.*, 2006). Most importantly taurine has been identified as the major free amino acid of sperm cells and seminal fluid (Holmes *et al.*, 1992a; Holmes *et al.*, 1992b; Guérin *et al.*, 1995 and Hinton, 1990). The antioxidative

property of taurine may be its major mode of enhancing sperm cells quality, but its osmoregulatory effect might be the contradicting mode of action on male reproduction. It has been documented that taurine may function as an antioxidant (Alvarez and Storey, 1983), capacitating agent (Meizel and Lui, 1980; Meizel, 1985), membrane-stabilizing factor (Mrsny, 1985) and motility factor (Boatman *et al.*, 1990) of sperm. It is noteworthy that cypermethrin treatment at 20 mg/kg was also significantly high in paired sperm reserves in the head segment of the epididymis. The implication is that the head of epididymis may not reflect the true picture of the impact of the different treatments. Attention has to be given to the tail of the epididymis which is a storage site since sperm reserves are directly related to sperm count. The observations on the testicular sperm reserves and the tail segment of the epididymis contradicts the report that taurine is vital for reproduction (Ebtehal, 2018). Combination of taurine and cypermethrin at the two doses tested did not enhance paired sperm reserves in all the segments of the epididymis and the testes. This observation was at variance from the report that showed that taurine (100 mg/kg/day, p.o) or combination of taurine and nandrolone decanoate, for 8 successive weeks reversed nandrolone decanoate-induced perturbations in sperm characteristics, normalized serum testosterone level, and restored the activities of the key steroidogenic enzymes; 3 β -HSD, and 17 β -HSD (Maha, 2015). Moreover, taurine prevented nandrolone decanoate-induced testicular toxicity and DNA damage by virtue of its antioxidant, anti-inflammatory, and anti-apoptotic effects (Maha, 2015). The ameliorative effect of taurine in the current experiment was not obvious. It was possible that the antioxidant effect may be reflecting in other semen parameters but

not in paired sperm reserves. Results of testosterone profiles did not support the work of Yang *et al.*, (2010b) who reported that taurine can stimulate testosterone secretion in vivo and in vitro. The significant difference in the testosterone profiles of group G (Cypermethrin with taurine 100 mg/kg) was a one point significance and may not make any meaning. Other parameters measured like length of epididymal segments, testicular filtrates volume, epididymal filtrate volumes, testicular volume, testicular weight and body weight of the rats did not show any difference among the groups. This may have happened due to the level of sensitivity of those parameters to the treatments. It was concluded that taurine at 50mg/kg and 100 mg/kg did not show any statistically significant positive effect on paired testicular sperm/spermatid reserves, paired sperm reserves of the tail and body segment of the epididymis. 100mg/kg of taurine showed consistently higher sperm reserves than 50 mg/kg across the testes and the three segments of the epididymis. Taurine did not prevent cypermethrin reduction of the sperm reserves. Taurine at the doses tested did not improve testosterone profiles of the Wistar rats. The mode of action of taurine on sperm reserves may be its osmoregulatory property. It was recommended that higher doses of taurine be tested to appreciate more of its impact on paired sperm reserves and testosterone profiles of Wistar rats.

ACKNOWLEDGEMENT:

We would like to appreciate and acknowledge Mr Edwin Avar, our supporting staff at the Department of Theriogenology, Faculty of Veterinary Medicine, University of Abuja.

