The Effects of the Pyrethroid Pesticide Cypermethrin on Gills and Kidneys (Trunk Mesonephroi) of Guppy's Fish (*Poecilia reticulata*)

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ABSTRACT

The present study explored the histopathological impacts of the pyrethroid pesticide cypermethrin on gills and trunk mesonephroi of guppy fish (45-day-old) juveniles. Five-day-old guppy larvae were exposed to 7×10^{-4} or 9.3×10^{-4} μ M/L of cypermethrin only once for 48-hours. Afterward, they were left to grow (in cypermethrin-free aquaria) until they reach 45-days-old. The juveniles were removed from the aquaria, anesthetized, dissected out and their gills and mesonephroi were processed for paraffin embedding, stained with haematoxylin and eosin, examined by light microscopy, photographed and described. The severity of the observed histopathological changes in gills and mesonephroi of cypermethrin-exposed juvenile's were concentration-dependent. In gills, the lesions were represented by hyperplasia of primary lamellae, shortening, fusion, epithelial lifting of the secondary lamellae; stasis; twisting of the primary lamella; leukocytes infiltration; rupture of the lamellar epithelium; focal proliferation of primary and secondary lamellar epithelial cells; hemorrhages; telangiectasia; hyperactivity of mucous cells and necrosis. In kidneys the histopathological changes included: glomerular damage, dilated capsular space, collapse of glomerular tuft, fluid accumulation and enlarged Bowman's space, dilatation of renal tubules, atrophy and pyknosis of renal epithelium, necrosis and excessive proliferation of the hematopoietic tissue.

Key Words: Cypermethrin, Gills, Glomerulus, Guppy's Fish, Hyperplasia, Lamellar epithelia, Mesonephroi, Pyknosis, Renal tubules.

INTRODUCTION

The guppy (*Poecilia reticulata*) is a small and colorful tropical ornamental teleost. It is a member of the family Poecilidae (Yap *et al.,* 2008) that have internal fertilization and bear live young (Auer *et al.,* 2010). They had introduced into several tropical countries in the 1940s for the biological control of mosquito larvae, the vectors of infectious malaria disease (Fernando and Phang, 1985; Rojas *et al.,* 2004) and filariasis (Dua *et al.,* 2007; Chandra *et al.,* 2008; Kusumawathie *et al.,* 2008). Because of short generation interval, ease of breeding in laboratories, and the availability of many different strains; the guppy has become a model organism for several biological studies (Brown, 1978; Houde, 1978; Evans *et al.,* 2003; Martyn *et al.,* 2006; Magellan and Magurran, 2007; Mobarak, 2009).

Cypermethrin is among the most effective pyrethroids that has a broad-spectrum composite insecticide and fast acting neurotoxin after skin contact and stomach action (Bradbury and Coats, 1989; Tao *et al.,* 2008). It kills target organisms by disrupting the function of the nervous system, thereby, causing excitability of gamma-aminobytyric acid receptors (Ramadan, 1988). Because of its quick insecticidal capabilities, low toxicity and easy biodegradability (Dorman and Beasley, 1991) cypermethrin has been extensively used in the last two decades in both developed (Shi *et al.,* 2011) and developing countries, especially Saudi Arabia and Egypt (Assayed *et al.,* 2010). It is widely used to control many pests, moth pests of cotton, fruits, vegetables crops and soybean (Meister, 1992; Carriquiriborde *et al.,* 2007), as well as indoor pests (Lepidoptera, cockroaches, and termites) (Choi *et al.,* 2006; Wang *et al.,* 2010). It has been also used to control cotton ball worm (*Heliothis armigera),* the larvae of mosquitoes and milk fishes during pond preparation in urban and agricultural environments (David *et al.,* 2004; Collins and Cappello, 2006) and for the control of ectoparasites which infest some companion animals (Velisek *et al.,* 2006). In fish aquaculture cypermethrin has been used against lice infestations (Das and Mukherjee, 2003). Cypermethrin is mainly released to the environment through its application, manufacture, transportation and storage. Therefore, it can be found in trace amounts or at higher concentrations in soil and air (Wang *et al.,* 2009) and in freshwater aquatic systems (Hu *et al.,* 2012). Cypermethrin has been reported as extremely toxic to fish and other aquatic organisms at very low concentrations (Bradbury and Coats, 1989; Sarkar *et al.,* 2005; Kumar *et al.,* 2010).

It has been found to accumulate in rat body fat, skin, liver, kidneys, adrenal glands, ovaries, lung, blood, heart and brain (Tao *et al.,* 2008) and in mouse testis (Wang *et al.,* 2009). In the available literatures, there are no study about the effect of cypermethrin on the development of gills and kidneys of guppy postnatal larva, therefore, the present study was undertaken to investigate the possible damaging effect of cypermethrin on the developing gills and mesonephroi of guppy's juveniles.

MATERIALS AND METHODS

Aquaria

The water in the aquaria was obtained from a header tank containing constantly aerated (dechlorinated) water composed of deionised water mixed with local tap water (5:1). The tap water was analyzed at the Department of

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Chemistry, Faculty of Science, Taif University and its specifications were as follows: pH 8.46, Total Dissolved Saline (TDS) 2.52 ppm, conductivity 5.40 μs. Then NaCl (450 mg/L) was added to waters that resulting in a conductivity of 1.2 mS/cm. All aquaria were provided with thermostats 100W, thermometers, air pumps, air lines, natural gravel, and gravel cleaner. The temperature was set between 22-24°C by heaters.

