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Evaluation of the Toxic Potentials of Cypermethrin Pesticide on Some Reproductive and Fertility Parameters in the Male Rats

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Abstract. Adult male Sprague-Dawley rats were exposed to tap water containing 0, 8,571, 17,143, or 34,286 ppm cypermethrin for 12 weeks. Based on water consumption per animal per day the rats received 13.15, 18.93, and 39.66 mg cypermethrin, respectively. Fertility was significantly reduced in male rats ingesting cypermethrin at a concentration of 13.15 and 18.93 mg in that the number of females impregnated by them was significantly reduced. The number of implantation sites was significantly reduced in females mated with males that had ingested cypermethrin at a concentration of 39.66 mg. A significant reduction in the number of viable fetuses was observed in females impregnated by the exposed males at all three doses of cypermethrin. The body weight gain was significantly lower in the treated males. Ingestion of cypermethrin at a concentration of 18.93 or 39.66 mg per day resulted in a significant increase in the weights of testes and seminal vesicles. Preputial gland weights were increased at all three concentrations of cypermethrin. Epididymal and testicular sperm counts as well as daily sperm production were significantly decreased in exposed males. The serum levels of testosterone, follicle-stimulating hormone and luteinizing hormone were significantly reduced in males exposed to 39.66 mg per day. Ingestion of cypermethrin at 18.93 and 39.66 mg/animal/day also resulted in a significant decrease in the perimeter and number of cell layers of the seminiferous tubules. The testes of treated animals were infiltrated with congested blood vessels with marked hemorrhage and a significant accumulation of connective tissue surrounding the seminiferous tubules, which contained a large number of immature spermatids. These results clearly demonstrate the adverse effects of cypermethrin pesticide on fertility and reproduction in male rats.

Cypermethrin is the common name of (±)-α-cyano-3-phenoxybenzyl (±)-cis,trans-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate. The chemical structure of cypermethrin is shown in Figure 1. Cypermethrin is a synthetic pyrthroid insecticide that has been used for several years against many pests, particularly *Lepidoptera*, cockroaches, and termites. Cypermethrin is widely used in Jordan and other countries and is locally produced in Jordan in amounts of 4,958 L/kg (Ministry of Agriculture 1996). It has been classified as class II to III in toxicity, with an LD_{50} of 250 mg/kg when administered orally in corn oil and 4,123 mg/kg when administered orally in aqueous suspension (Ray 1991; US EPA 1989). Various studies have investigated the toxic effects of cypermethrin in mammals; they have revealed increases in salivation, lack of coordination, muscle tremor and tonic-clonic convulsions. These signs of toxicity indicate that the target for this compound is the central nervous system in mammals (Desi *et al.* 1986). Long-term feeding studies have shown increased liver and kidney weights and adverse changes in liver tissues in test animals (U.S. EPA 1989). Pathological changes in the cortex of the thymus, liver, adrenal glands, lungs, and skin were observed in rabbits repeatedly fed high doses of cypermethrin (U.S. National Library of Medicine 1995).

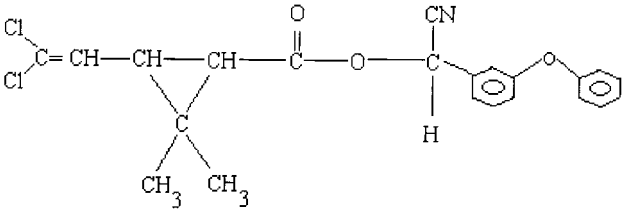

Fig. 1. Chemical structure of cypermethrin

In humans, urinary excretion of cypermethrin metabolites was complete 48 h after the last of five doses of 1.5 mg/kg/day (Ray 1991). Studies in rats have shown that cypermethrin is rapidly metabolized by hydroxylation and cleavage, with over 99% being eliminated within hours. The remaining 1% becomes stored in body fat. This portion is eliminated slowly, with a half-life of 18 days for the cis-isomer and 3.4 days for the trans-isomer (Ray 1991). Cypermethrin has a moderate persistence in soils. Under laboratory conditions, cypermethrin degrades more rapidly on sandy clay and sandy loam soils than on clay soils, and more rapidly in soils low in organic material (U.S. EPA 1989). In aerobic conditions, its soil half-life is 4 days to 8 weeks (U.S. EPA 1989; Kidd and James 1991;

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Wauchope *et al.* 1992). When applied to a sandy soil under laboratory conditions, its half-life was 2.5 weeks (Harris 1981). Cypermethrin is more persistent under anaerobic conditions (U.S. EPA 1989). It photodegrades rapidly with a half-life of 8–16 days.

