Androgenic Effects of *Cinnamomum camphora* in Male Sprague-dawley Rats

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**Authors’ contributions**

This work was carried out in collaboration among all authors. Author FID designed the study, wrote the protocol and reviewed the first draft of manuscript. Author OHA managed the literature searches, conducted experimental studies, performed the statistical analysis and also wrote the first draft of the manuscript. Author GGA edited and reviewed the final manuscript. All authors read and approved the final manuscript.

**Article Information**

DOI: 10.9734/JAMMR/2019/v31i730310

**Editor(s):**

(1) Dr. Muhammad Torequl Islam, Assistant Professor, Department of Pharmacy, Faculty of Life Science, Bangabandhu Sheikh Mujibur Rahman Science and Technology University, Bangladesh and Researcher, Ton Duc Thang University, Vietnam.

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Complete Peer review History: [http://www.sdiarticle4.com/review-history/53272](http://www.sdiarticle4.com/review-history/53272)

**Received 08 October 2019**
**Accepted 13 December 2019**
**Published 21 December 2019**

**ABSTRACT**

This study evaluated camphora-induced androgenic and histopathological changes in male Sprague-Dawley rats. Thirty-five animals weighing 200 g±20 g were used for this study and randomly divided equally into five groups, with seven rats in each group. Group A animals (normal control group) were served water and rat chow only; Groups B-D (treatment groups) were orally administered camphora in doses of 1 g/kg (Low-dose), 2 g/kg (Medium-dose) and 4 g/kg (High-dose) respectively while Group E (vehicle group) were orally administered 6 mL/kg olive oil (a solvent for camphora) per day for 56 days. There was a significant decrease (*P*< .05) in activity levels of Follicle-Stimulating Hormone (FSH); Superoxide Dismutase (SOD) when the treatment was compared with the control group. Also, a significant decrease (*P*< .05) in activity level of FSH was observed when the Medium-dose group was compared with Low-dose group. Insignificant irregular pattern in activity level of Testosterone was observed across the treatment groups when

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compared with the control. However, a significant increase (P<.05) in activity level of Testosterone was observed when the High-dose group was compared with the Medium-dose group. There was a significant increase (P<.05) in activity levels of Luteinizing Hormone (LH) and Malondialdehyde (MDA) when the treatment was compared with the control group. Semen analysis showed reduction in sperm concentration, motility and morphology with increasing concentration of camphora. Significant decrease was recorded in testicular weight when High-dose group was compared to Control and Low-dose groups. Histopathological changes were seen in the testes of the camphor administered groups, ranging from mild disintegrated interstitial tissues in Low-dose to severe degeneration and disintegration of both seminiferous and interstitial tissues in the testes in the Medium-dose and High-dose groups. In conclusion, camphora had androgenic and toxic effects on testis and may cause testicular tissue damage.

Keywords: Camphora; androgenic; testosterone; oxidative stress; spermatozoa; sperm characteristics; sprague-dawley rats.

1. INTRODUCTION

Camphora, with a formula of C_{10}H_{16}O is a waxy, flammable, transparent solid with a strong aroma. It is a terpenoid found in the wood of the camphor laurel, Cinnamomum camphora (L.), naturally occurring in Asian countries including Japan, Taiwan and China, but has been naturalised in other parts of the world; and also of the unrelated kapur tree, a tall timber tree from the same region [1,2]. It can also be synthesized from wood turpentine. This fragrant camphora tree is large with pale brown bark, dark green to yellowish leaves and small white flowers followed by small purple berries. All the plant parts possess the distinctive, easy-to-recognise camphoraceous aromatic odour. An active ingredient (1R)-(+) -camphora, i.e., natural camphora is yielded from the essential oil distilled from the wood [3]. Camphora is associated with a long-valued history for it being used diversely and extensively in the East: it is being used as a circulatory stimulant and analptic in China, whilst the Japanese used it to add small quantities to fireworks to make them brighter, and also as a component of torch-light material [4].