REFERENCES

- ABBASOGLUL, S., KANBAGLI, O. and BALKAN, J. (2001). The protective effect of taurine against thioacetamide hepatotoxicity of rats. *Human & Experimental Toxicology* 20(1):23-27.
- ABD-ALLAH, A.E.Y. (1995). Effect of some pesticides on reproduction. Ph.D. Thesis (Toxicology) Faculty of Veterinary Medicine, Cairo University.
- ALABI, J. F. (2005). Effects of energy supplementation on growth and reproductive function of Bunaji and Friesian x Bunaji bulls. Ph. D Thesis. Ahmadu Bello University, Zaria.
- ALVAREZ, J.G. and STOREY, B.T. (1983). Taurine, hypotaurine, epinephrine and albumin inhibit lipid peroxidation in rabbit spermatozoa and protect against loss of motility. *Biology of Reproduction*, 29:548-555.
- ANUPAM K., SHAILJA J., JOYDEEP D. and GEORGE Z. K. (2023). Pyrethroids toxicity in vertebrates and invertebrates and amelioration by bioactive compounds: A review, *Pesticide Biochemistry and Physiology*, Volume 196, 105615, ISSN 0048-3575. (<https://www.sciencedirect.com/science/article/pii/S0048357523002808>)
- ASSAYED, M. E., H. A, SALEM and KHALAF, A. A. (2008). Protective effects of garlic extract and vitamin C against Cypermethrin reproductive toxicity in male rats. *Research Journal of Veterinary Science*, 1: 1-5.
- BARLOW, S.M., SULLIVAN, F.M., and LINES, J. (2001). Risk assessment of the use of deltamethrin on bed nets for the prevention of malaria. *Food and Chemical*

- Toxicology*; 39: 407-422. Ref.: <https://tinyurl.com/yboe94to>
- BHAVSAR, T.M., PATEL, S.N. and LAU-CAM, C.A. (2010). Protective action of taurine, given as a pre-treatment or as a post treatment, against endotoxin-induced acute lung inflammation in hamsters. *Journal of Biomedical Science* 17: 1-19. Pubmed | Crossref | Others /
- BIOCOMPARE. (2020). Testosterone ELISA Kits from CUSABIO Technology LLC. The Buyers's Guide for Life Sciences.
- BOATMAN, D.E., BAVISTER, D.B. and CRUZ, E. (1990). Addition of hypotaurine can reactivate immotile golden hamster spermatozoa. *Journal of Andrology*, 11(1):66-72.
- CAROLINE, C. (1996). Insecticide fact sheet. *Journal of Pesticide Reform/Summer* Vol. 16, No 2.
- COLEMAN, G.L., BARTHOLD, S.W., OSBALDISTON, G.W., FOSTER, S.J. and JONAS, A.M. (1977). Pathological changes during aging in barrier-reared Fischer 344 male rats. *Journal of Gerontology*, 32(3):258-278.
- DIKEDI, P.N. (2012). Geo-electric probe for ground water in Giri, Nigeria. In: *Global Journal of Science Frontier Research. Physics and Space*. 3-4.
- EBTEHAL, M. F. (2018). Comparative Study of the Effect of Taurine, Caffeine, And /or Paracetamol on Male Fertility and Teratogenicity in Rats. (2018). *Journal of Pharmacy and Pharmaceutics* 5(1): 1-7.
- FAO. (1983). Food production trends in Africa. Food and Agricultural Organisation of the United Nations. Rome.
- GARBER, J.C., BARBEE, R.W., BIELITZKI, J.T., CLAYTON, L.A., DONOVAN, J.C., HENDRIKSEN, C.F.M., KOHN, D.F., LIPMAN, N.S., LOCKE, P.A., MELCHER, J., QUIMBY, F.W., TURNER, P.V., WOOD, G.A. and WÜRBEL, H. (Eds.). (2011). Guide for the Care and Use of Laboratory Animals, 8th edn., National Academies Press, Washington, <http://dx.doi.org/10.17226/12910>.
- GHAZOUANI, L., FERIANI, A., MUFTI, A., TIR M., BAAZIZ I., MANSOUR H.B and MNAFGUI K. (2020). Toxic effect of alpha cypermethrin, an environmental pollutant, on myocardial tissue in male wistar rats. *Environmental Science Pollution Research* 27, 5709–5717. <https://doi.org/10.1007/s11356-019-05336-2>
- GUERIN P, GUILLAUD J, and MENEZO Y (1995). Hypotaurine in spermatozoa and genital secretions and its production by oviduct epithelial cells in vitro. *Human Reproduction*, 10(4):866-872.
- HANDERSON, H. K. and PARKISON, F. N. (1981). Effect of Cypermethrin on haematology, clinical chemistry and gonads of male rabbit. *Veterinary Medical Journal, (Giza)*, 31(1): 32- 37.
- HARRIS, R, WEN, and S. REVIEW. (2012). Taurine: A “very essential” amino acid. *Molecular Vision*. 18:2673-2686. Pubmed | Crossref | Others
- HE, F. (2000). Neurotoxic effect of insecticides current and future research: A review. *Neurotoxicology*, 21(5): 829-835.