Cypermethrin is also subject to microbial degradation under aerobic conditions (U.S. EPA 1989). Cypermethrin is not soluble in water and has a strong tendency to adsorb to soil particles (Kidd and James 1991). Furthermore, cypermethrin is stable to hydrolysis with a half-life of more than 50 days and to photodegradation with a half-life of more than 100 days (U.S. EPA 1989). In pond waters and in laboratory degradation studies, pyrethroid concentrations decrease rapidly due to sorption to sediment, suspended particles and plants. Microbial degradation and photodegradation also occur (Muir *et al.* 1989; Agnihotri 1986).

Although insecticides like cypermethrin may be valuable in agriculture, many pesticides or their breakdown products can be found in trace amounts or higher levels in soil, air, and water. Clinical, occupational, or environmental exposure to these agents may cause serious health risks including reproductive function. Indeed, there is ongoing concern that pesticides like cypermethrin may be causing a variety of reproductive disorders in humans and wildlife. Recent studies have shown that a wide range of pesticides, in trace amounts, may lead to serious problems in both males and females, including infertility, increased mortality of offspring, and behavioral changes such as aggression (Berteau *et al.* 1989; Book *et al.* 1991; Prendergast *et al.* 1989; Russel *et al.* 1987). Despite the extensive research on the various toxic effects of cypermethrin, there is a shortage of studies evaluating any reproductive effects. The aim of the present study is, therefore, to investigate the effects of cypermethrin 10 administered in drinking water on the fertility and reproduction of adult male rats.

Materials and Methods

Animals

Adult male Sprague-Dawley rats (250–300 g, 80–90 days old) were raised in the animal house unit in the Faculty of Medicine at Jordan University of Science and Technology under controlled temperature of 21 ± 1°C in 12 h light, 12 h darkness schedule (lights on 06.00–18.00h). Food and water were offered *ad libitum*.

Administration of Cypermethrin Pesticide

Cypermethrin 10 pesticide was purchased from the Veterinary and Agricultural Products Co. Ltd. (VAPCO, Amman, Jordan) and was dissolved in tap water at a concentration of 34,286 (1/10 of the LD_{50}), 17,143 (1/20 of the LD_{50}), and 8,571 ppm (1/40 of the LD_{50}). Male rats were randomly assigned into groups of 10 animals each and allowed *ad libitum* access to tap water containing cypermethrin. Control male rats were given tap water only.

Rat oral LD_{50} for cypermethrin is 4,123 mg/kg (Pesticide Dictionary 1995). The dose was adjusted weekly according to the average body weight of the group (Ema *et al.* 1997). Cypermethrin, as a term, is going to be used in the text to indicate cypermethrin 10.

Fertility Test

Animals were observed daily from the first day of exposure to cypermethrin for clinical signs of toxicity. Their water consumption was measured every day and the body weights every week.

Fertility was estimated in adult male rats exposed to 0, 8,571, 17,143, and 34,286 ppm cypermethrin for 12 weeks. After 12 weeks of cypermethrin ingestion, each treated male was placed in an individual cage with two virgin untreated females of the same strain. They were left together for 10 days, during which two estrus cycles should have elapsed (Rugh 1968). Adult male rats that ingested cypermethrin as well as the control males were then removed and sacrificed for further evaluations. Ten days later, the mated females were killed by cervical dislocation under light ether anesthesia and the following measurements were recorded: number of pregnant females, number of implantation sites, number of viable fetuses, number of resorptions, and number of females with resorptions.

Evaluation of Reproductive Organ Weights

Cypermethrin-exposed and control males were sacrificed after 12 weeks of cypermethrin ingestion and the 10-day period of mating. The following organs were excised and weighed: paired testes, seminal vesicles (stripped of seminal fluid), and preputial glands.

Testicular and Epididymal Sperm Counts

The excised left testis and epididymis were weighed. Testis from each rat was placed in 10 ml of normal saline (0.9% sodium chloride) and refrigerated for later homogenization for spermatid count. Epididymis was placed in 15 ml of normal saline (0.9% sodium chloride) and refrigerated for later homogenization for epididymal sperm count.

