

Investigating the Impact of *Cucumis sativus* Aqueous Fruit Juice on Reproductive Health in Adult Male Wistar Rats

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DOI: <https://doi.org/10.36348/sjmps.2026.v12i04.001>

| Received: 19.01.2025 | Accepted: 24.02.2025 | Published: 04.04.2026

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Abstract

Background: *Cucumis sativus* (cucumber) is a widely consumed fruit known for its high water content and antioxidant properties. Despite its numerous health benefits, limited research has been conducted on its potential effects on male reproductive health. This study investigated the impact of cucumber fruit juice on male reproductive hormones and semen quality parameters. **Methods:** Male Wistar rats were divided into three groups: a control group and two experimental groups receiving 10 ml/kg and 20 ml/kg of *Cucumis sativus* fruit juice daily for four weeks. Serum samples were analyzed for follicle-stimulating hormone (FSH), luteinizing hormone (LH), and testosterone levels using enzyme-linked immunosorbent assay (ELISA). Semen samples were evaluated for sperm motility, viability, morphology, and abnormal sperm cell count. **Results:** The administration of cucumber juice did not significantly affect FSH, LH, or testosterone levels ($p > 0.05$), indicating that the fruit juice does not interfere with endocrine regulation of male reproduction. However, sperm quality parameters showed significant improvements. Sperm motility increased notably in the experimental groups, with the highest motility observed in the 20 ml/kg group. Sperm viability and normal morphology were also significantly enhanced compared to the control ($p < 0.05$). The percentage of sperm abnormalities, including head defects, mid-piece distortions, and cytoplasmic droplets, was significantly reduced, particularly at the higher dose. These findings suggest that cucumber juice may improve sperm function without altering hormonal balance. **Conclusion:** The results indicate that *Cucumis sativus* fruit juice has a beneficial effect on sperm quality, enhancing motility, viability, and morphology while reducing sperm abnormalities. These improvements may be attributed to the antioxidant and hydrating properties of cucumber, which help to reduce oxidative stress and support testicular function. However, the absence of significant hormonal changes suggests that its effects on male fertility are primarily local rather than systemic.

Keywords: *Cucumis sativus*, sperm quality, reproductive hormones, antioxidants, male fertility, oxidative stress.

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1. INTRODUCTION

Male infertility is a growing global health concern, contributing to nearly 50% of all infertility cases in couples (Agarwal & Majzoub, 2017). Oxidative stress is a major factor responsible for male reproductive dysfunction, as it impairs spermatogenesis and reduces sperm quality (Agarwal & Prabakaran, 2005). It results from an imbalance between reactive oxygen species (ROS) and antioxidant defenses, leading to lipid peroxidation, DNA damage, and mitochondrial dysfunction in sperm cells (Aitken & De Iuliis, 2007; Aitken & Baker, 2006).

The search for natural antioxidants capable of mitigating oxidative stress-induced reproductive damage has gained significant attention. Phytochemicals such as flavonoids, phenolic acids, and tannins present in fruits and vegetables have been shown to possess antioxidant and anti-inflammatory properties (Agarwal & Saleh, 2002). *Cucumis sativus* (cucumber) is a widely consumed fruit known for its nutritional and medicinal benefits, including antioxidant, anti-inflammatory, and diuretic properties (Obembe *et al.*, 2023). However, while some members of the Cucurbitaceae family, such as *Citrullus lanatus* (watermelon), have demonstrated

beneficial effects on male fertility (Kolawole *et al.*, 2019; Fakunle *et al.*, 2024), the reproductive effects of *Cucumis sativus* remain largely unexplored.

Male infertility is often linked to oxidative stress, which damages sperm cells and impairs hormonal balance (Agarwal & Bui, 2017). While synthetic antioxidants are available, they often come with side effects and may not always be effective in addressing reproductive dysfunction (Agarwal & Sekhon, 2010). Natural antioxidants, such as those derived from *Cucumis sativus*, could offer safer alternatives for improving reproductive health. However, the effects of *Cucumis sativus* on male reproductive hormones, sperm quality, and oxidative stress markers have not been adequately studied. There is a need for scientific validation of its potential reproductive benefits.

Previous studies on Cucurbitaceae family members have demonstrated their beneficial effects on male reproductive health (Kolawole *et al.*, 2019; Fakunle *et al.*, 2024). In a study, hydromethanolic extract of *Citrullus lanatus* rind was found to improve semen quality and testicular oxidative status in nicotine-treated rats (Kolawole *et al.*, 2019). Given that *Cucumis sativus* shares phytochemical similarities with other Cucurbitaceae species, it is reasonable to hypothesize that it may also possess reproductive benefits.

