

# Effects of Herbal Formulas on Male Reproductive System of High-Fat Diet Induced Obesity in Albino Rats

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## ABSTRACT

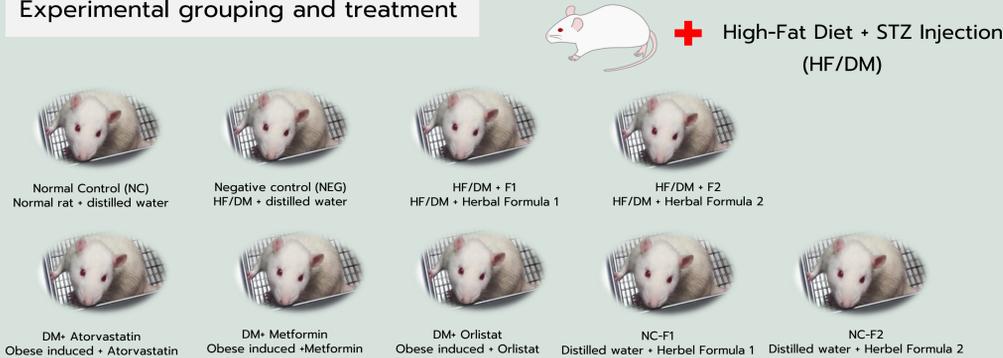
Obesity is a major risk factor for the development of type 2 diabetes, affecting both metabolic function and the male reproductive system. Studies have reported that obesity and diabetes contribute to reduced sperm quality, impacting motility, viability, and concentration, which are closely linked to male infertility. This study aimed to investigate the effects of two newly formulated herbal mixtures compared to synthetic medications, including metformin, orlistat, and atorvastatin, on the male system of albino rats induced with obesity and diabetes. Two herbal formulas were tested. Formula 1 consisted of *Dracaena cochinchinensis*, *Milusa velutina*, *Emblca officinalis*, *Piper interruptum*, and *Albizia procera*, whereas Formula 2 consisted of *Cinnamomum bejolghota*, *Milusa velutina*, *Acacia concinna*, *Ocimum gratissimum*, and *Albizia procera*. Male Wistar rats were divided into nine experimental groups, including a normal control group, a negative control group, two normal groups treated with herbal formulas, and obesity- and diabetes-induced groups treated with three conventional drugs. Obesity and diabetes were induced by high-fat diet and streptozotocin. Oral treatments were administered for one month. Reproductive organ weights were measured, and sperm quality was assessed by analyzing sperm motility, viability, and concentration, along with histological evaluations of the testes. The results showed that the negative control group exhibited a decline in relative reproductive organ weights, as well as reductions in sperm concentration, progressive motility, viability, and normal morphology compared to the normal control group. Treatment with Formula 1 and Formula 2 improved relative reproductive organ weights and restored sperm quality in obesity- and diabetes-induced rats. Additionally, histological analysis revealed that the herbal formula-treated groups improved structural changes in the testicular tissues of obesity- and diabetes-induced rats. These findings suggest that the novel herbal formulas have potential therapeutic efficacy in mitigating the adverse effects of obesity and diabetes on the male reproductive system.