Guppy (*Poecilia reticulata*) Specimens and Breeding Method

The present study was carried out in the laboratory of Zoological Research, Biology Department, Faculty of Science, Taif University, KSA. The guppy (*Poecilia reticulata*) specimens (only active, healthy and sexually mature males and females) were purchased two weeks prior to the experiments; from a local breeder in El-Taif, KSA, originally imported from Singapore. The fish were brought to the laboratory within 30 min in 2 black plastic bags (one contains females, while the other contains males) with sufficient air. The plastic bags were placed into the stock aquaria for about 35 min for acclimation. Then the bags were cut open and the fish (males and females) were allowed to swim into the aquaria water. All purchased fishes were mature and approximately of four-months old. The adult females were virgins and thus sexually receptive at the time of testing. Their coloration was fainter and their tails were more rounded than those of the males, they weighing about 1000±5 mg and 4.55±0.05 cm length. Each mature female was characterized by the presence of a distinct black part between its anal and pelvic fins. They were characterized by their long dorsal fin and golden red delta-shaped caudal fins. Also, in the inner anal fin parts were modified into the copulatory organ i.e. gonopodium. Specimens were checked daily for behavioral changes and signs of breeding activity. Pregnant females were separated individually in special fish incubators before giving the larvae. The new-born fry were removed within 3 to 20 hours in 8 L plastic aquaria till the experiments.

The 5-day-old larvae (control and cypermethrin-exposed) were reared in plastic aquaria (18 × 32 ×21 cm; Vol. 10 L) until they were investigated on the 45th day of postnatal life. The developing larvae were kept on a 12:12 h light: dark cycle at 22° C ± 2. They were allowed to feed (twice a day) on Aquadine Betta Basic Food of guaranteed composition; crude protein Min 35%, crude fat Min 5%, crude fiber Max 5%, crude ash Max. 10% and moisture Max. 10%.

Cypermethrin Pesticide

The pesticide used in the present study was a technical-grade cypermethrin [Cyperex 100 EC (Batch No. 21010618)], in the form of yellowish clear liquid (active ingredient: cypermethrin 10% W/V, density (g/ml): 0.904-0.912), maintained in one liter white plastic bottle and stored at ambient temperature. The

cypermethrin was kindly provided by Pioneers Chemical Factory Co., Al-Taif, KSA.

Determination of Cypermethrin LC$_{50}$

Following the determination of the adult cypermethrin LC$_{50}$ by Zarha (2014), the cypermethrin concentrations used for larvae were prepared by suspending appropriate amount of cypermethrin in the appropriate volumes of the dechlorinated water and based on the average weight of the 5-day-old larvae. The estimated LC$_{50}$ of cypermethrin for these larvae was 14×10^{-4} μM/L. The concentrations selected for the present study were ½ LC$_{50}$ (=7×10^{-4} μM/L) as the low dose and ⅔ LC$_{50}$ (=9.3×10^{-4} μM/L) as the high dose.

The Experimental Design

The cypermethrin doses were added to the water by a digital micropipette and left for 30 minutes to blend with the water and then specimens were introduced. During the experiment, the larvae were fed and the water was renewed every 24 hours. The exposure of the five-day-old guppy larvae to the selected concentrations was at once for 48-hours. Afterward, they were left to grow (in cypermethrin-free aquaria) until they became 45-day-old. Then they were removed from the aquaria, anesthetized, dissected out and their gills and mesonephroi were fixed in aqueous Bouin's solution for 24-hours, processed for paraffin embedding, stained with haematoxylin and eosin, examined by light microscopy, described and photographed.

RESULTS

The Gills

The Gills of Controls

The gills of guppy fish are made up of four gill arches (similar to all teleost) on either side of the head (Fig. 1a). Each gill arch is extended from floor to roof of the buccal cavity and contains primary lamellae (a few rows of filaments surrounded by undifferentiated tissue from which secondary lamellae (respiratory lamellae) are projecting laterally to line both sides. The primary lamella is covered by stratified squamous epithelium. Its tip is represented by a mass of undifferentiated tissue contains a marginal blood sinus lined by an endothelium. In the core of the primary lamellae there is a rigid mass of cartilaginous tissues surrounded by traces of vascular channels. The surface of the secondary lamellae is covered with a delicate layer of a simple squamous epithelium inside it there are lamellar blood sinuses separated by the pillar cells. Each secondary lamella contained about 8 red blood corpuscles nuclei some of them exhibited mitosis. Among the epithelial covering of the secondary lamellae some of the mucous cells and chloride cells are located. The chloride cells are more frequent at the base of the secondary lamellae. In this control group, the gill arches showed normal arrangement pattern except a