Sperm count was performed according to the method of Amann and Lambiase (1969). Briefly, the excised left testis or epididymis from each rat was sectioned by a disposable blade in 10 and 15 ml of normal saline in a conical glass petri dish, and then minced using a manual glass homogenizer. The homogenate was mixed using a vortex mixer and the number of sperm measured using a hemacytometer. Epididymal sperm counts were expressed as number of sperms per gram of epididymis. Testicular spermatid counts were expressed as the number of spermatids per gram of testis. The estimate of daily sperm production/gram of testis was calculated by dividing the spermatid count by 6.1, which is the duration of a seminiferous cycle during which developing spermatozoa are in the spermatid stage (Amman *et al.* 1976).

Hormone Assay

Blood samples were taken from the heart of animals under anesthesia using an 1 m syringe before they were sacrificed. Blood samples were centrifuged at 5,000 rpm for 4 min, and the serum samples were stored at −70°C for future analysis. Serum hormone levels were assayed using the method of double antibody enzyme immunoassay as described in the kits purchased from Biosource, Belgium (FERTIGENIX-TESTO-EASIA code 40 170 00, FERIGENIX-LH-EASIA, code 40 131 00, and FERTIGENIX-FSH-EASIA code 40 084 00).

Histological Evaluation and Morphometric Measurements of Testes

The excised testis was fixed in 10% formalin solution and then processed using standard laboratory procedures for histology. The

Table 1. Effect of long-term ingestion of cypermethrin on body weight gain and water consumption in adult male rats

Treatment	Body Weight Gain (g)[a,b]	Water Consumption (ml)[b]	Actual Dose Consumption (mg/rat/day)
Tap water	10.88 ± 6.60	16.1 ± 6.6	—
Cypermethrin 34,286 ppm	−41.10 ± 7.30†††	11.8 ± 6.1	39.66
Cypermethrin 17,143 ppm	−25.80 ± 5.03†††	10.9 ± 4.3†	18.93
Cypermethrin 8,571 ppm	10.70 ± 8.02††	14.9 ± 6.8	13.15

[a] Body weight gain = final body weight minus initial body weight.
[b] Results are expressed as mean ± SD.
† $p < 0.05$, †† $p < 0.005$, ††† $p < 0.0001$ significantly different from control group (Student *t* test).

tissue was embedded in paraffin blocks, sectioned perpendicular to the longest axis of the testis at 7 μm thickness and stained with hematoxylin and eosin. Stained sections were mounted with DPX (Dextran Plasticiser Xylene) and examined using light microscopy. The following morphometric measurements were recorded: number of cell layers per seminiferous tubule (average of 10 randomly selected seminiferous tubules per section); number of seminiferous tubules per field (average of 10 random readings); and perimeter and lumen diameter of seminiferous tubules using a calibrated ocular lens (average in 10 randomly selected seminiferous tubules per section).

Results

Effect of Cypermethrin on Body Weight Gain and Water Consumption

Table 1 demonstrates the effects on body weight gain (final body weight minus initial body weight) and water consumption of male rats exposed to 0, 8,571, 17,143, and 34,286 ppm cypermethrin. The actual doses that the animals received based on water consumption per animal per day were 0, 13.15, 18.93, and 39.66 mg, respectively. Body weight gain reduced in males ingested 39.66 and 18.93 mg/animal/day ($p < 0.0001$) or 13.15 mg/animal/day ($p < 0.005$) cypermethrin. Water consumption decreased only in males ingested 18.93 mg/animal/day ($p < 0.05$).

Effect of Cypermethrin on Fertility

The results depicted in Table 2 demonstrate the toxic effects of cypermethrin on male fertility. As can be seen, fertility was reduced in males ingesting 39.66 or 18.93 mg/animal/day. The number of pregnant females impregnated by males ingesting 39.66 mg/day/animal ($p < 0.01$) or 18.93 mg/animal/day ($p < 0.05$) was decreased. The number of implantation sites was reduced in females impregnated by males ingesting 39.66 mg/animal/day ($p < 0.05$) cypermethrin. Furthermore, the number of viable fetuses was reduced in females impregnated by males that ingested 39.66, 18.93 ($p < 0.0001$) and 13.15 mg/animal/day ($p < 0.005$) cypermethrin. The total number of resorptions per group and the number of females with resorptions were increased in females impregnated by males who ingested 39.66, 18.93, and 13.15 mg/animal/day ($p < 0.0001$) cypermethrin.