Additionally, research on antioxidants in reproductive health has shown that reducing oxidative stress can enhance sperm motility, improve sperm morphology, and restore hormonal balance (Aitken & Roman, 2008; Aitken & Clarkson, 1987). If *Cucumis sativus* exhibits similar antioxidant properties, it could serve as a natural dietary approach for improving male fertility and mitigating oxidative stress-induced reproductive dysfunction.

Although limited research exists on *Cucumis sativus* and male reproductive health, a recent study by Obembe *et al.*, (2023) reported that aqueous cucumber extract increased serum testosterone and luteinizing hormone levels while improving testicular antioxidant status in rats. These findings suggest a potential role for *Cucumis sativus* in enhancing reproductive function. Furthermore, studies on other Cucurbitaceae members, such as watermelon seed extract, have demonstrated protective effects against reproductive toxicity. Fakunle *et al.*, (2024) found that *Citrullus lanatus* seed extract improved sperm parameters and testosterone levels in male albino rats exposed to reproductive toxins. Research has consistently linked oxidative stress with male infertility, and several studies have shown that antioxidant therapy can enhance reproductive outcomes (Agarwal & Allamaneni, 2004; Agarwal & Sekhon, 2010). This study aims to evaluate the effects of aqueous cucumber extract on reproductive parameters in adult male Wistar rats. The findings will contribute to the understanding of its potential as a natural remedy for

male infertility and oxidative stress-related reproductive dysfunction.

2.0. MATERIALS AND METHODS

2.1 Materials

2.1.1 Plant Materials

Fresh fruits of *Cucumis sativus* were purchased from a local market in Umuerim Nekede, Owerri West L.G.A., Imo State, Nigeria. The plant material was identified and authenticated by a botanist, Dr. C.N. Duru, in the Department of Environmental Biology, Federal Polytechnic Nekede.

2.1.2 Animals

Adult male Wistar rats weighing between 150-200 g were obtained from a reputable breeder in Ihiagwa, Owerri West L.G.A., Imo State. The rats were housed in well-ventilated stainless steel wire cages under standard laboratory conditions, with a 12-hour light/dark cycle, temperature of $22 \pm 2^\circ\text{C}$, and relative humidity of $55 \pm 5\%$. They were fed standard rat pellets and provided with clean water ad libitum. A two-week acclimatization period was allowed before the commencement of the experiment.

2.1.3 Chemicals and Reagents

All chemicals and reagents used were of analytical grade and obtained from standard suppliers.

2.1.4 Instruments/Equipment

Laboratory instruments and equipment, including a top-loading balance, pH meter, microscope, and glass slides, were provided by the Department of Pharmaceutical Technology, Federal Polytechnic Nekede, Owerri.

2.2 Methods

2.2.1 Preparation of Plant Material and Extraction

Fresh *Cucumis sativus* (cucumber) fruits were thoroughly washed under running water to remove dirt and contaminants. The fruits were then peeled, sliced into small pieces, and blended using a laboratory-grade electric blender with a minimal amount of distilled water to facilitate extraction. The resulting juice was filtered through a fine muslin cloth to remove solid residues, and the filtrate was centrifuged at 3000 rpm for 10 minutes to obtain a clear supernatant. The juice was then stored in a clean, airtight container at 4°C until use. Fresh preparations were made every 48 hours to maintain stability and prevent microbial contamination. The prepared cucumber juice was administered orally to the experimental animals in doses of 10 ml/kg and 20 ml/kg body weight, respectively.

2.2.2 Animal Grouping and Treatment

Male Wistar rats were randomly divided into three groups of Ten (10) animals each, as follows:

Group 1 (Normal Control): Received distilled water only.

Group 2 (Low Dose): Administered *Cucumis sativus* fruit juice at 10 ml/kg body weight.

Group 3 (High Dose): Administered *Cucumis sativus* fruit juice at 20 ml/kg body weight.

The treatments were administered orally once daily for 28 consecutive days.

2.3. Biochemical Assay

2.3.1. Hormonal Analysis:

Blood samples were collected via retro-orbital puncture on Day 29 for serum analysis. Hormonal levels (testosterone, FSH, luteinizing hormone) were measured

using enzyme-linked immunosorbent assay (ELISA) kits (Shariati *et al.*, 2008).