slight epithelial lifting of a few secondary lamellae (Fig. 1b).
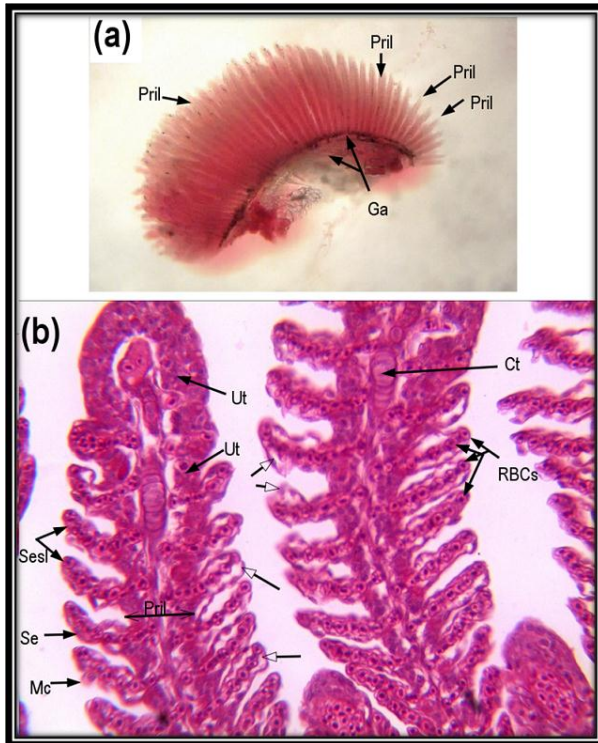
Figure 1 (a, b): a) A complete guppy fish gill arch with the primary lamellae being arranged as rows on the gill arch. X20. b) A longitudinal section of the gills showing its normal structural appearance with a slight epithelial lifting of a few secondary lamellae (black hallow-head arrows). H&E, X400. **Ct**: Cartilaginous tissue, **Ga**: Gill arch, **Mc**: Mucus cell, **Pril**: primary lamella, **RBCs**: Red Blood Cells, **Se**: Squamous epithelium, **Secl**: Secondary lamella, and **Ut**: Undifferentiated tissue.

The Gills of $7x10^{-4}$ µM/L Cypermethrin-Exposed Juveniles

The observed histopathological changes in gills of the exposed group ranged from slight to moderate lesions [i.e. the stages 1 and 2 described by Poleksic and Mitrovic-Tutundsic (1994)]. The slight stage (1) is represented by hyperplasia of the undifferentiated tissue of primary lamellae, shortening, fusion and moderate epithelial lifting of some lower secondary lamellae (Fig. 2a). The moderate stage (2) changes are represented by stasis or aneurysm which determined by the congestion of blood cells thereby becoming a compact homogenous mass (Fig. 2), twisting of the primary lamella (Fig. 2a), thinning of the proliferated tissue and fusion of adjacent secondary lamellae as a result of vacuoles formation (Fig. 2b).

The Gills of $9.3x10^{-4}$ µM/L Cypermethrin-Exposed Juveniles

Exposure to the high cypermethrin concentration caused different lesions varied from slight to severe [i.e. the stages 1-3 described by Poleksic and Mitrovic-