Effect of Cypermethrin on Weights of Reproductive Organs

The data presented in Table 3 show the effect of exposure to cypermethrin on weights of some male reproductive organs. Absolute weight of testes was increased in males exposed to cypermethrin at a concentration of 34,286 ($p < 0.005$) and 17,143 ppm ($p < 0.05$). The absolute weight of seminal vesicles was increased in males exposed to 34,286 ppm ($p < 0.0001$) and 17,143 ppm ($p < 0.005$) cypermethrin. The relative weight of the seminal vesicles was increased in males exposed to 34,286 ppm ($p < 0.05$) cypermethrin. The absolute weight of preputial gland was increased in males that ingested 39.66 ($p < 0.0001$), 18.93 ($p < 0.005$), and 13.15 mg/animal/day ($p < 0.05$) cypermethrin. The relative weight of the preputial gland was also increased in males exposed to 39.66 ($p < 0.005$), 18.93, and 13.15 mg/animal/day ($p < 0.05$) cypermethrin.

Effect of Cypermethrin on Sperm Counts

Table 4 demonstrates the results obtained after exposure to cypermethrin on sperm counts of adult male rats. Epididymal sperm counts were reduced in males that ingested 39.66, 18.93, and 13.15 mg/animal/day cypermethrin ($p < 0.05$). Testicular sperm counts and daily sperm production were reduced in males exposed to 39.66 and 18.93 mg/animal/day ($p < 0.0001$) and 13.15 mg/animal/day ($p < 0.005$) cypermethrin.

Effect of Cypermethrin (39.66 mg/animal/day) on Serum Levels of Testosterone FSH, and LH

Serum -hormone levels of testosterone, follicle-stimulating hormone (FSH), and luteinizing hormone (LH) were reduced in adult male rats ingesting cypermethrin at a dose of 39.66 mg/animal/day ($p < 0.0001$) (Table 5). It is noteworthy that the hormone levels were not measured in animals exposed to cypermethrin at the two lower concentrations.

Table 2. Effect of long-term ingestion of cypermethrin on fertility of adult male rats

Treatment	No. of Males	No. (%) of Pregnant Females	No. of Implantation Sites[a]	No. of Viable Fetuses[a]	Total No. of Resorptions/Total No. of Implantation Sites	No. (%) of Animals with Resorptions
Tap water	8	15/16 (93.8)	9.07 ± 1.44	9.07 ± 1.44	0/136	0/16 (00.0)
Cypermethrin 34,286 ppm	10	11/20** (55.0)	7.00 ± 2.19†	4.18 ± 1.83†††	31/77***	9/11*** (81.8)
Cypermethrin 17,143 ppm	10	12/20* (60.0)	8.00 ± 1.65	6.25 ± 1.66†††	21/96***	8/12*** (66.6)
Cypermethrin 8,571 ppm	10	14/20 (70.0)	7.64 ± 2.59	6.29 ± 2.87††	19/107***	8/12*** (66.6)

[a] Results are expressed as mean ± SD.
† $p < 0.05$, †† $p < 0.005$, ††† $p < 0.0001$ significantly different from control group (Student *t* test).
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.0001$ significantly different from control group (Chi-square test).

Table 3. Effect of long-term ingestion of cypermethrin on reproductive organ weights of adult male rats

Treatment	No. of Males	Absolute Testes Weight (g) (mg/100 g B.wt)[a]	Absolute Seminal Vesicles Weight (g) (mg/100 g B.wt)[a]	Absolute Preputial Gland Weight (g) (mg/100 g B.wt)[a]
Tap water	8	2.90 ± 0.36 (961.5 ± 72.0)	0.56 ± 0.07 (187.5 ± 23.0)	0.14 ± 0.04 (45.3 ± 13.0)
Cypermethrin 34,286 ppm	10	3.55 ± 0.32†† (1,030.4 ± 99.0)	0.79 ± 0.10††† (228.7 ± 29.0)†	0.23 ± 0.04††† (65.7 ± 10.0)††
Cypermethrin 17,143 ppm	10	3.50 ± 0.42† (963.0 ± 90.0)	0.76 ± 0.13†† (210.3 ± 33.0)	0.25 ± 0.07†† (68.1 ± 19.0)††
Cypermethrin 8,571 ppm	10	3.16 ± 0.29 (1,018.2 ± 130.0)	0.66 ± 0.11 (213.3 ± 46.0)	0.21 ± 0.07† (67.9 ± 27.0)†

