VOLUME - 11, ISSUE - 11, NOVEMBER - 2022 • PRINT ISSN No. 2277 - 8160 • DOI : 10.36106/gjra

Original Research Paper | Environmental Science

HISTOPATHOLOGICAL CHANGES IN THE GILL OF FRESHWATER TELEOST HETEROPNEUSTES FOSSILIS (BLOCH) EXPOSED TO METANIL YELLOW

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ABSTRACT The chronic toxic effect of Metanil Yellow on the gills of freshwater teleost Heteropneustes fossilis (Bloch) was studied. The fishes were exposed for 45 days treatment in 2g/L of Metanil Yellow. However, after 45 days treatment, marked pathological changes in the gills were found. Necrosis found in the primary gill lamellae. Shortened and clubbing ends of the secondary gill lamellae. Buldging tip of primary gill filaments and distortion was occurred in the shape of secondary filament. Pycnotic nuclei, vacuolization and degenerative epithelial cells were found.

KEYWORDS : Histopathology, Gill, Metanil Yellow, Heteropneustes fossilis (Bloch)

INTRODUCTION

A non-permitted synthetic food colour Metanil Yellow is principally the monosodium salt of 3-[[4-(Phenyl amino) phenyl] azo] benzene sulfonic acid which is used in different food items namely biriyani, ghugni, different sweet items *viz*., laddu, jalebi, bundia, amriti etc. The acute and short term toxicity of popular blend of Metanil Yellow and Orange –II in albino rats was recorded by Singh and Khanna (1998). Toxicity of Metanil Yellow and Derma Orange to a fresh water fish *Channa punctatus* was reported by Goel and Basu (1989). Gupta *et al*., (2002) reported the tumor promotion by Metanil Yellow and Malachite Green during rat hepatocarcinogenesis. Many authors (Mehrotra *et al.,* 1974; Khanna and Das 1991; Gupta *et al*., 2002) have investigated the toxic effects of Metanil Yellow. In fish, gills play vital functions like respiration, osmotic regulation and excretion. Gills act as tissue indicator of water quality and also for the assessment of environmental impact. In the present work, an attempt was made to evaluate the chronic toxic effects of Metanil Yellow on the histology of gill tissues of the freshwater teleostean catfish *Heteropneustes fossilis* (Bloch).

MATERIALS AND METHODS

Teleostean fish, *Heteropneustes fossilis* (Bloch) of 23.2 ± 1.5 cm with an average weight of 64.3 ± 2.0 g were collected from local pond of East Barddhaman, W.B. and after collection the fishes were acclimatized in glass aquaria of dechlorinated water and fed with *Tubifex* sp. twice daily for two weeks. Water temperature and pH were maintained during experimentation. After acclimatization two sets carrying ten fish specimens in each glass aquaria as control and treated were arranged. One set of the test fishes were fed with Metanil Yellow at a dose of 2g/L for 45 days. On the 46th day of the experiment the desired gill tissues were collected from both control and treated specimens and were subjected to histopathological technique. For this the required tissues were fixed in aqueous Bouin's fluid solution. After decalcification of gills, the paraffin sections of 4-5 micron were cut and stained in Delafield's Haematoxylin and Eosin solution.

RESULTS AND DISCUSSION

In fish gills are the main respiratory organs and they provide maximum oxygen for intracellular oxidation. The gills are situated in the pharynx. Each teleostean gill consists of a longer lower limb supported by ceretobranchial, and a shorter upper limb supported by the epibranchial. Each gill arch bears gill rakers towards the inner (buccal) side and gill filaments towards the outer (opercular) side. Each gill arch bears two hemibranchs, which are formed by endodermal evaginations in the form of leaf like folds, called gill filaments or primary gill lamellae. The primary gill lamellae (PGL) of *Heteropneustes fossilis* consist of a central rod like supporting axis and a row of secondary gill lamellae (SGL) also termed as respiratory lamellae are present on each side of the primary gill lamellae (PGL) whereas the secondary lamellae (SGL) are highly vascularised and are covered with a thin layer of squamous epithelial cells (Fig. 1). Single nucleus is found in each blood cell of secondary lamellae.

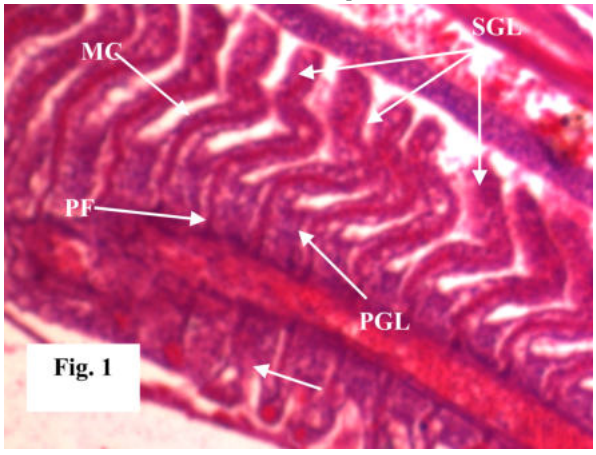
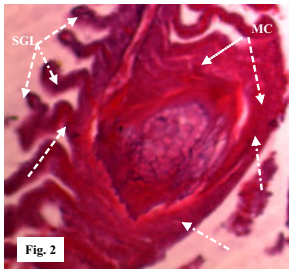