Tutundsic (1994)]. Changes similar to those observed in the previously mentioned case were also detected in such group (Fig. 3a and 4a). In addition, extra changes of stage 1 such as, leukocytes infiltration (Fig. 3a) and thinning of respiratory epithelium are investigated (Fig. 4a). Stage 2 lesions are in the form of rupture of the lamellar epithelial cells (Fig. 3a), complete fusion of all secondary lamellae (Fig. 3b, 4b), focal proliferation of primary and secondary lamellar epithelial cells -which reflected by increased thickening of proliferated tissue (Fig. 3b)- hemorrhages (Fig. 4b) with rupture of epithelium, telangiectasia which is a marked swelling of blood sinuses of the secondary lamellae (Fig. 3), oedematous separation of primary and secondary lamellae (Fig. 3b) and hyperactivity of mucous cells (Fig. 4a, b). Necrosis (stage 3) of some of the lamellar epithelial cells is also detected (Fig. 3, 4b).
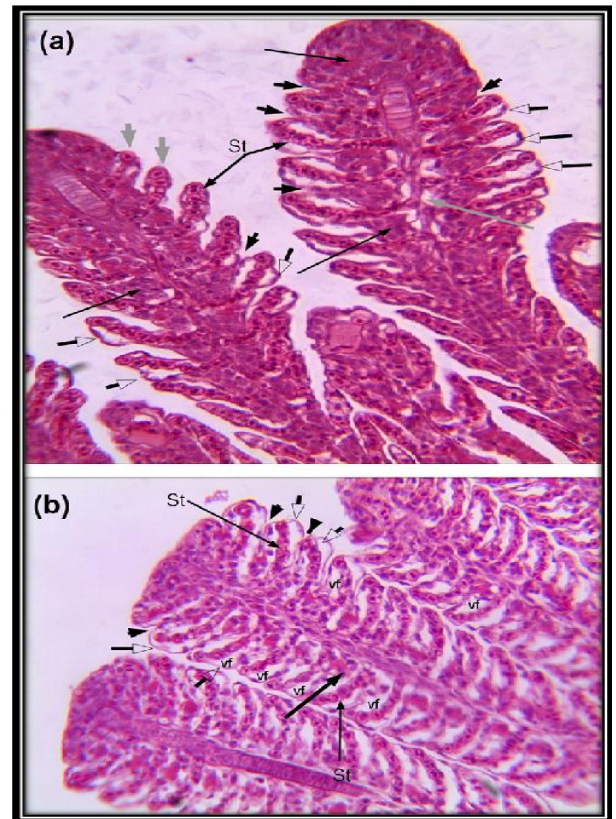
Figure 2 (a, b): Photomicrographs of the gills of guppy fish Juveniles exposed for forty five days to low ($7x10^{-4}$ µM/L) cypermethrin concentration (H&E, X400). a) A longitudinal section of a juvenile's gill with hyperplasia of the undifferentiated tissue of primary lamellae (long black arrows), fusion of the secondary lamellae (short thick black arrows), shortening of some secondary lamellae (short thick gray arrows), epithelial lifting of some secondary lamellae (black hallow-head arrows), stasis (St) and twisting of the primary lamella (long black thin arrow). b) A longitudinal section of a second juvenile's gills with thinning of the proliferated tissue (long thick black arrow), epithelial lifting of some secondary lamellae (black hollow-head arrows), fusion of adjacent secondary lamellae (black arrow heads) as a result of vacuoles formation (Vf) and stasis (St).
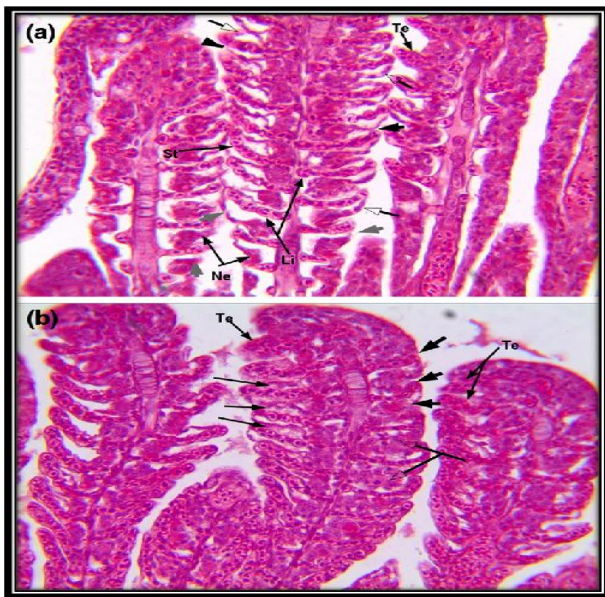
Figure 3 (a, b): Photomicrographs of the gills of guppy fish Juveniles exposed for forty five days to high $(9.3 \times 10^{-4}$ μM/L) cypermethrin-concentration (H&E, X400). a) A longitudinal section of a juvenile's gill with fusion (black arrow heads), moderate epithelial lifting of some secondary lamellae (black hallow-head arrows), leukocytes infiltration (Li), stasis (St), telangiectasia (Te) rupture (gray arrow heads) and necrosis (Ne) of some of the lamellar epithelial cells. b) A longitudinal section of a second juvenile's gill with complete fusion of the secondary lamellae (short thick black arrows), focal proliferation of primary and secondary lamellar epithelial cells (black hollow-head arrows), telangiectasia (Te) and oedematous separation of primary and secondary lamellae leads to sloughing at their tips (thin black arrows).
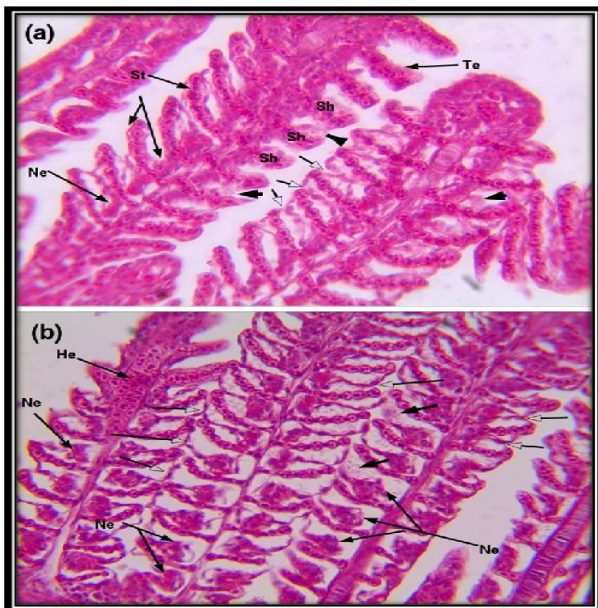

Figure 4 (a, b): highly damaged gills of high $(9.3 \times 10^{-4}$ μM/L) cypermethrin concentration-exposed forty five-day-old guppy fish juveniles (H&E, X400). a) A juvenile's gill with

thinning of respiratory and lamellar epithelium (two-headed black thin arrow), epithelial lifting and fusion of the secondary lamellae (black hallow-head arrows), hyperactivity of mucous cells (black head arrows), telangiectasia (Te), stasis (St), shortening of some secondary lamellae (Sh) and necrosis (Ne) of some of the lamellar epithelial cells. b) Another juvenile's gill filaments with severe epithelial lifting and complete fusion of the secondary lamellae (black hollow-arrowheads), hyperactivity of mucous cells (black thick arrows), hemorrhage (He) and necrosis (Ne) of most of the lamellar epithelial cells.

