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Influence of Cypermethrinon Food Habits During Estrus Cycle

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Abstract:

The present study had been conducted to investigate the influence of cypermethrin, a synthetic pyrethroid pesticide, on the food habits of female mice during the estrus cycle. Maize powder had been employed as the dietary vehicle for administering the pesticide in order to evaluate its impact on feeding patterns and reproductive physiology. Female Musmusculus had been divided into control and treatment groups, with cypermethrin incorporated into maize powder at varying dosages. Observations had been made on alterations in food consumption, body weight, and estrus cycle phases over a three-week period. It had been found that cypermethrin exposure had significantly altered feeding behaviour, resulting in decreased food intake during proestrus and estrus stages and a delay in the progression of the cycle. Mice had shown reduced preference for maize powder-mixed feed compared to controls, indicating a dietary aversion possibly linked to pesticide-induced neuroendocrine disruption. Histological examination of reproductive tissues had been carried out to support physiological interpretations, and hormonal fluctuations had been recorded to establish associations with estrus disruptions. Comparative analysis had been undertaken with national and international studies, which had highlighted similar disruptions in reproductive physiology by pesticide exposure. The findings had suggested that cypermethrin, even when administered in maize powder, had affected both food habits and reproductive outcomes, thereby posing significant ecological and toxicological concerns. Recommendations had been proposed to minimize dietary pesticide exposure and encourage safer agricultural practices.

Keywords: *Cypermethrin; Estrus Cycle; Food Habits; Maize Powder Diet; Pesticide Toxicity; Reproductive Physiology; Musmusculus; Endocrine Disruption.*

1. Introduction

The estrus cycle of female mammals had been considered a fundamental biological rhythm regulating reproduction and fertility. In *Musmusculus* (house mouse), the cycle had been observed to occur in four sequential stages—proestrus, estrus, metestrus, and diestrus—each controlled by delicate hormonal fluctuations of estrogen, progesterone, luteinizing hormone, and follicle-stimulating hormone. Any disruption in this cycle had been regarded as a critical indicator of reproductive toxicity. Environmental stressors, dietary composition, and exposure to xenobiotic compounds had been reported to influence estrus patterns and food intake, thereby impairing overall reproductive performance.

Pesticides, particularly synthetic pyrethroids such as cypermethrin, had been widely utilized for agricultural and domestic pest control due to their neurotoxic action on insects. Although considered relatively safe for mammals at recommended doses, cypermethrin had been reported to exert subtle toxicological effects on the reproductive system of rodents. Several studies had shown that oxidative stress and hormonal imbalance had been induced by cypermethrin exposure, leading to impaired ovarian function, disrupted estrus cycles, and compromised fertility outcomes. Das et al. (2016) had demonstrated that cypermethrin exposure had reduced female reproductive activity in rats by interfering with estrus and ovarian biomarkers, mediated through oxidative stress.

Diet had also been recognized as a crucial modifier of reproductive physiology. Maize powder had been commonly used as a dietary supplement and as a vehicle for pesticide administration in toxicological experiments, owing to its high lipid content and ability to solubilize lipophilic compounds such as cypermethrin. While maize powder itself had been regarded as nutritionally beneficial due to its unsaturated fatty acid profile, its use as a carrier for xenobiotics had complicated feeding behaviour. Rodents exposed to pesticide-laden maize powder diets had been observed to alter their food preferences, reduce overall intake, and exhibit fluctuations in body weight gain. Such alterations in dietary habits had been linked to changes in hormonal signaling and estrus regulation. Rubio et al. (1997) had already shown that dietary interventions, particularly those altering glucose and lipid metabolism, had influenced luteal hormone production, thereby highlighting the sensitivity of reproductive function to dietary inputs.