Results are expressed as mean ± SD.
† $p < 0.05$, †† $p < 0.005$, $p < 0.0001$ significantly different from control group (Student *t* test).
[a] Relative weights.

Table 4. Effect of long-term ingestion of cypermethrin on testicular and epididymal sperm counts in adult male rats

Treatment	Epididymal Sperm Count/g Epididymis* No. × 10^4	Testicular Sperm Count/g testis* No. × 10^4	Daily Sperm Production/ g Testis* No. × 10^4
Tap water	195.0 ± 62.6	59.0 ± 9.3	9.7 ± 1.5
Cypermethrin 34,286 ppm	136.4 ± 11.1†	40.8 ± 6.9†††	6.7 ± 1.1†††
Cypermethrin 17,143 ppm	141.3 ± 23.1†	43.1 ± 4.6†††	7.1 ± 0.8†††
Cypermethrin 8,571 ppm	146.1 ± 28.5†	44.2 ± 5.6††	7.2 ± 0.9††

* Results are expressed as mean ± SD.
† $p < 0.05$, †† $p < 0.005$, ††† $p < 0.0001$ significantly different from control group (Student *t* test).

Effect of Cypermethrin on the Histology of Testes and Some Morphometric Measurements

Histological sections of the testis of adult male rats after ingestion of cypermethrin via drinking water were carried out to see whether the reduction in male fertility observed in this study was in part due to cypermethrin effect on the structure of the testis. In general, all sections observed at all concentrations used were found to have congested blood vessels, islands of hemorrhage at areas surrounding seminiferous tubules indicated by the presence of red blood cells in the interstitial tissue and increased amount of connective tissue between seminiferous tubules (Figure 2A and 2B). A significant number of immature spermatids were also observed in the lumen of some seminiferous tubules as compared to controls (Fig. 3).