The Mesonephroi of Guppy Juveniles

The Mesonephroi of Controls

The tissue of mesonephroi of guppy juvenile is made up of nephrons and an interstitial hematopoietic tissue. Each nephron consists of glomeruli enclosed by a Bowman's capsule, the proximal, distal and collecting renal tubules. The glomerulus is a spherical network of densely packed anastomosing capillaries that are surrounded by Bowman's capsule (Fig. 5). The Bowman's capsule consists of a single layer of flattened epithelial cells resting on a basement membrane and it has a visceral (internal) and parietal layers. The visceral layer surrounds the glomerular capillaries or the podocytes which are modified epithelial cells (Fig. 6 a). The proximal and distal tubules are lined by simple cuboidal cells with brush borders at the luminal surface of the proximal epithelium, while the collecting tubules have high cuboidal epithelium (Fig. 6 b).
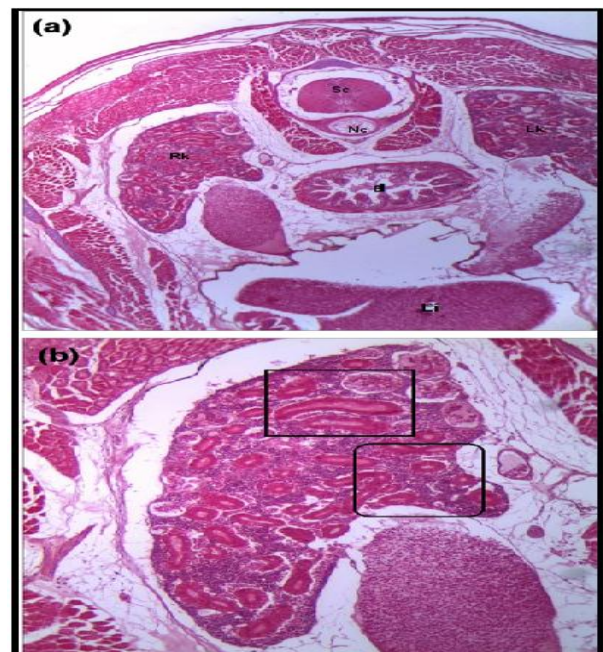

Figure 5 (a, b): Photomicrographs to show the structure of the trunk mesonephroi of a control forty five- day-old guppy juvenile. a) A transverse section displays the left (Lk) and right (Rk) kidney. The spinal cord (Sc), notochord (Nc), intestine (I) and part of the liver (Li) are also seen (H&E, X40). b) Magnification of the right kidney (H&E, X100).
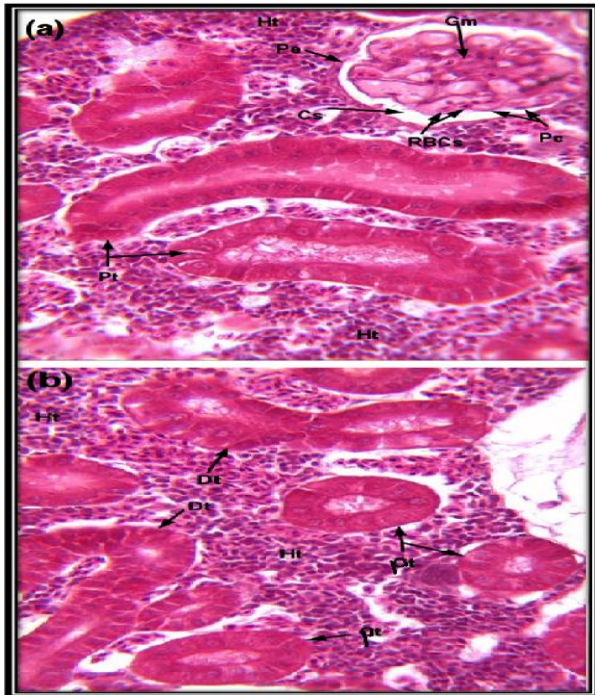
Figure 6 (a, b): Magnified parts of Figure 5b (H&E, X400). (a) The part (in the upper square) of Figure 5b magnified to show the renal corpuscle constituents, the proximal tubules (Pt) and the hematopoietic tissue (Ht). Each renal corpuscle consisted of a glomerular mesangium (Gm) located in between the glomerular capillaries a capsular space (Cs), a parietal epithelium (Pe), and red blood cells (RBCs). (b) Another part (in the lower square) of Figure 5b magnified to show the distal tubules (Dt), the proximal tubules (Pt) as well as the hematopoietic tissue (Ht).