Fig.1: Photomicrographs of the gill tissue of control (C) *Heteropneustes fossilis* [H-E] which showing normal aspect of primary filament (PF), primary gill lamellae (PGL), secondary lamellae (SGL) and mucous cell (MC) (normal arrows). (C) [10 X 20]



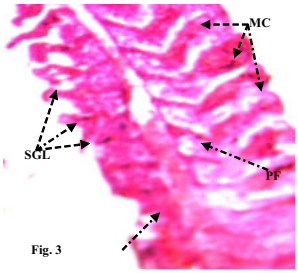


Fig. 2: Photomicrographs of the gill tissue of Metanil Yellow (MY) treated *Heteropneustes fossilis* [H-E] which showing shortened and clubbing ends of the secondary gill lamellae (SGL) and damaged mucous cell (MC) (broken arrows). (MY, 45d) [10 X 40]

Fig. 3: Photomicrographs of the gill tissue of Metanil Yellow (MY) treated *Heteropneustes fossilis* [H-E] which showing distortion and damages in the primary gill filament (PF), secondary gill lamellae (SGL) and mucous cell (MC) (broken

arrows). (MY, 45d) [10 X 40]

After an exposure of 45 days treatment with Metanil Yellow huge changes have been found in the gill tissues. Gill rakers and filaments were distorted and damaged. Buldging tips were found in primary gill filaments (PF) and distortion occurred in secondary filament (Fig. 2). Necrosis was shown in the primary gill lamellae (PGL). Shortened and clubbed ends of secondary gill lamellae (SGL) and hyperplasia and hypertrophy of nuclei were found after toxicosis of Metanil Yellow (Fig. 3).

Histopathological study has revealed that Malachite Green causes detrimental effects in liver, gill, kidney, intestine, gonads and pituitary gonadotropic cells. It has been found to causes sinusoidal congestion and focal necrosis in liver, damages mitochondria and also causes nuclear alterations (Gerundo *et al*., 1991). Hypertrophy and vacuolisation followed by necrosis and cirrhosis have been observed in hepatocytes of *Heteropneustes fossilis* following treatment with Malachite Green (Srivastava *et al*., 1998a). Exposure to this dye has also found to cause severe damage to gills, resulting in necrosis of lamellar cells and gill epithelium, and leucocyte infiltration in rainbow trout (Gerundo *et al*., 1991) and *Heteropneustes fossilis* (Srivastava *et al*., 1998b).

Gill lesions in zinc treated *Heteropneustes fossilis* was reported by Hemalatha and Banerjee (1977). So many researchers (Daoust *et al*., 1984; Karlson-Norgren *et al*., 1985; Tophon *et al* ., 2003; Gupta and Kumar 2006; Al-Attar, 2007; Kaoud and El-Dahshan, 2010; Patel and Bahadur, 2010; Khoshnood *et al*., 2011; Patnaik *et al*., 2011) observed the pathological lesions in fish gills exposed to heavy metals. Changes in the primary and secondary gill lamellae of *Heteropneustes fossilis* were observed after an exposure of Malathion for 15 days (Yadav *et al*., 2018). The chronic toxicity of non-permitted food colour Metanil Yellow (MY) for an exposure of 45 days to teleostean catfish *Heteropneustes fossilis* has shown histopathological changes in stomach, intestine, liver and kidney of *H. fossilis* (Sarkar and Ghosh, 2010). Degenerations in the seminiferous tubules and spermatocytes and vacuolations in the sertoli cells of *albino rat* (*Rattus norvegicus)* were shown when exposed to Metanil Yellow for 30 and 45 days (Sarkar and Ghosh, 2012a). Histopathological and ultrstructural changes in the stomach, intestine, liver and kidney of *albino rat* (*Rattus norvegicus*) were observed (Sarkar and Ghosh, 2012). Sarkar and Ghosh (2017) reported the histopathological lesions in spleen of *albino rat* (*Rattus norvegicus)* were found after fed with Metanil Yellow for 30 and 45 days. But maximum distortion and degeneration occurred in both the white pulp and red pulp regions after 45 days treatment. The present observations in *Heteropneustes fossilis* clearly demonstrate the gill tissues affected most severely in response to Metanil Yellow intoxication.

CONCLUSION

The damages shown in gill tissues vary not only with its concentration but with the time of exposure period. During the tenure of 45 days treatment with synthetic food colour Metanil Yellow, maximum damages were shown in primary and secondary gill lamellae.