## Introduction

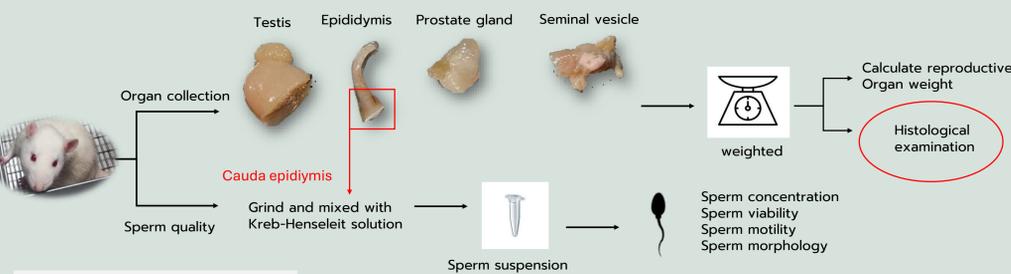
Obesity and diabetes are escalating global health issues that lead to significant metabolic complications, including insulin resistance, hyperglycemia, and cardiovascular dysfunction. These conditions adversely affect male reproductive health, impacting organs such as the testis, epididymis, seminal vesicle, and prostate gland. While conventional medications like orlistat, statins, and metformin are commonly used for weight and metabolic control, concerns remain regarding their side effects and long-term sustainability. Recent research has focused on herbal medicine as a potential alternative due to its metabolic benefits and fewer adverse effects. Studies have shown that certain medicinal plants can positively influence sperm and testosterone production in men (Moghadam et al., 2022). Additionally, specific herbal formulations have demonstrated lipid-lowering effects and potential in reducing obesity (Zhang et al., 2022). This study evaluates two herbal formulations containing bioactive compounds known for their antioxidant, anti-inflammatory, and metabolic regulatory properties. The first formulation includes *Dracaena cochinchinensis*, *Milusa velutina*, *Emblca officinalis*, *Piper interruptum*, and *Albizia procera*. The second formulation consists of *Cinnamomum bejolghota*, *Milusa velutina*, *Acacia concinna*, *Ocimum gratissimum*, and *Albizia procera*. This study aims to assess the efficacy of these herbal formulations in improving male reproductive organ function and structure in an obesity and diabetes-induced rat model. The findings may provide insights into the development of herbal-based therapeutic strategies for metabolic disorders and male reproductive health.

## Methodology

### Experimental grouping and treatment



### Sample Collection



### Histological process



## Results and Discussion

**Table 1** Relative reproductive organ weights of HF/DM induced rats treated with two herbal formulas at a dose of 200 mg/kg for 30 days, compared to synthetic drugs.

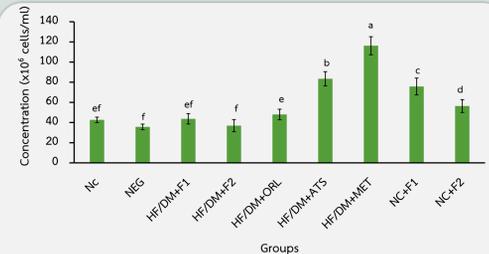
Treatments	Relative weight			
	testes (g/100g BW)	epididymis (mg/100g BW)	seminal vesicle (g/100g BW)	prostate gland (g/100g BW)
NC	0.38 ± 0.04 <sup>ab</sup>	135.37 ± 5.94 <sup>ab</sup>	0.39 ± 0.06 <sup>a</sup>	0.17 ± 0.03 <sup>ab</sup>
NEG	0.33 ± 0.04 <sup>b</sup>	112.98 ± 1.02 <sup>a</sup>	0.32 ± 0.03 <sup>a</sup>	0.12 ± 0.04 <sup>a</sup>
HF/DM+F1	0.40 ± 0.03 <sup>ab</sup>	138.94 ± 19.17 <sup>ab</sup>	0.39 ± 0.08 <sup>a</sup>	0.14 ± 0.03 <sup>a</sup>
HF/DM+F2	0.40 ± 0.04 <sup>ab</sup>	136.28 ± 18.57 <sup>ab</sup>	0.38 ± 0.05 <sup>a</sup>	0.15 ± 0.04 <sup>a</sup>
HF/DM+ORL	0.31 ± 0.12 <sup>b</sup>	119.56 ± 31.20 <sup>a</sup>	0.41 ± 0.06 <sup>a</sup>	0.13 ± 0.03 <sup>a</sup>
HF/DM+ATS	0.36 ± 0.03 <sup>ab</sup>	116.62 ± 13.01 <sup>a</sup>	0.37 ± 0.06 <sup>a</sup>	0.18 ± 0.03 <sup>ab</sup>
HF/DM+MET	0.37 ± 0.04 <sup>ab</sup>	134.33 ± 26.64 <sup>ab</sup>	0.36 ± 0.06 <sup>a</sup>	0.15 ± 0.02 <sup>a</sup>
NC+F1	0.44 ± 0.04 <sup>a</sup>	152.53 ± 12.82 <sup>b</sup>	0.38 ± 0.02 <sup>a</sup>	0.25 ± 0.15 <sup>b</sup>
NC+F2	0.40 ± 0.00 <sup>ab</sup>	143.63 ± 4.11 <sup>ab</sup>	0.35 ± 0.03 <sup>a</sup>	0.19 ± 0.06 <sup>ab</sup>

Herbal treatments, particularly Formula 1 and Formula 2, demonstrated a promising ability to mitigate the adverse effects of obesity and diabetes on reproductive organ weights, performing comparably or better than conventional pharmaceutical drugs.