The perimeter of the seminiferous tubule decreased in males

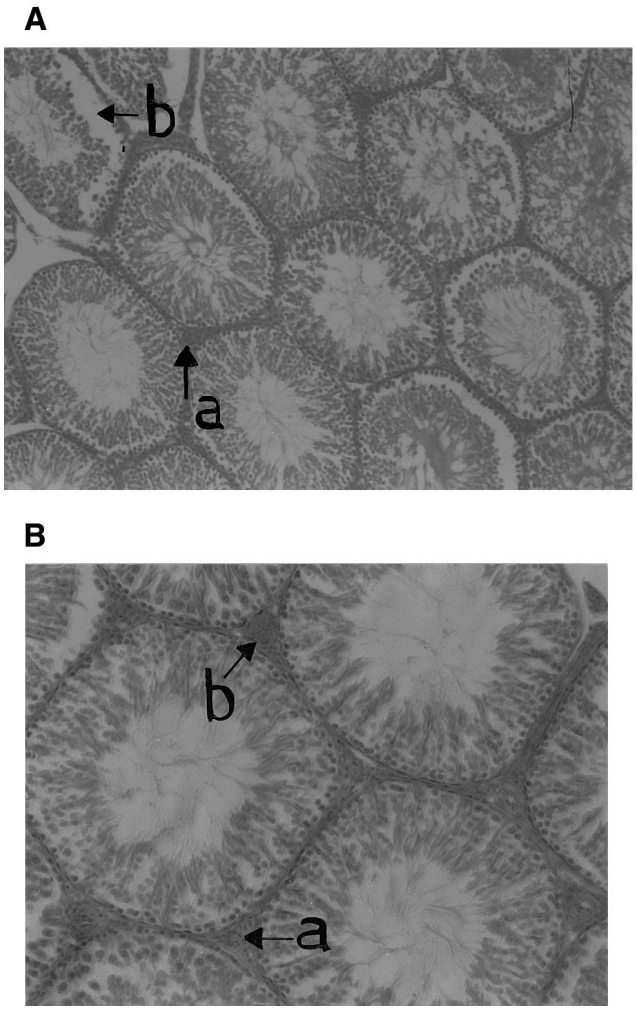

Fig. 2. A: Cross-section of the seminiferous tubules in the testis of a cypermethrin-treated rat (39.66 mg/day/rat) showing (a) increased amounts of interstitial connective tissue and (b) a distorted tubule (hematoxylin and eosin stain). Magnification: 600× B: Higher magnification of 2A showing (a) connective tissue and (b) congested blood vessels (hematoxylin and eosin stain). Magnification: 1,500×

that ingested 39.66 and 18.93 mg/animal/day ($p < 0.05$) cypermethrin. Seminiferous lumen diameter was not affected in males that ingested cypermethrin. On the other hand, the number of seminiferous tubules was reduced in males that ingested 39.66 and 18.93 mg/animal/day ($p < 0.05$) cypermethrin. A decrease in the number of cell layers of the seminiferous tubules was observed in males that ingested 39.66, 18.93 ($p < 0.0001$), and 13.15 mg/day ($p < 0.005$) cypermethrin (Table 6).

Statistical Analysis

Differences between control and cypermethrin-exposed animals were analyzed by either Chi-square test or student *t* test using SPSS for windows. The p values of less than 0.05 were considered statistically significant.

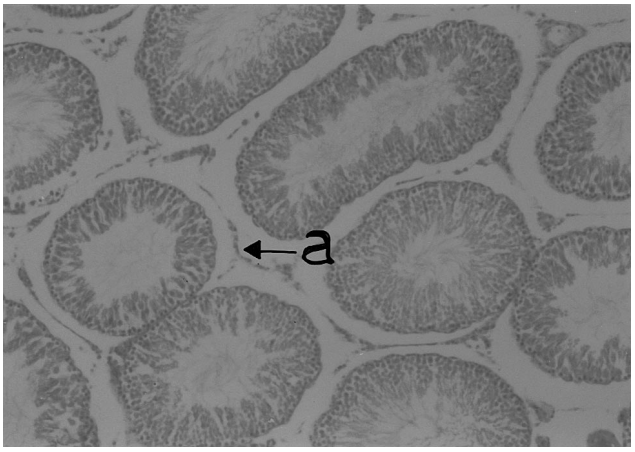

Fig. 3. Cross-section of the seminiferous tubules in the testis of a control rat showing (a) regularly arranged tubules with little connective tissue (hematoxylin and eosin stain). Magnification: 600×

Table 5. Effect of cypermethrin (39.66 mg/day/rat) on serum levels of testosterone, FSH, and LH

Treatment	Testosterone (ng/ml)	FSH (mlU/ml)	LH (mlU/ml)
Tap water (control)	5.45 ± 1.34	0.94 ± 0.12	1.69 ± 0.85
Cypermethrin (39.66 mg/day/animal)	3.15 ± 0.76*	0.46 ± 0.27*	0.16 ± 0.13*

Results are expressed as mean ± SD.
* $p < 0.0001$ significantly different from the control group (Student's *t*-test).

Discussion

The present study was designed to investigate any adverse effects of cypermethrin pesticide on fertility and reproduction of adult male rats. Cypermethrin pesticide was chosen in this study because it is widely used by the farmers in many parts of Jordan, especially in the Jordan valley. The animal model used in this study was used previously by several workers to assess the adverse effects of pesticides on fertility and reproduction in laboratory animals (Ema *et al.* 1997; Harazono *et al.* 1996; Toth *et al.* 1989; Lu and Kennedy 1986). The doses used in the present study were selected according to the LD_{50} value of cypermethrin.