The Mesonephroi of $7x10^{-4}$ μM/L Cypermethrin-Exposed Juveniles

The histopathological changes observed in this exposed group were ranged from mild to severe damage of glomeruli and an increase of the capsular space (Fig. 7). Partial adhesion and collapse of glomerular tuft with the appearance of debris in an enlarged Bowman's space were observed in one sample. Also, the epithelium of the renal tubules exhibited degeneration and pyknosis, while other tubules showed an abnormal dilatation. Furthermore, necrosis of the hematopoietic tissue had resulted in abnormally increased spaces between the renal tubules and the hematopoietic tissues (Fig. 7b). Severe damage was represented by degeneration and detachment of renal tubular epithelial cells with the cellular debris being located within their lumen, an abnormal dilatation of some renal tubules, as well as presence of leucocytes into the tubular lumens (Fig. 8a). In addition, partial adhesion and collapse of glomerular tuft with the appearance of debris in Bowman's space as well as an excessive proliferation of the hematopoietic tissue were also detected (Fig. 8b). Also, most of the renal tubules were obliterated due to abnormal dilatations of some renal tubules, degeneration of some of the renal tubular epithelial cells and necrosis of the hematopoietic tissue (Fig. 8c).
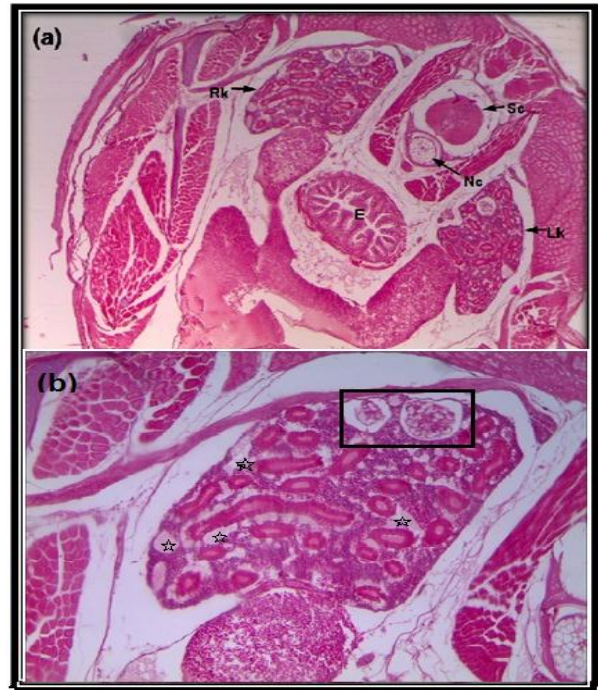
Figure 7(a, b): Transverse sections of the trunk mesonephroi of a guppy fish juvenile exposed to the low ($7x10^{-4}$ μM/L) cypermethrin concentration for forty five day. (a) Displays the left (Lk) and right (Rk) mesonephroi. The spinal cord (Sc), notochord (Nc), and intestine (E) are also seen. H&E, X40. (b) Magnification of the right mesonephros. An abnormal dilatation of some renal tubules, an increase of the capsular space (in rectangle), and spaces abnormally increased between the renal tubules and the hematopoietic tissue (*) are also seen. (H&E, X100).
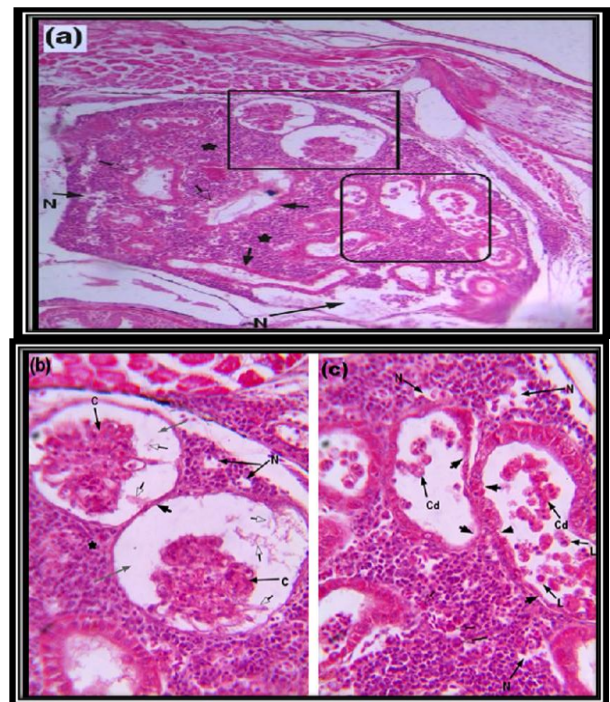

Figure 8 (a-c): A trunk mesonephros of a forty five-day-old guppy fish juvenile exposed to the low ($7x10^{-4}$ μM/L)

cypermethrin concentration. (b) Shows renal tubules obliterated, an excessive proliferation of the hematopoietic tissue (*). An abnormal dilation of some renal tubules (black arrows), degeneration of some of the renal tubular epithelial cells (black hollow-head arrows) and necrosis (N) of the hematopoietic tissue are also seen. H&E, X100. (b) The part (in the upper square) of Figure 8a magnified to show partial adhesion (black arrow head), collapse (C) of glomerular tuft with the appearance of debris (black hallow-head arrows) in enlarged Bowman's space (gray arrows). Necrosis (N) and massive proliferation of hematopoietic tissue (*) around the Bowman's capsule are also seen. H&E, X400. (c) The part (in the lower square) of Figure 8a magnified to show detachment of epithelium (black arrow heads) of the renal tubules with the cellular debris (Cd) being located within their lumen as well as infiltration of leucocytes (L) into the tubular lumens. Leucocytes infiltration (black hollow-head arrows) and necrosis (N) of the hematopoietic tissue are also seen. H&E, X400.