- HINTON, B.T. (1990). The testicular and epididymal luminal amino acid microenvironment in the rat. *Journal of Andrology* 11(6):498-505. /
- HOLMES, R.P., GOODMAN, H.O., HURST, C.H., SHIHABI, Z.K. and JARROW, J.P. (1992a). Hypotaurine in male reproduction. In. Taurine. Nutritional Value and Mechanisms of Action. New York: Plenum Press Lombardini JB, Schaffer SW, Azuma J. (eds) *Advances in Experimental Medicine and Biology*: volume 315, 437-441. Springer, Boston, MA https://doi.org/10.1007/978-1-4615-3436-5_53
- HOLMES, R.P., GOODMAN, H.O., SHIHABI, Z.K., and JARROW, J.P. (1992b). The taurine and hypotaurine content of human semen. *Journal of Andrology*, 13(3):289-292.
- HU, J.M., IKEMURA, R., CHANG, K.T., SUZUKI, M., NISHIHARA, M. and TAKAHASHI, M. (2000). Expression of cysteine sulfinate decarboxylase mRNA in rat mammary gland. *Journal of Veterinary Medical Science*, 62(8):829-834.
- HUXTABLE, R.J. (1992). Physiological Actions of Taurine. *Physiological Reviews*, 72(1):101-163.
- INCHEM. (1989). Joint meeting of the FAO Panels of experts on pesticide residues Rome; and the environmental and the WHO expert group on pesticide residues Rome; <http://www.inchem.org>. Accessed 8/3/2010.
- ISABELLE, R., ALAIN, S. and MARCEL, T. (1996). Molecular cloning and sequence analysis of the cDNA encoding rat liver cysteine sulfinate decarboxylase (CSD). *Biochimica et biophysica acta. BBA-GeneStructure and Expression* 1307(2):152- 156.
- JENNIFER, E. J, WILLIAM, E. B. and ANTONIO C. S. C.(1997). Extragonadal Sperm Reserves, Sperm-Depletion Rates, Numbers of Sperm per Mating, and Fertility With Successive Matings by Intact or Unilaterally Vasectomized Rats. *Journal of Andrology*. Vol. 18. No. 6. Copyright© American Society of Andrology
- KWARI, H.D. and WAZIRI, M.A. (2001). Body weight, withers height, scrotal circumference, penis size and spermatozoa reserve of Balami rams. *Sokoto Journal of Veterinary Science*, 3: 81-86.
- LEARY, W., UNDERWOOD, R., ANTHONY, S., CARTNER, D., COREY, T., GRANDIN, C.G., GWALTNEY-BRANT, M.A., MCCRACKIN, R., MEYER, D., MILLER, J. and SHEARER, R.Y. (2013). AVMA Guidelines for the Euthanasia of Animals, 2013 edition. 978-1-882691-21-0.
- LING, S., YU-BANG, W., HONG, S., CHEN, Y., XIA, H., JIAN-HUA, Q., JIAN-WEI, Z and XIN-RU, W. (2008). Effects of Fenvalerate and Cypermethrin on rat sperm motility patterns in vitro as measured by computer assisted sperm analysis. *Journal of Toxicology and Environmental Health Part A*. Volume 71, (5) Pp. 325-332.

