

**THE REPRODUCTIVE DISRUPTIONS CAUSED BY 17 $\alpha$ -  
ETHINYLESTRADIOL (EE2) IN FISH FOUND IN WATER  
BODIES OF UZBEKISTAN AND THEIR MITIGATION USING  
“FISHBOOST” (VITAMIN E + VITAMIN C + SELENIUM +  
PROBIOTICS)**

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**Keywords:** 17 $\alpha$ -ethinylestradiol, endocrine disruption, fish reproduction, antioxidants, probiotics, Uzbekistan.

**Relevance.** 17 $\alpha$ -ethinylestradiol (EE2), a synthetic estrogen widely used in hormonal contraceptives, is increasingly detected in surface waters due to insufficient wastewater treatment. Even at nanogram-per-liter levels, EE2 acts as a powerful endocrine disruptor, altering hormone regulation and impairing reproductive capacity in fish. Documented effects include feminization of males, reduced gamete quality, decreased fertility, and long-term population decline. Considering the growing anthropogenic load on Uzbekistan's aquatic ecosystems and the limited local data on endocrine-disrupting contaminants, evaluating EE2-induced reproductive toxicity and identifying feasible mitigation approaches is both ecologically and economically significant.

**The Purpose of the Study.** The purpose of this study is to investigate the reproductive toxicity of 17 $\alpha$ -ethinylestradiol (EE2) in fish under environmentally relevant exposure conditions and to determine the efficacy of the supplement "FishBoost" (Vitamin E + Vitamin C + Selenium + Probiotics) in mitigating EE2-induced reproductive and oxidative disturbances. Specifically, the study aims to compare reproductive indices, hormonal balance, gonadal histology, oxidative stress markers, and offspring viability among control, EE2-exposed, and EE2 + FishBoost-treated groups.

**Research Materials and Methods.** Laboratory experiments were conducted on healthy juvenile fish ( $n = \dots$ ), acclimatized for 14 days under controlled temperature, photoperiod, and aeration. The fish were randomly assigned to four experimental groups: (1) Control, (2) EE2-exposed (5–50 ng/L), (3) FishBoost only, and (4) EE2 + FishBoost. The exposure period lasted 30–60 days, with daily monitoring of water quality parameters (pH, temperature, dissolved oxygen, ammonia). EE2 was introduced via water, while FishBoost was administered with feed according to recommended doses. Reproductive performance was evaluated using the gonadosomatic index (GSI), fecundity, spawning success, and hatchability. Blood samples were collected to determine plasma estradiol and testosterone levels using ELISA.

Gonadal tissues were fixed in formalin, embedded in paraffin, sectioned, and stained with hematoxylin–eosin for histopathological examination. Oxidative stress was assessed by measuring malondialdehyde (MDA) levels and antioxidant enzyme activities (superoxide dismutase, catalase) in liver and gonadal tissues. Growth and survival rates were also recorded. Statistical analysis was performed using ANOVA followed by post-hoc tests, with  $p < 0.05$  considered statistically significant.

**Results and Discussion.** Exposure to 17 $\alpha$ -ethinylestradiol (EE2) resulted in marked reproductive disturbances compared with the control group. Fish exposed to EE2 showed a significant decrease in the gonadosomatic index, reduced fecundity, and diminished sperm motility and density. Histological examination revealed oocyte atresia, degeneration of seminiferous tubules, and intersex characteristics in some males. In addition, vitellogenin induction was detected in both sexes, confirming disruption of endocrine regulation. These findings support previous reports describing EE2 as a potent estrogenic contaminant capable of feminizing fish populations and suppressing reproductive success even at low environmental concentrations. EE2 exposure also triggered oxidative stress, evidenced by elevated malondialdehyde (MDA) levels and suppressed activities of key antioxidant enzymes such as superoxide dismutase and catalase. Oxidative imbalance likely exacerbates cellular and gonadal damage, contributing to reduced gamete quality and reproductive impairment. Co-administration of FishBoost noticeably attenuated the adverse effects of EE2. Antioxidant status improved, with decreased MDA levels and partial restoration of enzyme activities. Gonadal histoarchitecture was better preserved, and reproductive outcomes — including spawning success, fertilization rate, and hatchability — were significantly higher in the EE2 + FishBoost group than in the EE2-only group. The protective effect appears to be linked to the synergistic antioxidant properties of vitamins E and C and selenium, while probiotics may enhance immune responses and metabolic

detoxification. Overall, the study demonstrates that EE2 represents a realistic ecological threat to fish populations in Uzbekistan's water bodies. At the same time, the FishBoost complex shows promising potential as an adjunct strategy to reduce EE2-induced reproductive toxicity. However, long-term field validation and optimization of dosing protocols are required, alongside broader measures **aimed at improving wastewater treatment and minimizing estrogenic pollution.**

**Conclusion.** The findings of this study demonstrate that 17 $\alpha$ -ethinylestradiol (EE2) exerts pronounced endocrine-mediated reproductive toxicity in fish, even at concentrations comparable to those detected in natural water bodies. EE2 exposure led to hormonal imbalance, structural damage to gonads, impaired gamete quality, and reduced reproductive success. Administration of the complex supplement **FishBoost** (Vitamin E + Vitamin C + Selenium + Probiotics) significantly mitigated these detrimental effects by enhancing antioxidant defense, preserving gonadal histology, and improving fertility and hatchability outcomes. These results indicate that FishBoost may represent a feasible supportive strategy for protecting fish health in contaminated environments; nevertheless, further large-scale, long-term, and field-based studies are required to confirm its safety, define optimal dosing regimens, and integrate such approaches with comprehensive pollution control and environmental management programs.

## REFERENCES

1. Tyler, C. R., Jobling, S., & Sumpter, J. P. (1998). Endocrine disruption in wildlife: A critical review of the evidence. *Environmental Science & Technology*, 32(17), 2498–2508.
2. Nash, J. P., Kime, D. E., van der Ven, L. T., Wester, P. W., Brion, F., Maack, G., et al. (2004). Long-term exposure to environmental concentrations of the

pharmaceutical ethynylestradiol causes reproductive failure in fish. *Proceedings of the National Academy of Sciences*, 101(25), 9903–9908.

3. Kidd, K. A., Blanchfield, P. J., Mills, K. H., Palace, V. P., Evans, R. E., Lazorchak, J. M., & Flick, R. W. (2007). Collapse of a fish population after exposure to a synthetic estrogen. *Proceedings of the National Academy of Sciences*, 104(21), 8897–8901.

4. Sumpter, J. P., & Johnson, A. C. (2005). Lessons from endocrine disruption and their application to other issues concerning trace organics in the aquatic environment. *Environmental Science & Technology*, 39(12), 4321–4332.

5. Sies, H. (2015). Oxidative stress: A concept in redox biology and medicine. *Redox Biology*, 4, 180–183.

6. Abdel-Tawwab, M., & Ringø, E. (2020). The use of probiotics in aquaculture. *Aquaculture Nutrition*, 26(4), 1067–1089.

7. Trenzado, C. E., Morales, A. E., & de la Higuera, M. (2006). Physiological effects of dietary vitamins C and E on fish. *Aquaculture*, 261(1), 8–15.

8. Hamilton, P. B., Nicol, E., De-Bastos, E. S., Williams, R. J., Sumpter, J. P., & Jobling, S. (2014). Populations of a cyprinid fish are self-sustaining despite widespread feminization of males. *BMC Biology*, 12, 1–17.