It is a constituent of a variety of foods, and typical sources are herbs, such as basil, rosemary, sage, coriander, and marjoram [5]. Camphora is used for different purposes such as stimulation of circulatory and respiratory systems, psychological stimulation, and cosmetics for dermal use [6]. Furthermore, it is used for modulating sexual activity, inducing abortion, contraception, and reducing milk production in lactating women [7]. Camphora can be administered through inhalation, ingestion or dermal routes [8]. Following exposure, metabolism of camphora is mediated by cytochrome P450 [9], a class of heme-containing mono-oxygenases widely distributed in humans and animals cells. The resulting hydroxylated metabolites of camphora following cytochrome P450 action are conjugated with glucuronic acid and excreted in the urine [10].

Signs of toxicity have been reported in rats orally administered acute doses of camphora. Consumption of food which reduced in a dose-dependent manner, weight reduction, convulsion, and piloerection were the reported signs of toxicity [11]. In primary culture of chick embryo liver cells, camphora caused enhanced porphyrin accumulation ranging from 5 to 20-fold [12]. According to Enaibe, et al. [13], kidney of rabbits administered various doses of camphora revealed mild edema with glomerulonephritis, tubular necrosis, glomerular lobulations, and congestion of the blood cells, suggesting a cytotoxic effect on the organ. Furthermore, camphora exposures resulted into significant structural changes including thickness of myometrium with a large expansion in the uterus cavity, reduction in the size of epithelial cells, and an increase in inactive chromosomes in the uterus of pregnant rats [14]. Still according to Linjawi [14], in the uterus, there were significant increases in cellular infiltration, the appearance of epithelial cells and nucleuses degradation, disappearance of nuclear envelope, as well as significant increase in numbers of white blood cells during pregnancy period.

Similarly, with respect to the study of Al-Qudsi and Linjawi [15], the number of uterine glands was fewer with a concomitant increase in the endometrial thickness and enlargement of the lumen cavity, endometrial epithelium showed cubical epithelium, cytoplasmic vacuolation, marked decrease in the height of the uterine
epithelium, and large lumen and increased endometrial thickness as a result of endometrial stromal cell proliferation with very small endometrial glands compared with uterus of control animals. Therefore, we investigated the effect of camphora on the histomorphometry, oxidative stress, seminal fluid parameters and hormonal milieu in male Sprague Dawley rats.

2. MATERIALS AND METHODS

2.1 Drug

Edible camphora tablets (\((C_{10}H_{16}O; CAS\# 76-22-2; 96\% purity)\) were supplied by Zhejiang Chemicals Import and Export Corporation, China, dissolved in Olive oil which was supplied by Andalucia, Goya en Espana, S.A.U Sevilla, Spain. All chemicals and reagents were of analytical grade, products of Sigma Chemical Co., Saint Louis, MO, USA or BDH Chemical Ltd, Poole, England.

2.2 Experimental Animals

2.2.1 Animals

A total of thirty-five healthy Sprague-Dawley rats weighing between 200 ± 20 g were used for this study. They were housed in standard well ventilated wire mesh plastic cages in the Animal room of the Department of Anatomy, College of Medicine of the University of Lagos under standard room temperature ranging between 26ºC-28ºC and relative humidity of 50-55%. The animals were exposed to twelve hours light and twelve hours dark cycle and were left to acclimatize for a period of two weeks before the commencement of the experiment. The animals were identified by different ear tags. All experimental procedures and techniques were approved by the departmental committee on the use and care of animals and tissue collection. The rats were allowed unrestricted access to water and commercial rat chow ad libitum. The weights of the animals were taken every week.

2.3 Experimental Design

The animals were divided into five groups (Groups A, B, C, D and E) of seven animals each. Group A (Control) received rat chow and distilled water only but were not administered camphora. Group B rats received low doses of Camphora (1 g/kg) while Group C received medium doses of Camphora (2 g/kg). Meanwhile, Group D received high doses of Camphora (4 g/kg) while Group E served as the vehicle group by receiving Olive oil (6mL/kg). Retro-orbital sampling using capillary tubes was used for blood/plasma sample collection.

2.4 Drug Preparation

Camphora tablets were crushed into powdery form using sterilized mortar and pestle and dissolved in olive oil based on calculated mean lethal dose (LD_{50}) in previous study conducted by Somade, et al. [16], and administered orally with the use of a feeding tube (size 6) for 56 days after acclimatization. The body weights of animals were recorded weekly.