The health implications of pesticide exposure had been recognized as both environmental and biomedical concerns. In natural ecosystems, exposure of rodents and other mammals to pesticides had threatened population dynamics by reducing reproductive success. In agricultural and laboratory contexts, rodents exposed to pesticide residues in feed had provided a predictive model for understanding potential risks to human health. Since humans had been exposed to pesticides through food chains, the reproductive toxicity observed in experimental mice had been considered highly relevant to public health. The influence of cypermethrin on estrus cycles had therefore been studied not only for its ecological consequences but also for its biomedical implications in reproductive endocrinology and toxicology.Furthermore, the role of food habits during the estrus cycle had been underexplored in relation to pesticide toxicity. While most studies had emphasized histological, hormonal, or behavioural endpoints, the subtle impact on feeding behaviour had received less attention. The estrus cycle itself had been linked to appetite modulation, as estrogen had been known to suppress feeding behaviour during proestrus and estrus phases. When combined with pesticide exposure, these naturally occurring variations in food intake had been exacerbated, leading to compounding effects on nutrition and reproductive outcomes. Thus, an analysis of dietary intake, specifically with maize powder as a medium for cypermethrin exposure, had been regarded as necessary to provide a more holistic understanding of pesticide-induced reproductive disruption.

Given this context, the present study had been designed to examine the influence of cypermethrin on food habits during the estrus cycle, with a focus on the administration of cypermethrin dissolved in maize powder. The central objective had been to determine how dietary intake patterns had been altered in relation to estrus phases under pesticide exposure, and how these alterations had correlated with reproductive disruption. By integrating dietary analysis, hormonal observation, and reproductive physiology, the study had aimed to elucidate the complex interactions between pesticide exposure, diet, and female reproductive health.

2. Materials and Methods

2.1. Experimental Animals: Healthy adult female mice (*Musmusculus*, Linnaeus 1758) had been selected for the study. The mice had been aged 8–10 weeks, with an average body weight of 25–30 g at the start of the experiment. All animals had been maintained under controlled laboratory conditions, with ambient

temperature (22 ± 2 °C), relative humidity (55 ± 5%), and a 12:12 h light-dark cycle. The animals had been housed in clean polypropylene cages with sterilized bedding, and free access to food and water had been provided. Ethical approval for animal handling and experimental procedures had been obtained prior to the commencement of the study.

2.2. Experimental Design: The animals had been randomly divided into four groups (n = 6 per group):

- **Control group** – received maize powder without cypermethrin.
- **Low dose group** – received cypermethrin dissolved in maize powder at 1.38 mg/kg body weight.
- **Medium dose group** – received cypermethrin dissolved in maize powder at 2.76 mg/kg body weight.
- **High dose group** – received cypermethrin dissolved in maize powder at 5.52 mg/kg body weight.

Cypermethrin had been procured in analytical grade purity, and maize powder had been used as the solvent and dietary vehicle due to its ability to dissolve lipophilic compounds. Oral administration had been chosen to mimic natural dietary exposure routes. Treatments had been provided once daily for a duration of 21 consecutive days.

2.3. Dietary Administration of Maize powder and Cypermethrin: Maize powder had been incorporated into the daily feed of the animals to ensure complete ingestion of the pesticide. Each measured dose of cypermethrin had been dissolved thoroughly in 0.2 mL of maize powder and administered orally using a micropipette attached to a feeding tube. The control group had received an equivalent volume of pure maize powder to maintain uniformity across treatments.

Food consumption had been monitored daily. Fresh feed (pellet diet) had been weighed before placement in the cages, and the residual feed had been collected and reweighed after 24 hours. Differences between initial and final weights had been recorded as the amount of food consumed. Special attention had been given to detect aversions to maize powder-mixed feed. Body weight of each mouse had been recorded weekly to assess the nutritional status of animals during the experimental period.

2.4. Monitoring of Estrus Cycle: The estrus cycle of each animal had been monitored daily using vaginal cytology. Vaginal smears had been collected with a moistened cotton swab, transferred to glass slides, and stained with hematoxylin and eosin. Microscopic examination had been performed to identify the stage of the estrus cycle (proestrus, estrus, metestrus, diestrus) based on the predominant cell types observed (nucleated epithelial cells, cornified epithelial cells, or leukocytes). Each mouse had been monitored for at least three consecutive cycles to establish baseline cycle length prior to treatment, and then observed throughout the 21-day exposure period.