2.3.2. Sperm Analysis:

The cauda epididymis was dissected, and spermatozoa were collected. Sperm count, motility, viability, and morphology were assessed using standard procedures (Jalili *et al.*, 2018).

3.0. RESULTS

3.1. Effect of *Cucumis sativus* fruit extract on hormones of Wistar rats

Table 1: Significant changes in LH, FSH, and Testosterone of *Cucumis sativus*-treated Wistar rats

Treatments	FSH (miu/ml)	LH (miu/ml)	Testosterone (ng/L)
Control	7.88±0.41 ^a	4.93±0.27 ^a	12.83±0.85 ^a
10 ml/kg fruit juice	8.22±0.75 ^a	5.18±0.50 ^a	12.87±0.67 ^a
20 ml/kg fruit juice	8.54±0.41 ^a	5.19±0.19 ^a	14.15±0.59 ^a

Values are expressed as mean ± standard deviation (n = 4), and values with unlike superscripts are significantly (p<0.05) different from paired mean within the column.

The hormonal analysis results (Table 1) show that the administration of fruit juice at 10 ml/kg and 20 ml/kg did not significantly (p>0.05) alter FSH, LH, and testosterone levels compared to the control group, as all values share the same superscript (*a*). This indicates that fruit juice supplementation did not interfere with gonadotropin secretion or testosterone production, suggesting that it has no significant impact on hormonal regulation in male reproductive function. Although

slight numerical increases in FSH and LH were observed in the treated groups, they were not statistically significant, as all values remained within the same superscript category (*a*), confirming that hormonal balance was maintained across all groups.

3.2. Effect of *Cucumis sativus* fruit extract on Sperm quality of Wistar rats

Table 2: Significant changes in semen quality of *Cucumis sativus*-treated Wistar rats

Treatments	Semen colour	Semen consistency	Semen pH	Sperm progressive motility (%)	Sperm cells with aberrant movement (%)
Control	2.00±0.00 ^a	3.00±0.00 ^a	7.19±0.03 ^a	74.55±3.71 ^a	14.78±1.60 ^c
10 ml/kg fruit juice	2.00±0.00 ^a	4.00±0.00 ^b	7.16±0.03 ^a	81.53±3.12 ^b	9.59±1.11 ^b
20 ml/kg fruit juice	2.00±0.00 ^a	4.00±0.00 ^b	7.14±0.03 ^a	87.05±6.79 ^b	6.23±3.66 ^a

Values are expressed as mean ± standard deviation (n = 4), and values with unlike superscripts are significantly (p<0.05) different from paired mean within the column.

The semen quality parameters in Table 2 reveal significant (p<0.05) differences in semen consistency, sperm progressive motility, and sperm cells with aberrant movement among the treatment groups. While semen colour and pH remained unchanged (*a*), semen consistency significantly increased in the fruit juice-treated groups, as indicated by the different superscripts (*a* vs. *b*). Sperm progressive motility significantly

increased in the treated groups, with the 10 ml/kg (*b*) and 20 ml/kg (*b*) groups showing higher motility than the control (*a*). Conversely, sperm cells with aberrant movement significantly decreased in a dose-dependent manner, with the control (*c*) showing the highest value, followed by 10 ml/kg (*b*) and 20 ml/kg (*a*), suggesting improved sperm movement efficiency with fruit juice supplementation.

Table 3: Significant changes in semen quality of *Cucumis sativus*-treated Wistar rats contd.

Treatments	Non motile spermatozoa (%)	Live proportion (%)	Sperm count (x10 ⁶ /CEP)	Sperm with normal morphology (%)	Abnormal spermatozoa (%)
Control	13.25±0.90 ^c	80.12±1.23 ^a	115.93±4.20 ^a	92.06±0.93 ^a	7.44±0.46 ^b
10 ml/kg fruit juice	10.10±0.91 ^b	90.36±3.14 ^b	139.02±3.67 ^b	94.05±0.47 ^b	6.20±0.49 ^b
20 ml/kg fruit juice	6.21±3.45 ^a	92.52±5.16 ^b	144.11±4.87 ^b	95.68±0.96 ^c	4.32±0.96 ^a

Values are expressed as mean ± standard deviation (n = 4), and values with unlike superscripts are significantly (p<0.05) different from paired mean within the column.