At the end of administration, the rats were weighed and sacrificed 24 hrs after the last administration, using ketamine as anesthesia. The testes were harvested and then weighed with a sensitive weighing scale. The harvested testicular tissues were dissected transversely. One halves were immediately suspended in ice-cold 0.1 M phosphate buffer (pH 7.4) for biochemical assays using a tissue homogenizer and the other halves were fixed in 10% formal saline solution (fixative) for histological assay. The epididymis was also removed for epididymal sperm count. Part of it was smeared with normal saline to immediately check for the motility of the sperm under light microscope and was immediately scored (%).

2.5 Histological Procedures

The testes were transferred into a universal bottle containing 10% formal saline for 72 hours. Tissues were processed for microscopic examination using a standard protocol and 5 μm thick paraffin sections were made. Slides were stained with routine haematoxylin and eosin stains and photomicrographs were made at a magnification of 100 and 400 using Olympus and leica microscopes [17].

2.6 Statistical Analysis

Data were analyzed using SPSS 22.0 (SPSS Inc., Chicago, USA) at P< .05 and Excel 2013 (Microsoft Corporation, USA). Data were expressed as mean±SEM. Means were compared using one-way Analysis of Variance (ANOVA) test.

3. RESULTS AND DISCUSSION

Animals in the groups of Control, Vehicle (6 mL/kg Olive oil), Low-dose (1 g/kg), and Medium
dose (2 g/kg) appeared healthy and showed normal behaviour throughout the study, but in High-dose (4 g/kg) group, animals were less active; sluggish to food and water; breathing clumsily; having running nose and were seldom undergoing seizures after administration. A single mortality was recorded in the High-dose group; that occurred after a prolonged rigorous seizure.

### 3.1 Effect of Camphora on Body Weight (g) of Adult Male Sprague-Dawley Rats

There was significant increase in body weights of the rats in all the treatment groups when pre and post-administration body weights were compared. This is similar to what was observed for control animals. There was significant decrease in post-administration body weights when high-dose group was compared to control, low-dose and medium-dose groups and a general decrease in post administration body weights when the treatment groups were compared to the control group and this decrease is dose dependent. However, a significant increase in body weight at post-administration was observed when Vehicle (6 mL olive oil) was compared to treatment (Table 1).

### 3.2 Effect of Camphora on Testicular Weight (g) of Adult Male Sprague-Dawley Rats

A significant reduction in testicular weight was observed when High-dose group was compared to Control and Low-dose groups. However, a significant increase in testicular weight was observed when the vehicle group was compared to Control, low-dose, medium-dose and high-dose groups. A general, dose dependent decrease was observed when the treatment groups were compared to the control group (Table 2).

### 3.3 Effect of Camphora on Hormonal Milieu of Adult Male Sprague-Dawley Rats

A significant increase was recorded in LH activity level when treatment groups were compared to control group. Also, an increase in value was observed when medium-dose was compared to low-dose group, same as when the high-dose group was compared to medium-dose group. A significant decrease in LH activity level was recorded when vehicle group was compared to treatment groups. Statistically significant reduction was observed in FSH activity levels when treatment group was compared to control group. Increase in values was recorded when high dose was compared to low- and medium-doses. There was a decrease in FSH level when vehicle was compared to control, but an increase was seen when vehicle group was compared to treatment groups. An irregular pattern in the activity level of Testosterone was observed as increase in values was recorded when low- and high-dose groups were compared to control group, but a reduction was seen when medium-dose was compared to control group. Significant increase in Testosterone level was recorded when vehicle was compared to control as similar observations were made when vehicle was compared to treatment groups (Table 3).

### 3.4 Effect of Camphora on Oxidative Stress Markers of Adult Male Sprague-Dawley Rats

There was a significant reduction in the level of Superoxide dismutase (SOD) when Treatment groups and Vehicle group were compared to the Control group. However, a significant increase in the level of Malondiadyhide (MDA) indicating lip peroxidation was recorded when all the treatment groups were compared to Control group, with High-dose group showing a significant increase when compared to Medium-dose group.