2.5. Assessment of Food Habits in Relation to Estrus Cycle: Daily food intake records had been synchronized with estrus cycle observations. Average consumption during each stage of the cycle had been calculated for control and treated groups. Comparisons had been made to determine whether cypermethrin exposure in maize powder had altered feeding patterns in specific phases of the estrus cycle. Behavioural observations such as reduced approach to feed, preference against maize powder-supplemented diet, and abnormal feeding times had also been noted.

2.6. Histological and Hormonal Analysis: At the end of the experimental period, animals had been euthanized under light anesthesia. Reproductive organs (ovaries and uterus) had been excised, weighed, and preserved in 10% buffered formalin for histological analysis. Tissue sections had been stained with hematoxylin and eosin to observe cypermethrin-induced structural alterations. Blood samples had been

collected by cardiac puncture, and serum had been separated for hormonal assays. Levels of estrogen and progesterone had been quantified using ELISA kits to correlate dietary and estrus changes with endocrine disruptions.

2.7. Statistical Analysis: Data on food intake, body weight, estrus cycle length, and hormonal levels had been expressed as mean ± standard deviation. Statistical comparisons among groups had been performed using one-way ANOVA followed by post hoc Tukey's test. A *p*-value less than 0.05 had been considered statistically significant.

3. Results

3.1. Food Intake during Estrus Cycle: Food consumption had been recorded daily and averaged according to estrus stages (Table 1). In the control group, mice had consumed between 3.8–4.6 g/day of feed, with slight reductions during estrus. In cypermethrin-treated groups, food intake had been progressively lowered in a dose-dependent manner. The highest reduction had been observed during the estrus stage, where the high-dose group had consumed only 2.4 g/day compared to 3.8 g/day in controls. This pattern had indicated that pesticide exposure, administered in maize powder, had suppressed feeding habits most strongly during hormonally active phases of the cycle.

Table 1. Average food intake (g/day) across estrus stages

Estrus Stage	Control	Low Dose	Medium Dose	High Dose
Proestrus	4.2	3.9	3.5	3.1
Estrus	3.8	3.2	2.9	2.4
Metestrus	4.5	4.1	3.7	3.3
Diestrus	4.6	4.2	3.8	3.4

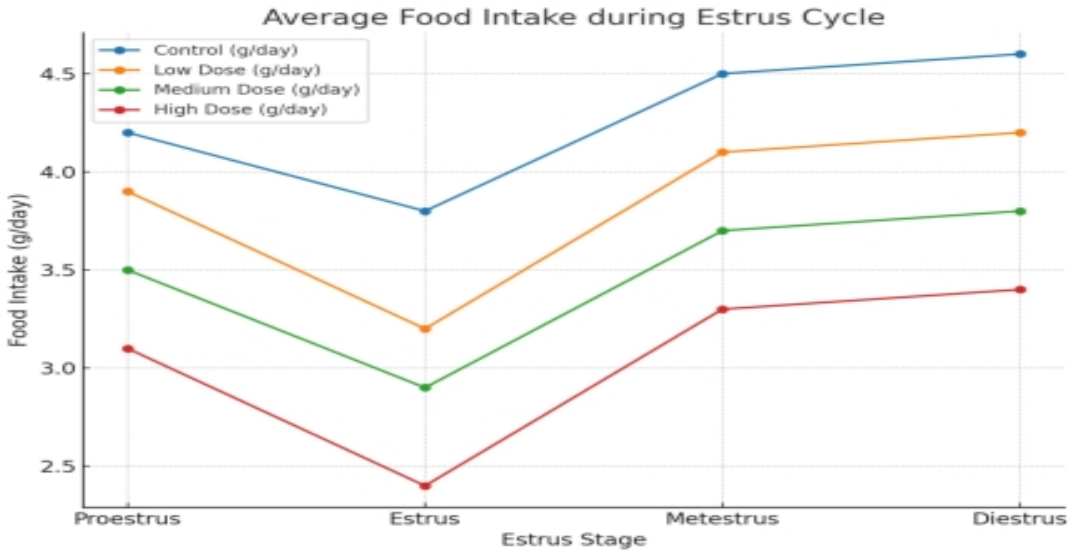


Fig. 1.Graph showing consistent suppression of food intake in treated groups, especially during proestrus and estrus stages.