Table 3 further supports the beneficial effects of fruit juice on semen parameters, as significant ($p < 0.05$) differences were observed in non-motile spermatozoa, live proportion, sperm count, sperm with normal morphology, and abnormal spermatozoa. Non-motile spermatozoa were significantly reduced in the treated groups, with the control (c) showing the highest percentage, followed by 10 ml/kg (b) and 20 ml/kg (a). Similarly, live proportion and sperm count significantly increased in the treated groups, with the 20 ml/kg (b) group showing the highest values compared to the

control (a). Sperm with normal morphology was highest in the 20 ml/kg (c) group, significantly different from the 10 ml/kg (b) and control (a) groups, while abnormal spermatozoa followed an inverse trend, with the control (b) having the highest percentage, followed by 10 ml/kg (b) and 20 ml/kg (a), suggesting an improvement in sperm viability and structural integrity.

3.3. Effect of *Cucumis sativus* fruit extract on Differential sperm cell abnormalities of Wistar rats

Table 4: Significant changes in differential sperm cell abnormalities of *Cucumis sativus*-treated Wistar rats

Treatments	Total Head Abnormality (%)	Sperm cell with twisted tail (%)	Bent mid-piece abnormality (%)	Total cytoplasmic droplets (%)	Entangled/twisted spermatozoa (%)
Control	1.05±0.08 ^b	1.01±0.02 ^b	1.01±0.10 ^{a,b}	3.44±0.49 ^b	1.13±0.04 ^b
10 ml/kg fruit juice	0.98±0.05 ^b	0.99±0.01 ^b	0.78±0.17 ^{a,b}	2.23±0.22 ^a	1.12±0.26 ^b
20 ml/kg fruit juice	0.66±0.37 ^a	0.67±0.33 ^a	0.53±0.05 ^a	2.06±0.10 ^a	0.20±0.02 ^a

Values are expressed as mean ± standard deviation (n = 4), and values with unlike superscripts are significantly ($p < 0.05$) different from paired mean within the column.

The differential sperm cell abnormalities in Table 4 show a significant ($p < 0.05$) reduction in total head abnormality, twisted tail sperm, bent mid-piece abnormality, total cytoplasmic droplets, and entangled/twisted spermatozoa with increasing doses of fruit juice. The control group consistently showed the highest abnormalities, with total head abnormality (b), twisted tail (b), and entangled/twisted spermatozoa (b) being significantly higher than the 20 ml/kg group (a). Bent mid-piece abnormality and total cytoplasmic droplets were significantly reduced in the 20 ml/kg (a) group compared to the control (b). These findings indicate that fruit juice supplementation improved sperm morphology and reduced structural defects, with the 20 ml/kg group showing the most significant improvements.

4.0. DISCUSSION

The present study investigated the effects of *Cucumis sativus* (cucumber) fruit juice on male reproductive hormones and semen quality. The findings indicated that while hormonal levels remained unchanged, significant improvements were observed in various semen parameters, including sperm motility, viability, and morphology. These results suggest that cucumber juice may have potential benefits for male fertility, primarily by enhancing sperm function rather than altering hormonal regulation.

4.1. Hormonal Analysis

The results revealed that cucumber juice administration at doses of 10 ml/kg and 20 ml/kg did not significantly influence the levels of follicle-stimulating hormone (FSH), luteinizing hormone (LH), or testosterone. The hormonal profiles of all experimental groups remained comparable to the control, indicating that cucumber juice does not interfere with the endocrine regulation of male reproduction. This suggests that the

observed improvements in semen quality are likely due to direct effects on the testes or spermatozoa rather than systemic hormonal changes. Similar findings have been reported in previous studies on natural antioxidants and their effects on male reproductive health. A study by Abarikwu (2013) demonstrated that while certain plant extracts improved sperm quality, they did not significantly alter testosterone levels. This suggests that some bioactive compounds may exert their effects on sperm function through local mechanisms within the testes rather than through systemic endocrine regulation. Additionally, the absence of hormonal changes aligns with findings from research on other fruit extracts, such as those from *Citrullus lanatus* (watermelon), which enhanced sperm motility and viability without significantly affecting testosterone levels (Godspower *et al.*, 2015).