The results presented herein clearly demonstrate that ingestion of cypermethrin for 12 weeks induced adverse effects on male fertility and reproduction. Several reproductive parameters were adversely affected after ingestion of the pesticide cypermethrin by adult male rats. The pregnancy rate, the number of implantation sites, and the number viable fetuses were significantly reduced in females impregnated by cypermethrin-exposed males. In addition, the serum levels of testosterone, FSH, and LH were all reduced in males who ingested 39.66 mg/animal/day cypermethrin. The observed decrease in male fertility could be explained by the fact that the pesticide acted directly on the testes and influenced the androgen biosynthesis pathway. An agent acting directly on the brain, hypothalamus,

Table 6. Effect of long-term ingestion of cypermethrin on morphometric measurements of seminiferous tubules in adult male rats

Treatment	Perimeter (mm) (10×)	Lumen Diameter (mm) (10×)	No. of Seminiferous Tubules/Field (10×)	No. of Cell Layers/Seminiferous Tubule (40×)
Tap water	0.41 ± 0.02	0.16 ± 0.03	18.70 ± 2.58	6.53 ± 0.56
Cypermethrin 34,286 ppm	0.36 ± 0.05†	0.15 ± 0.05	14.90 ± 5.32†	4.75 ± 0.94†††
Cypermethrin 17,143 ppm	0.36 ± 0.04†	0.17 ± 0.03	15.4 ± 2.6†	4.95 ± 0.51†††
Cypermethrin 8,571 ppm	0.41 ± 0.11	0.17 ± 0.03	17.80 ± 1.81	5.20 ± 0.83††

Results are expressed as mean ± SD.
† $p < 0.05$, †† $p < 0.005$, ††† $p < 0.0001$ significantly different from control group (Student *t* test).

or anterior pituitary gland will indirectly affect the testes and will possibly affect sexual activity (Amann 1982). These conclusions are strongly supported by the wide array of abnormalities seen when histological sections of the testes were examined. These abnormalities include the accumulation of connective tissue between the seminiferous tubules, the significant reduction in the number of seminiferous tubules and the release of premature spermatids into the lumen of the seminiferous tubules. Similar studies have indicated a strong link between male infertility and exposure to over than 50 pesticides, including pyrthroids (Cox 1996). A significant increase in the proportion of dead or abnormal sperm in mice was reported after exposure to the pesticides cypermethrin (Bunya and Pati 1988) or deltamethrin (Bunya and Pati 1990). Similar results were observed in rats after exposure to fenvalerate, another pyrthroid pesticide (Pati and Bunya 1989).

In the present study, the significant increase in the number of resorptions in females mated with males ingested cypermethrin may be attributed to an increase in preimplantation mortality of unhealthy fertilized ova due to alterations in sperm quality.

The results presented in this work also show that the weight of the testes, seminal vesicles, and preputial glands were significantly increased in males ingested cypermethrin in a dose-dependent manner. The increase in seminal vesicle and preputial gland weights argue that androgen production may actually be increased rather than decreased as observed in this study. The increased weight of testis, and possibly seminal vesicle and preputial gland may be attributed to the accumulation of interstitial connective tissue observed in the testes. However, other factors, such as alterations in circulating thyroid hormone levels or thyroid function, can't be excluded. The size and activity of the preputial gland in rodents are clearly influenced by a variety of steroid hormones (Ebling 1963). Preputial glands also produce behavior-modulating phermones that alter fighting and other behavior in the rat (Brain *et al.* 1983).

Ingestion of cypermethrin caused a significant reduction in both epididymal and testicular sperm counts in a dose-dependent manner. Such reduction may be caused by a direct effect of the pesticide on testicular Leydig and Sertoli cells, causing a decrease in testosterone production. In line with the current study, exposure to the pesticide ethylene dibromide has been reported to cause a significant reduction in sperm motility and viability, suggesting that exposure may affect accessory sex glands (Schraeder *et al.* 1988). Furthermore, exposure to epichlorohydrin resulted in reduction in epididymal sperm numbers and increased abnormal sperm morphology in animals with manifested histopathological changes (Toth *et al.* 1989; Kluwe *et al.* 1983).

Despite unlimited access to food, there was a significant decrease in body weight gain in male rats exposed to cypermethrin (Table 1). It would appear that this reduction in body weight gain is a clear indication of general toxicity. This magnitude of toxicity, which may make the animals rather lethargic, might have affected the animals indirectly rather than having any specific effect on reproductive function. Chaplin *et al.* (1993) showed that the reproductive system of male rats was relatively resistant to body weight reduction down to even 70% of the body weight of control animals.

In conclusion, our results strongly suggest that exposure to the pesticide cypermethrin would have adverse effects on fertility and reproduction in adult male rats. However, the mode of action of this pesticide on both fertility and the reproductive system requires further investigation.

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