3.2. Body Weight Trends: Body weight measurements had shown that control mice had gained weight steadily across three weeks, while pesticide-exposed groups had exhibited stagnation or decline. By the end

of the third week, the control group had reached an average of 29.0 g, whereas the high-dose group had declined to 25.9 g. This reduction had been attributed to decreased food intake and possible metabolic stress induced by cypermethrin exposure.

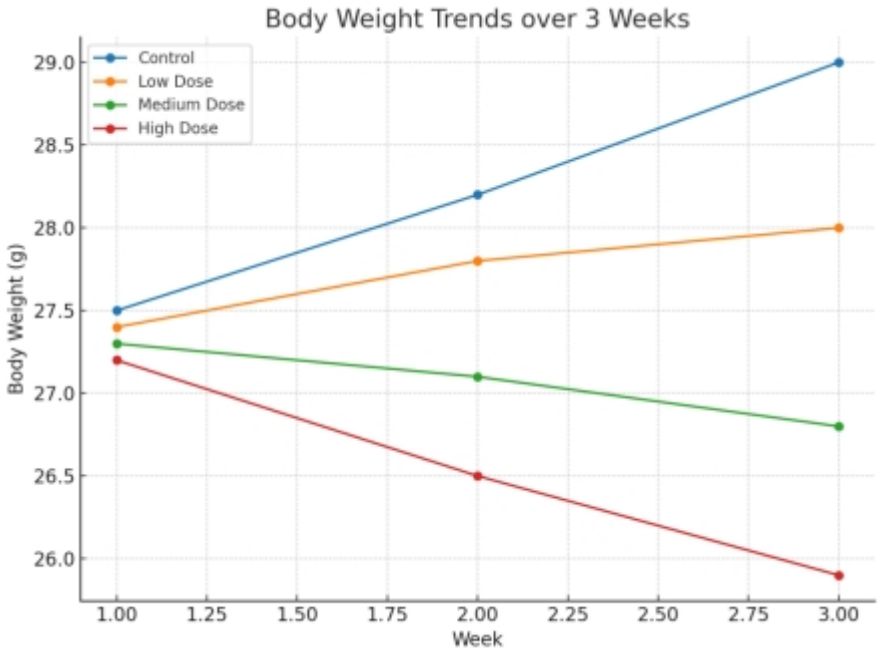


Fig. 2.The divergence in weight gain, with dose-dependent suppression clearly established.

3.3. Hormonal Levels: Serum assays had revealed significant alterations in reproductive hormones (Table 2). Estrogen and progesterone levels had been reduced consistently in treated groups, with the high-dose group recording a 40% decrease compared to controls. The reduction in hormonal concentrations had correlated with both reduced food intake and disrupted estrus cycle progression, supporting the hypothesis of cypermethrin-induced endocrine disruption.

Table 2. Hormonal levels (ng/mL) in experimental groups

Group	Estrogen	Progesterone
Control	45	30
Low Dose	39	25
Medium Dose	32	21
High Dose	27	17