REFERENCES

1. Al-Attar, A.M. (2007). The influences of nickel exposure on selected physiological parameters and gill structure in the teleost fish, *Oreochromis niloticus*. Journal of Biological Sciences., 7(1):77-85.
2. Daoust, P.Y., Wobeser, G. and Newstead, J.D. (1984). Acute pathological effects of inorganic mercury and copper in gills of rainbow trout. Veterinary Pathology., 21(1):93-101.
3. Hemalatha, S. and Banerjee, T.K. (1997). Histopathological analysis of sublethal toxicity of zinc chloride to the respiratory organs of the air breathing catfish *Heteropneustes fossilis* (Bloch). Biological Research., 30:b 11-21.
4. Gerundo, N., Alderman, D.J., Clifton-Hadely, R.S., Feist, S.W. (1991). Pathological effects of repeated doses of malachite green: a preliminary study. Journal of Fish Diseases., 14:521-532.
5. Goel, A.K. and Basu, P.S. (1989). Toxicity of Metanil Yellow and Derma Orange on fresh water fish *Channa punctatus*. Journal of Applied. Toxicology., 15(2):65-71.
6. Gupta, A.K. and Kumar, A. (2006). Histopathological lesions in the tissues of *Cirrhinus mrigala* (Ham.) fingerlings exposed to a sublethal concentration of mercury. Journal of Environmental Biology., 27(2):235-239.
7. Gupta, S., Sundarrajan, M. and Rao, K.V.K. (2002). Annual Conference of the Environmental Mutagen Society of India Symposium on Environmental Genomics and Health Sciences, Lucknow, India, 19th March.
8. Kaoud, H.A. and El-Dahshan, A.R. (2010). Bioaccumulation and histopathological alterations of theheavy metals *in Orechromis niloticus* fish. Nature and Science., 8(4):147-154.
9. Karlson-norrgren, L., Runn, P., Haux, C., Forlin, L. (1985). Cadmium induced changes in gill morphologyof zebra fish Brachydaniorerio (Hamilton-Buchanan) and rainbow trout *Salmogairdneri* Richardson. Journal of Fish Biology., 27: 81-95.
10. Khanna, S.K. and Das, M. (1991). Toxicity, Carcinogenic potential and clinical epidemiological studies on dyes intermediates. Journal of Scientific and Industrial Reseach., 50: 964-974.
11. Khoshnood, Z., Khodabandeh S., Shahryari Moghaddam, M. and Mosafer Khorjestan, S. (2011). Histopathological and pathomorphological effects of mercuric chloride on the gills of *Persian sturgen*, *Acipenser persicus*, fry. International Journal Natural Resources and Marine Sciences., 1(1):23-32.
12. Mehrotra, N.K., Khanna, S.K. and Singh, G.B. (1974). Haematological studies in rats fed with Metanil Yellow. Environmental Physiology and Biochemistry., 4:232-235.
13. Patel, J.M. and Bahadur, A. (2010). Histopathological alterations in *Catla catla* induced by chronic exposure of copper ions. Journal of Cell and Tissue Research., 10(3): 2365-2370.
14. Patnaik, B.B., Howrela, H.J., Mathews, T. and Selvanayagam, M. (2011). Histopathology of gill, liver, muscle and brain of *Cyprinus carpio communis* L exposed to sublethal concentration of lead and cadmium. African Journal of Biotechnology., 10(57):12218-12223.
15. Sarkar, R. and Ghosh A.R. (2010). Metanil Yellow, a food additive induces the responses at cellular and sub-cellular organisations of stomach, intestine, liver, and kidney of *Heteropneustes fossilis* (Bloch). Pollution Research., 29(3):453-460.
16. Sarkar, R. and Ghosh, A.R. (2012a). Toxicological effect of Metanil Yellow on the testis of albino rat. International Journal of Basic and Applied Medical Sciences., 2(2): 40-42.
17. Sarkar, R. and Ghosh, A.R. (2012b). Metanil Yellow – an azo dye induced histopathological and ultrastructural changes in albino rat (*Rattus norvegicus*). The Bioscan., 7(3): 427-432.
18. Sarkar, R. and Ghosh, A.R. (2017). Histopathological lesions in spleen of Metanil Yellow fed albino rat (*Rattus norvegicus*). International Journal of Scientific Research., 6(5):19-20.
19. Singh, R.L. and Khanna, S.K. (1988): Acute and short term toxicity studies on Orange II. Veterinary and Human Toxicology., 29:300-304.
20. Srivastava, A.K., Sinha, R., Singh, N.D., Srivastava, S.J. (1998b). Histopathological changes in a freshwater catfish, *Heteropneustes fossilis* following exposure to malachite green. Proceedings of the Natural Academy of Sciences, India., 68(B):123-127.
21. Srivastava, S.J., Singh, N.D., Sinha, R. and Srivastava, A.K. (1998a). Malachite green induced histopathological lesions in the liver of a freshwater catfish, *Heteropneustes fossilis* (Bloch). Journal of Advanced Zoology., 19(1):46-49.
22. Thophon, S., Kruatrache, M., Upatham, E.S., Pokethitiyook, P., Sahaphong, S. and Jaritkhuan, S. (2003). Histopathological alterations of white seabass *Lates calcarifer* in acute and sub chronic cadmium exposure. Enviromental Pollution., 121:307-320.
23. Yadav, N., Singh, M. and Yadav, P. (2018). Histopathology of gill of freshwatwer fish *Heteropneustes fossilis* after the exposure of Malathion. Paripex-Indian Journal of Research., 7(8):86-87.