The Mesonephroi of 9.3x10⁻⁴ µM/L Cypermethrin-Exposed Juveniles

The histopathological changes observed in this exposed group were similar to those observed in the previous case. However, in some samples, there was an atrophy of the epithelium of renal tubules associated with hemorrhage within the tubular lumen of other tubules. Also, inflammation of the renal tubules, glomerular hypercellularity, edema formation and fluid accumulation in Bowman's space were also observed associated, in some samples, with damage of the Bowman's capsule (Fig. 9a). There was also a mild to severe necrosis and pyknosis of the hematopoietic tissue, which in turn resulted in an abnormal increased spaces between the renal tubules and this tissue (Fig. 9b).
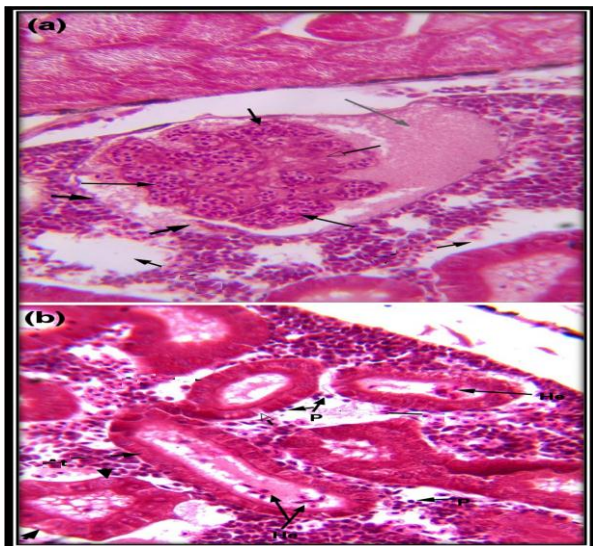
Figure 9 (a,b): Mesonephric parts of a high (9.3x10⁻⁴ µM/L) cypermethrin concentration-exposed forty five-day-old guppy fish juveniles (H&E, X400). (a) Showing glomerular hypercellularity (thin black arrows), damage of the Bowman's capsule wall (short thick black arrows), edema (black hollow-head arrow), fluid accumulation in

increased Bowman's space (gray arrow) and wide empty spaces (thin short arrows) of the hematopoietic tissue. (b) Displaying degeneration of some cells of the renal tubular epithelium (black hollow-head arrow), degeneration of the basal cytoplasm of some renal tubules epithelium (black arrow heads) and hemorrhage (He) within the tubular lumens. Pyknosis (P) of the hematopoietic tissue is also seen.

DISCUSSION

The structure of control guppy's gills presented here is similar to the description of Çaliskan et al. (2003). The extent of damage observed on the current 45-day-old guppy juveniles' gills is varied as the cypermethrin concentration increased. The most frequent histopathological changes observed -on both the low and high cypermethrin exposed juveniles' gills- are represented by hyperplasia of the undifferentiated tissue of primary lamellae, shortening, fusion and epithelial lifting of secondary lamellae and stasis or aneurysm, twisting of the primary lamella, thinning of the proliferated tissue and fusion of adjacent secondary lamellae as a result of vacuoles formation, leukocytes infiltration, thinning of respiratory epithelium, rupture of the lamellar epithelial cells, focal proliferation of primary and secondary lamellar epithelial cells, hemorrhages with rupture of epithelium, telangiectasia, oedematous separation of primary and secondary lamellae, hyperactivity of mucous cells and necrosis. The majority of these histopathological changes are in agreement with previous studies on the effect of cypermethrin on gills of the rainbow trout (*Oncorhynchus mykiss*) (Velisek et al., 2006); Nile tilapia (*Oreochromis niloticus*) (Ayoola and Ajani, 2007); African catfish (*Clarias gariepinus*) (Ayoola and Ajani, 2008); Nile tilapia (*Oreochromis niloticus*) (Korkmaz et al., 2009); fresh water fish *Clarias gariepinus* (Velmurugan et al., 2009); and the fingerlings of *Heterobranchus bidorsalis* (Olufayo and Alade, 2012). In addition, the histopathological changes in the present study are also in agreement with Caliskan et al. (2003), who observed similar changes on the gills of adult guppy fish (*Lebistes reticulatus*) exposed to lethal and sublethal concentrations of beta-cypermethrin.

The lifting of epithelial layer from gill lamellae and necrosis, the degeneration of secondary lamellae due to edema, the shortening of secondary lamellae observed in the present study are similar to those reported by Erkmen et al. (2000) in gills of *L. reticulatus* exposed to another pyrethroid insecticide cyphenothrin. Furthermore, in the present study, the secondary lamellae showed stasis or aneurysm and this defect is similar to that reported in *Cyprinus carpio* after acute exposure to deltamethrin (Cengiz, 2006). Cengiz and Unlu (2006) reported epithelial hypertrophy, necrosis, epithelial lifting, oedema, aneurism, dilatation of the capillaries of primary lamellae and lamellar fusion in the gills of *Gambusia affinis* exposed to deltamethrin. Also, Velmurugan et al. (2007a) reported epithelial hyperplasia, aneurism, epithelial necrosis,

desquamation, epithelial lifting, oedema, shortening of secondary lamellae and lamellar fusion in the gills of *Cirrhinus mrigala* exposed to sublethal concentrations of lambda-cyhalothrin.