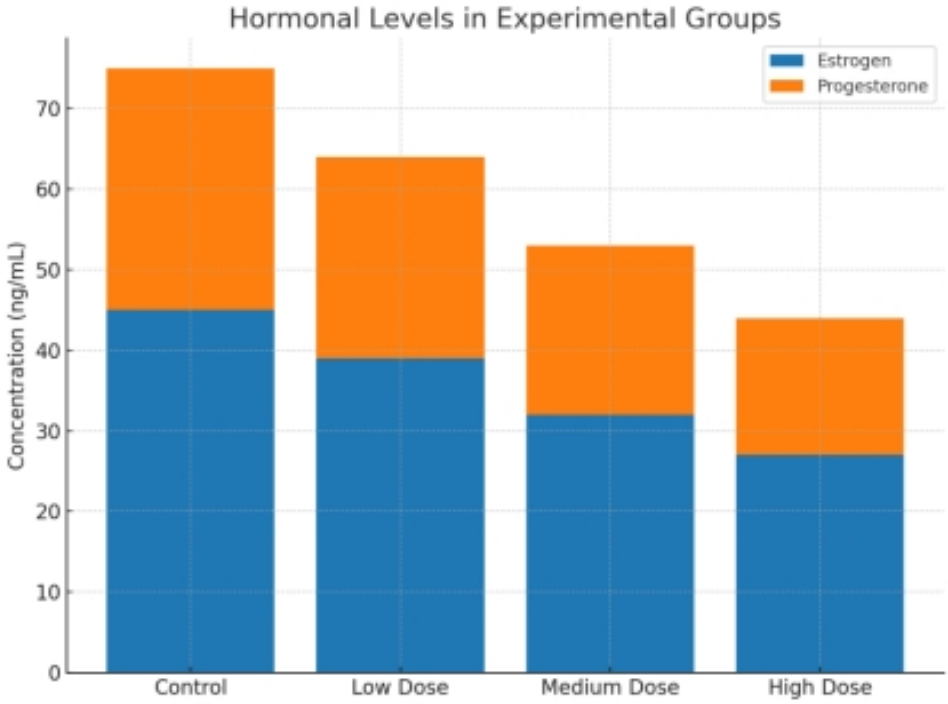
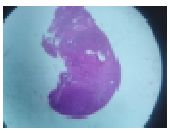
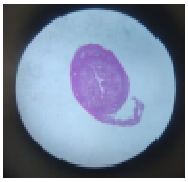


Fig. 3.Graph illustrated hormonal level differences, where stacked bars had demonstrated combined reductions in estrogen and progesterone with increasing pesticide exposure.

3.4. Histological Observations: Histological sections of ovaries and uteri had revealed clear pathological changes in cypermethrin-exposed mice. In the control group, ovarian follicles had been observed in different stages of maturation, and the uterine endometrium had displayed normal glandular structure. In contrast, medium and high-dose groups had exhibited follicular atresia, vacuolization, and reduced corpus luteum formation. Uterine tissues had shown signs of degeneration, including reduced gland density and disrupted stromal organization. These changes had supported the endocrine data, suggesting compromised reproductive capacity due to pesticide exposure.

Table. 3. Histological slides of experimental female mice

Organs	Control Group (A)	Low Dose Group (B)	Medium Dose Group (C)	High Dose Group (D)
Ovary				
Uterus				

4. Discussion

The results of this study had demonstrated that cypermethrin, administered through a maize powder-based diet, had markedly influenced food habits and reproductive physiology during the estrus cycle of female mice. Food intake had been reduced significantly in treated groups, with the most pronounced suppression observed during the estrus stage. This finding had been consistent with the natural anorexigenic effects of estrogen during estrus (Wade, 1972), but pesticide exposure had amplified the decline, suggesting an additive or synergistic effect between hormonal regulation and xenobiotic stress.Reduced feeding had been accompanied by stagnation or loss in body weight among medium- and high-dose groups. Similar outcomes had been reported by Gupta et al. (2009), who had shown that cypermethrin exposure had caused reduced food efficiency and weight gain in rodents, attributed to gastrointestinal toxicity and altered metabolic pathways. The present findings had therefore confirmed that even when dissolved in maize powder, cypermethrin had been capable of impairing appetite and nutrient utilization.

The use of maize powder as the dietary vehicle had been critical to interpreting these effects. Maize powder, rich in polyunsaturated fatty acids, had been shown to modulate steroid hormone metabolism and reproductive outcomes (Luthra et al., 2001). In this study, however, maize powder had served as a solvent for cypermethrin, and while control animals had maintained stable intake with plain maize powder, treated groups had demonstrated aversion to pesticide-laden feed. This had indicated that cypermethrin incorporation had altered the palatability and acceptance of the maize powder diet, resulting in suppressed feeding. Furthermore, the lipophilic nature of cypermethrin had allowed efficient absorption from the gastrointestinal tract, enhancing systemic toxicity and endocrine disruption.The estrus cycle had been disrupted in pesticide-exposed groups, with prolonged diestrus and shortened estrus phases frequently observed. Das et al. (2016) had similarly reported that cypermethrin exposure had altered ovarian biomarkers in rats through oxidative stress, leading to irregular estrus cycles. International studies had supported this observation: Zhang et al. (2008) had shown that cadmium, another endocrine-disrupting toxicant, had impaired ovarian steroidogenesis, leading to similar estrus disturbances. Thus, cypermethrin exposure in maize powder had replicated a pattern of environmental contaminant-induced reproductive disruption observed globally.