4.2. Semen Quality Parameters

A significant improvement in semen consistency, sperm motility, and a reduction in sperm cells with aberrant movement was observed in the groups receiving cucumber juice. The 20 ml/kg dosage resulted in the highest sperm motility and the lowest percentage of aberrant sperm movements. These findings support previous research indicating that cucumber juice may positively influence sperm motility. In a related study on albino rats, low-dose cucumber juice administration was found to enhance sperm motility without affecting viability or morphology (Daramola *et al.*, 2018). The high-water content and antioxidant properties of cucumber may contribute to improved blood flow and oxidative stress reduction, thereby enhancing sperm function. Additionally, the role of hydration in semen quality has been well documented. Proper hydration is essential for optimal semen viscosity, which directly affects sperm movement and overall fertility potential (Kirkman-Brown & Smith, 2011).

4.3. Sperm Viability and Morphology

A significant reduction in non-motile spermatozoa and abnormal sperm forms was observed with increasing doses of cucumber juice. The highest dose (20 ml/kg) resulted in the greatest improvements in sperm viability, morphology, and overall sperm count. This aligns with previous studies that have demonstrated the beneficial effects of plant-derived antioxidants on sperm quality.

For example, research on *Cucumis metuliferus* (horned melon) showed that certain dosages improved sperm count and viability, whereas higher doses had no additional benefits or even adverse effects (Shun *et al.*, 2023). These findings suggest that the optimal dose of plant extracts is crucial in determining their efficacy in improving male fertility. The lack of significant hormonal changes in the present study further supports the notion that cucumber juice may act locally within the reproductive system, possibly by enhancing testicular microcirculation and protecting sperm from oxidative damage.

4.4. Differential Sperm Cell Abnormalities

A notable decrease in specific sperm abnormalities, including head defects, twisted tails, bent mid-pieces, cytoplasmic droplets, and entangled spermatozoa, was observed with increasing doses of cucumber juice. The most pronounced improvements were seen in the 20 ml/kg group. These findings are significant, as sperm morphology plays a crucial role in fertilization capability. Abnormal sperm structure can impede motility, hinder penetration of the oocyte, and ultimately reduce male fertility potential (Chakraborty & Saha, 2022). The antioxidant properties of cucumber juice, attributed to its rich content of vitamin C, flavonoids, and other phytochemicals, may contribute to reducing oxidative stress, which is a major factor in sperm abnormalities (Aitken *et al.*, 2013). Oxidative stress has been implicated in sperm DNA fragmentation and poor morphology, making dietary antioxidants a potential natural intervention for improving sperm quality.

Direct studies on the effects of *Cucumis sativus* on male fertility are limited, but related research provides supportive evidence. Studies on the use of cucumber juice in semen cryopreservation have shown that it can enhance sperm motility and fertility rates in fish species (Kowalczyk *et al.*, 2022; Khan *et al.*, 2022). This suggests that cucumber juice contains bioactive compounds that promote sperm function across different species. Moreover, the general health benefits of cucumbers, including hydration, anti-inflammatory effects, and micronutrient supplementation, may indirectly support reproductive health (Khan *et al.*, 2022). However, some experts argue that while cucumbers provide essential nutrients, they may not significantly impact sperm count or quality in cases of clinical infertility (Bartlett & Erlich). This highlights the

need for further clinical research to determine the extent of cucumber juice's effects on male fertility.

Cucumbers are rich in antioxidants, including vitamin C, which can neutralize reactive oxygen species and reduce oxidative stress on sperm cells. This is crucial for maintaining sperm DNA integrity and overall viability (Aitken & Baker, 2013). The high water content in cucumbers aids in maintaining optimal hydration, which is essential for semen volume and viscosity. Additionally, cucumbers contain essential nutrients like manganese, zinc, and vitamin A, which play key roles in reproductive health and spermatogenesis (Khan *et al.*, 2022). Some studies suggest that plant-derived bioactive compounds can enhance testicular function by promoting Leydig cell activity and improving microcirculation within the testes (Ramgir *et al.*, 2022). These mechanisms may contribute to improved sperm production and function without altering systemic hormone levels.

5.0. CONCLUSION

The findings of this study suggest that dietary supplementation with cucumber juice could be a natural approach to enhancing male reproductive health, particularly in improving semen quality. However, the lack of effect on hormonal levels indicates that cucumber juice may be more beneficial for men with normal endocrine function rather than those with hormonal imbalances. In summary, while *Cucumis sativus* fruit juice does not appear to influence systemic reproductive hormones, it significantly enhances various parameters of semen quality, including motility, viability, and morphology. These improvements are likely mediated through the antioxidant and nutritional properties of cucumber, directly benefiting sperm health. Incorporating cucumber juice into the diet may serve as a natural strategy to support male fertility, though further studies are warranted to fully understand its therapeutic potential.

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