and the respiratory epithelium, leukocytes infiltration and hyperactivity of mucous cells. The normal histological structure of the mesonephroi described here is similar to the description of Genten *et al.* (2009). The histopathological changes observed on the cypermethrim-exposed 45-day-old juveniles' mesone-phroi were concentration dependent and ranged from mild to severe damage. The observed pyknosis and necrosis of the epithelial cells of some renal tubules are similar to those noted by Ayoola and Ajani (2007, 2008) after exposure of the Nile tilapia (*Oreochromis niloticus*) and the African catfish (*Clarias gariepinus*) juveniles to cypermethrin. These changes and others like extruding degenerated cells into the tubular lumen, narrowness of tubular lumen, and appearance of leukocytes in the interstitial tissue are in agreement to those reported by Prashanth (2011) in kidneys of the freshwater fish *Cirrhinus mrigala* exposed to cypermethrin. Also, the dilated renal tubules and tubular necrosis reported in the present study are similar to those reported by Olufayo and Alade (2012) in the fingerlings of *Heterobranchus bidorsalis*. Similarly, Korkmaz *et al.* (2009) reported necrosis in the tubular epithelial cells, glomerular atrophy and nuclear pyknosis in hematopoietic tissue in the kidneys of the adult Nile tilapia (*Oreochromis niloticus*) after exposure to cypermethrin. The present study also reported narrowing of the tubular lumen, atrophy of the glomerulus, enlarged Bowman's capsule, necrosis in the epithelial cells and pyknosis in the hematopoietic tissue. These histopathological changes are in accordance with Velmurugan *et al.* (2009) who studied the effects of sublethal concentrations of cypermethrin on the kidneys of the fresh water fish *Clarias gariepinus*. The mesonephroi histopathological changes in the present study also agree with the reports of the effects of other pyrethroids on fish kidneys. For example, Velmurugan *et al.* (2007a,b) reported necrosis of tubular epithelium, narrowing of the tubular lumen, contraction of the glomerulus and expansion of space inside the Bowman's capsule in the kidney tissues of *Cirrhinus mrigala* exposed to sublethal concentrations of lambda-cyhalothrin. Velmurugan *et al.* (2007b) also reported necrosis of tubular epithelium, pyknotic nuclei in the hematopoietic tissue, narrowing of the tubular lumen, contraction of the glomerulus and expansion of space inside the Bowman's capsule in *C. mrigala* exposed to fenvalerate. However, the results in the present study disagree with the report of Velisek *et al.* (2006) who did not demonstrated any histopathological changes in the kidneys of the rainbow trout (*Oncorhynchus mykiss*) after exposure to cypermethrin. In addition, some histopathologic changes in the present study was newly recorded which include, heamorrage within the tubular lumen, inflammation of the renal tubules, decreased

However, some histopathological changes in the present study are newly recorded which included: twisting of the primary lamella, thinning of the proliferated tissue

number of tubules, glomerular hypercellularity, edematous and fluid accumulation in Bowman's space, leukocytes infiltration and highly obliterated renal tubules due to excessive proliferation of the hematopoietic tissue. The present study concluded that cypermethrin induced concentration-dependent mild to severe histopathological lesions in the gills and kidneys (trunk mesonephroi) of the developing guppy's juveniles.

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تأثير مبيد الآفات البيروثرويدى سيبرميثرين على خياشيم و كُلي (الجذع المتوسطة)-صغار سمك الجوبى (بيوسيليا ريتيكيولاتا)

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الملخص العربي

تناولت تلك الدراسة إكتشاف التأثيرات النسيجية المرضية لمبيد الآفات البيروثرويدي سيبرميثرين على الخياشيم والكُلى المتوسطة فى جذع صغار سمك الجوبي عمرالخامسة والأربعين يوما. تم تعريض يرقات الجوبي عمر خمسة أيام ل ٠.٠٠٠٧ ميكرو مول/لتر أو ٠.٠٠٠٩٣ ميكرو مول/لترمن السيبرميثرين مرة واحدة و لمدة ٤٨ ساعة. بعد إنتهاء مدة التعريض، أزيلت اليرقات من الأحواض وتم نقلها إلى أحواض جديدة خالية من المبيد وتركت لتنمو حتى بلغت عمرالخامسة والأربعين يوماً. بعد ذلك أخذت الصغار وتم تخديرها وشرحت وفصلت الخياشيم والكُلى المتوسطة من منطقة الجذع، وذلك لطمرهم بالشمع وصبغهم بصبغتي الهيماتوكسلين و الأيوسين وتغطيتهم بعد ذلك بالكندا بلسم. وباستخدام المجهر الضوئي، فقد تم تسجيل ووصف التغييرات النسيجية الناتجة عن التعرض للسيبرميثرين وتصويرها. إختلفت حدة التغييرات النسيجية المرضية الملاحظة على خياشيم وكُلى صغار سمك الجوبى حسب التركيز المستخدم من السيبرميثرين. تمثلت الأضرار فى الخياشيم بتضخم في الخيوط الخيشومية الإبتدائية وقصر وإندماج وإنفصال لطلائية الصفائح الخيشومية الثانوية وتجلط للدم والتواء في الصفائح الخيشومية الابتدائية وإرتشاح في كريات الدم البيضاء وتمزق طلائية الخيوط الخيشومية وتكاثر موضعى لطلائية الخيوط الخيشومية الإبتدائية والثانوية ونزيف وإنتفاخ واضح للجيوب الدموية فى الصفائح الخيشومية الثانوية وفرط في نشاط الخلايا المخاطية بالإضافة إلى نكرزة (أو موت للخلايا). أما فى الكُلى فقد إشتملت التغييرات على تلف في الكبيبات وإتساع فراغ محفظة بومان وإنهيار كتلة الكبيبة مع ظهور بقايا خلوية في محفظة بومان وتمدد للأنيبيبات الكلوية وضمور في طلائية الأنيبيبات وتغلظ أنوية الخلايا الطلائية للأنيبيبات ونكرزة (أو موت للخلايا) و زيادة في تكاثر خلايا النسيج البينى. خلصت تلك الدراسة إلى أن التعرض للسيبرميثرين قد تسبب فى أضرار بالغة لأنسجة الخياشيم والكُلى لصغار سمك الجوبى.