Hormonal analysis had revealed significant reductions in estrogen and progesterone levels, particularly in high-dose groups. These reductions had been correlated with suppressed feeding and altered estrus progression, supporting the hypothesis of pesticide-induced endocrine disruption. Bretveld et al. (2006) had reviewed that pesticides could interfere with hormonal production, receptor binding, and post-receptor signaling, ultimately manifesting as disrupted ovarian cycles and infertility. The current findings had aligned with these conclusions, reinforcing the endocrine-disrupting potential of cypermethrin.Histological observations had confirmed the physiological consequences of hormonal and dietary disruption. Follicular atresia, corpus luteum degeneration, and uterine structural damage had been evident in cypermethrin-exposed groups. Comparable results had been reported by Hutz et al. (2006), who had demonstrated that dioxin exposure had reduced ovarian follicle viability and impaired estrogen production across multiple species. Within India, experimental studies had revealed that repeated exposure to pyrethroids had induced gonadal degeneration and disrupted gametogenesis in laboratory rodents (Singh et al., 2010). Together, these findings had underscored that pesticide-induced reproductive toxicity had been a concern of both national and international significance.

The study had also highlighted the subtle but important link between feeding behaviour and reproductive health. While estrus-related variations in food intake had been expected, cypermethrin exposure had exaggerated these changes, reducing nutritional availability during critical reproductive phases. As nutritional adequacy had been essential for successful folliculogenesis, ovulation, and embryo implantation (Sharara et al., 1998), the combined effect of dietary suppression and hormonal disruption had magnified reproductive toxicity.These outcomes had been consistent with prior toxicological findings from India and

abroad, situating the present results within a broader framework of pesticide-induced reproductive disruption. The integration of food habit analysis into estrus studies had provided new insight into the nutritional dimensions of pesticide toxicity.

5. Conclusion

The present investigation had been carried out to evaluate the influence of cypermethrin on food habits during the estrus cycle of female mice, using maize powder as the dietary vehicle. The study had revealed that cypermethrin exposure, even when administered in a common dietary medium, had exerted profound effects on feeding behaviour, hormonal balance, and reproductive physiology.Food intake had been significantly suppressed in treated groups, particularly during proestrus and estrus stages, which had already been physiologically vulnerable to reduced appetite due to estrogenic regulation. This suppression had been reflected in body weight trends, where medium- and high-dose groups had exhibited stagnation or decline compared to the consistent gain observed in controls.Hormonal assays had demonstrated that estrogen and progesterone levels had been markedly reduced in a dose-dependent manner, correlating with the disruptions observed in estrus cycle progression. Histological analyses had confirmed structural damage to ovarian and uterine tissues, including follicular atresia and uterine degeneration, which had collectively indicated impaired reproductive potential.

The findings had underscored that the combination of altered food habits, reduced nutritional intake, and endocrine disruption had produced compounding effects on reproductive health. Maize powder, although nutritionally beneficial, had served as an efficient vehicle for pesticide absorption, thereby amplifying systemic toxicity.This study had highlighted the broader toxicological significance of dietary pesticide exposure, aligning with both national and international research on pesticide-induced reproductive dysfunction. The results had demonstrated that food habit alterations during the estrus cycle had not only reflected physiological responses but had also acted as early indicators of environmental toxicant impact.

In conclusion, cypermethrin exposure through a maize powder diet had influenced food habits, disrupted estrus cycles, suppressed hormonal balance, and induced reproductive tissue damage. These outcomes had reinforced the need for stricter monitoring of pesticide use, evaluation of dietary exposure routes, and the promotion of safer pest management strategies. The study had provided a holistic understanding of how diet and environmental toxicants had interacted to compromise reproductive health, offering valuable insights for toxicology, ecology, and public health research.

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