- LI, J. H., LING, Y.Q., FAN, J. J., ZHANG, X.P. and CUI, S. (2006). Expression of cysteine sulfinate decarboxylase (CSD) in male reproductive organs of mice. *Histochemistry and Cell Biology*, 125:607-613.
- LOBO, M.V.T., ALONSO, F.J.M. and RIO, R.M. (2000). Immunohistochemical localization of taurine in the male reproductive organs of the rat. *Journal of Histochemistry and Cytochemistry* 48(3):313-320.
- MAHA, A.E.A. (2015). Amelioration of nandrolone decanoate-induced testicular and sperm toxicity in rats by taurine: Effects on steroidogenesis, redox and inflammatory cascades, and intrinsic apoptotic pathway. *Toxicology and Applied Pharmacology* Volume 282, Issue 3, Pp 285-296
- MEIZEL, S., LUI, C.W., WORKING, P.K. and MRSNY, R.J. (1980). Taurine and hypotaurine: their effects on motility, capacitation and the acrosome reaction of hamster sperm in vitro and their presence in sperm and reproductive tract fluids of several mammals. *Development, Growth and Differentiation*, 22(3):483-494.
- MEIZEL, S. (1985). Molecules that initiate or help stimulate the acrosome reaction by their interaction with the mammalian sperm surface. *American Journal of Anatomy*, 174(3):285-302.
- MILENKOVIĆ, D., ĐOROVIĆ, J. and JEREMIĆ, S. (2017). Free radical scavenging potency of dihydroxybenzoic acids. *Journal of Chemistry*: 1-9. Pubmed | Crossref | Others
- MRSNY, R.J. and MEIZEL, S. (1985). Inhibition of hamster sperm Na⁺,K⁺-ATPase activity by taurine and hypotaurine. *Life Science* 36(3):271-275.
- NIITTYNEN, L., NURMINEN, M.L., and KORPELA, R. (1999). Role of arginine, taurine and homocysteine in cardiovascular diseases. *Ann Med* 31(5): 318-326. Pubmed | Crossref | Others /
- OERTEL, W.H., SCHMECHEL, D.E., WEISE, V.K., RANSOM, D.H., TAPPAZ, M.L., KRUTZSCH, H.C. and KOPIN, I.J. (1981). Comparison of cysteine sulphinic acid decarboxylase isoenzymes and glutamic acid decarboxylase in rat liver and brain. *Neuroscience*, 6(12):2701-2714.
- PARK E, PARK SY, WANG C, XU J, LAFAUCI G, and SCHULLER-LEVIS, G. (2002). Cloning of murine cysteine sulfinic acid decarboxylase and its mRNA expression in murine tissues. *BBA-Gene Structure and Expression*, 1574(3):403-406.
- PASANTES-MORALES, H. LOPEZ-COLOME, A.M., SALCEDA, R. and MANDEL, P. (1976). Cysteine sulphinate decarboxylase in chick and rat retina during development. *Journal of Neurochemistry* 27(5):1103-1106.
- PRIYANKA S., ANSHU R., KHUSHBOO C., PREETY M., AND SUDESH R. (2023). *ACS Omega* 8 (16), 14766-14773 DOI: 10.1021/acsomega.3c00817
- SANCHEZ-PARTIDA, L.G., SETCHELL, B.P. and MAXWELL, W.M.C.(1997). Epididymal compounds and antioxidants in diluents for the frozen storage of ram spermatozoa. *Reproduction, Fertility and*

Development, 9(7):689-696.