## Acknowledgements

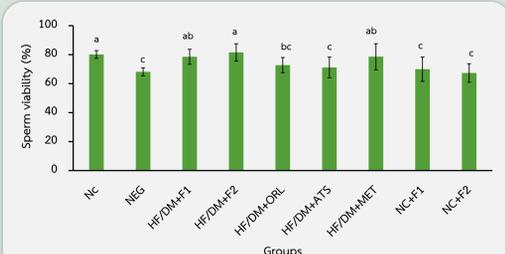
I would like to express my deepest gratitude to my professor at the Department of Biology, Chiang Mai University, for their invaluable guidance, support, and encouragement throughout this research. Their expertise and insightful advice have been instrumental in shaping the direction of this study. I sincerely appreciate their patience and dedication in mentoring me, as well as their constructive feedback, which has greatly contributed to the completion of this work. Additionally, I would like to extend my gratitude to Chiang Mai University for providing the necessary resources and facilities that made this research possible. Thank you for your unwavering support and inspiration.

**Figure 1** Sperm concentration of HF/DM induced rats treated with two herbal formulas at a dose of 200 mg/kg for 30 days, compared to synthetic drugs.

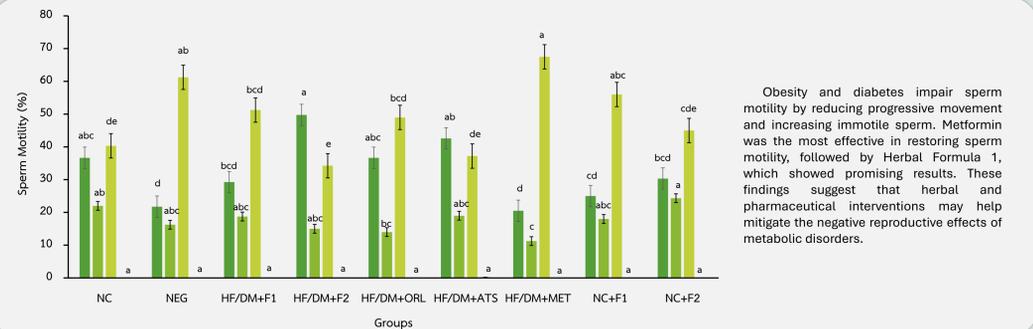


Metformin demonstrated the highest efficacy in restoring sperm concentration in obesity- and diabetes-induced rats, followed by atorvastatin. Herbal treatments showed moderate improvements, suggesting potential reproductive benefits. These findings highlight the importance of metabolic health in male fertility and indicate that both pharmaceutical and herbal interventions may help mitigate the adverse effects of obesity and diabetes on sperm quality.

**Figure 2** Sperm viability of HF/DM induced rats treated with two herbal formulas at a dose of 200 mg/kg for 30 days, compared to synthetic drugs.

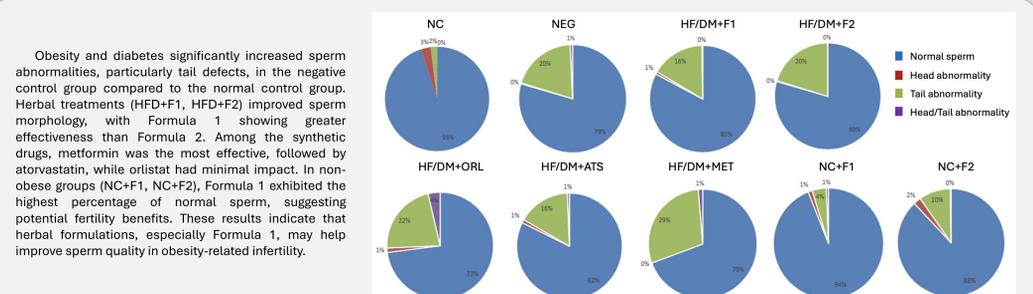


Obesity and diabetes significantly reduce sperm viability, confirming their detrimental effects on male fertility. Among treatments, metformin demonstrated the strongest improvement, restoring sperm viability to near normal levels. Herbal formulas also showed potential benefits, albeit to a lesser extent. These findings support the role of metabolic regulation in preserving sperm function and suggest that both pharmaceutical and herbal interventions may help improve sperm viability in individuals affected by obesity and diabetes.