TUHINA D., RINI G., ANURAG P., ANANYA P., SURYA K. D., TAMANNA R., DEBJANI C., and SUJATA M.C. (2017). Dose-Dependent Hematological, Hepatic and Gonadal Toxicity of Cypermethrin in Wistar Rats. Toxicology and forensic medicine. ICINE

Openventio. Volume 2 : Issue 2 Journal
<http://dx.doi.org/10.17140/TFMOJ-2-122>

UBAH, S. A, OGWU, D., REKWOT PETER, I., RWUAAN, J. S. AND CHIBUOGWU, I. C. (2016). Gonadal and Epididymal Sperm Reserves of Yankasa Rams Treated with Cypermethrin. *American Journal of Biomedical and Life Sciences* volume 4 DO 10.11648/j.ajbls.20160402.12

UBAH S.A., AGBONU O.A., COLUMBUS P.K., ABAH K.O., CHIBUOGWU I.C, ABALAKA S.E, ABAYOMI, S.B, ENEM S.I., EJIOFOR C.E., and AJAYI I.E. (2021), Effects of date fruit (*Phoenix dactylifera*) on sperm cell morphology and reproductive hormonal profiles in cypermethrin-induced male infertility in Wister rats, *Scientific African*, Volume 11, e00713, ISSN 2468-2276,
<https://www.sciencedirect.com/science/article/pii/S246822762100017X>

USEPA, (1989). Risk assessment: guidance for superfund. In: Human Health Evaluation Manual (Part A), Interim Final, vol 1. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington DC.

VAN DER HORST, C.J.G. and GROOTEN, H.J.G. (1966). The occurrence of hypotaurine and other sulfur containing amino acids in seminal plasma and spermatozoa of boar, bull and dog. *Biochim Biophys Acta.*, 117(2):495-497.

VILENA K., BLANKA T.L., ANA L. V., ANJA K., NEVENKA K., VEDRAN V. M., MIRTA. M., ALICA P., DAVOR Ž., SUZANA Ž. (2022). Evaluation of Toxic Effects Induced by Sub-Acute Exposure to Low Doses of α -Cypermethrin in Adult Male Rats Toxics DOI [10.3390/toxics10120717](https://doi.org/10.3390/toxics10120717)

WALLACE, D.R. and DAWSON, R. (1990). Decreased plasma taurine in aged rats. *Gerontology* 36:19-27.

WANG, X-Z., LIU, S-S., SUN., WU, J-Y., ZHOU, Y-L AND ZHANG, J-H. (2009). β - Cypermethrin impairs reproductive function in male mice by inducing oxidative stress. *Theriogenology*, 72, 599-611

WMO. (2012). World weather information service – Abuja, World Meteorological Organisation. Retrieved 1 October, 2012. In:
<http://www.touristlink.com/nigeria/abuja/overview.htm>.

XU, Y.X., WAGENFELD, A., YEUNG, C. H., LEHNERT. W. and COOPER, T.G. (2003). Expression and location of taurine transporters and channels in the epididymis of infertile heterozygous mice. *Mol. Reprod Dev.* 64(2):144-51 doi 10.1002/mrd.10250.PMID:12506346.

- YANG, J. WU, G. FENG, Y. LV, Q. LIN, S. and HU, J. (2010a). Effects of taurine on male reproduction in rats of different ages. *Journal of Biomedical Science* 17(Suppl 1):S9.
<http://www.jbiomedsci.com/content/17/S1/S9>
- YANG, J.C., WU, G.F., FENG, Y., SUN, C.M., LIN, S.M. and HU, J.M. (2010b). CSD mRNA expression in rat testis and the effect of taurine on testosterone secretion. *Amino Acids*, 39(1):155-160, DIO: 10.1007/s00726-009-0388-7./
- YEUNG, C.H., ANAPOLSKI, M., SETIAWAN, I., LANG, F. and COOPER, T. G, (2004). Effects of putative epididymal osmolytes on sperm volume regulation of fertile and infertile c-ros transgenic Mice. *Journal of Andrology*. 25(2):216-23 doi 10.1002/j.1939-4640.2004.tb02781.x.PMID: 14760007.