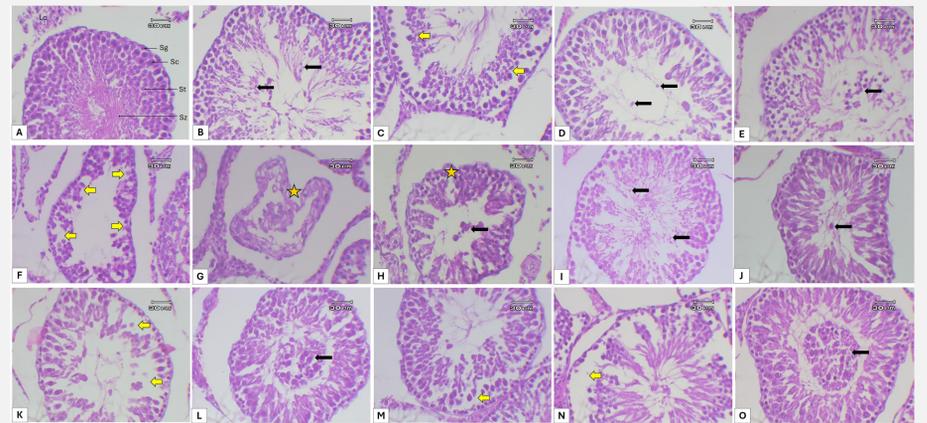
Obesity and diabetes impair sperm motility by reducing progressive movement and increasing immotile sperm. Metformin was the most effective in restoring sperm motility, followed by Herbal Formula 1, which showed promising results. These findings suggest that herbal and pharmaceutical interventions may help mitigate the negative reproductive effects of metabolic disorders.

**Figure 3** Sperm motility of HF/DM induced rats treated with two herbal formulas at a dose of 200 mg/kg for 30 days, compared to synthetic drugs.



**Figure 4** Proportions of sperm morphology of HF/DM induced rats treated with two herbal formulas at a dose of 200 mg/kg for 30 days, compared to synthetic drugs.

Obesity and diabetes induced significant testicular damage, as observed in the negative control group, which exhibited disorganized seminiferous tubules, sloughing germ cells (black arrows), desquamated germ cells (yellow arrows), and atrophic seminiferous tubules (yellow stars). In contrast, the normal control group displayed normal Leydig cells (Lc) and well-organized seminiferous tubules with intact spermatogonia (Sg), primary spermatocytes (Ps), Sertoli cells (St), and spermatozoa (Sz). Treatment with metformin partially restored testicular architecture; however, signs of germ cell sloughing and desquamation were still present, indicating incomplete recovery.



**Figure 5** Testicular histology of HF/DM induced rats treated with two herbal formulas at a dose of 200 mg/kg for 30 days, compared to synthetic drugs. Normal control group (A), Negative control group (B, C), HF/DM+F1 (D), HF/DM+ORL (F, G, H), HF/DM+ATS (I), HF/DM+MET (J, K), NC+F1 (L, M), and NC+F2 (N, O). H&E stain, 20x. spermatogonia (Sg), primary spermatocytes (Ps), Sertoli cells (St), spermatozoa (Sz), and Leydig cells (Lc), sloughing germ cells (black arrows), desquamated germ cells (yellow arrows), and atrophic seminiferous tubules (yellow stars)

## Conclusion

Obesity and diabetes negatively impacted male reproductive health, leading to reduced sperm quality, viability, and motility, as well as abnormal testicular histology. Treatment with herbal formulas 1 and formula 2 improved sperm parameters and testicular structure, confirming comparably to or better than conventional drugs. Among synthetic drugs, metformin showed the most significant improvement, while orlistat had limited effects. These findings suggest that herbal formulations may serve as a potential therapeutic approach to mitigate the adverse effects of obesity and diabetes on male fertility.

## References

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