### Table 1. Effect of camphora on body weight (g) of adult male sprague-dawley rats

<table>
<thead>
<tr>
<th>Group</th>
<th>Body weight</th>
<th>% Weight difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-administration</td>
<td>Post-administration</td>
</tr>
<tr>
<td>Control</td>
<td>198.58±2.29</td>
<td>218.94 ± 2.66</td>
</tr>
<tr>
<td>Low-dose</td>
<td>185.76±6.93</td>
<td>209.42±5.53</td>
</tr>
<tr>
<td>Medium-dose</td>
<td>189.40±4.49</td>
<td>207.28±5.40</td>
</tr>
<tr>
<td>High-dose</td>
<td>180.48±6.53</td>
<td>186.54±6.42</td>
</tr>
<tr>
<td>Vehicle (oil)</td>
<td>220.40±7.88</td>
<td>235.04±7.40</td>
</tr>
</tbody>
</table>

Values are expressed as Mean ± Standard Error of Mean (SEM). *P< .05 significant compared to Control; **P< .05 significant compared to Low-dose; ***P< .05 significant compared to Medium-dose and ^P< .05 significant compared to high dose; *P< .05 significant compared to Pre-administration
Table 2. Effect of camphora on testicular weight (g) of adult male Sprague-Dawley rats

<table>
<thead>
<tr>
<th>Group</th>
<th>Testicular Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>1.16±.01</td>
</tr>
<tr>
<td>Low-dose</td>
<td>1.14±.02</td>
</tr>
<tr>
<td>Medium-dose</td>
<td>1.11±.01</td>
</tr>
<tr>
<td>High-dose</td>
<td>1.05±.01&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>Vehicle (olive oil)</td>
<td>1.32±.04&lt;sup&gt;abcd&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Values are expressed as Mean ± Standard Error of Mean (SEM). <sup>a</sup>P< .05 significant compared to Control; <sup>b</sup>P< .05 significant compared to Low-dose; <sup>c</sup>P< .05 significant compared to Medium-dose and <sup>d</sup>P< .05 significant compared to high dose.

Table 3. Effect of camphora on hormonal milieu of adult male Sprague-Dawley rats

<table>
<thead>
<tr>
<th>Group</th>
<th>LH (mIU/mL)</th>
<th>FSH (mIU/mL)</th>
<th>TT (ng/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>.86±.04</td>
<td>3.37±.01</td>
<td>1.06±.05</td>
</tr>
<tr>
<td>Low-dose</td>
<td>5.08±.33&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.80±.14&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.07±.09</td>
</tr>
<tr>
<td>Medium-dose</td>
<td>5.26±.35&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.54±.05&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>.93±.04</td>
</tr>
<tr>
<td>High-dose</td>
<td>6.20±.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.82±.04&lt;sup&gt;ac&lt;/sup&gt;</td>
<td>1.40±.16&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Vehicle (olive oil)</td>
<td>1.10±.03&lt;sup&gt;abcd&lt;/sup&gt;</td>
<td>2.00±.07&lt;sup&gt;ac&lt;/sup&gt;</td>
<td>1.88±.26&lt;sup&gt;abcd&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Values are expressed as Mean ± Standard Error of Mean (SEM). <sup>a</sup>P< .05 significant compared to Control; <sup>b</sup>P< .05 significant compared to Low-dose; <sup>c</sup>P< .05 significant compared to Medium-dose and <sup>d</sup>P< .05 significant compared to high dose.

Table 4. Effect of camphora on oxidative stress markers of adult male Sprague-Dawley rats

<table>
<thead>
<tr>
<th>Group</th>
<th>SOD (µmol/ml/min/mg pro)</th>
<th>MDA (µmol/ml/min/mg pro)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>9.58±.65</td>
<td>1.59±.23</td>
</tr>
<tr>
<td>Low-dose</td>
<td>4.00±.33&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.28±.31&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Medium-dose</td>
<td>3.80±.48&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.58±.61&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>High-dose</td>
<td>4.09±.32&lt;sup&gt;ac&lt;/sup&gt;</td>
<td>3.87±.04&lt;sup&gt;ac&lt;/sup&gt;</td>
</tr>
<tr>
<td>Vehicle (olive oil)</td>
<td>9.06±.42&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.40±.28&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Values are expressed as Mean ± Standard Error of Mean (SEM). <sup>a</sup>P< .05 significant compared to Control; <sup>b</sup>P< .05 significant compared to Low-dose; <sup>c</sup>P< .05 significant compared to Medium-dose and <sup>d</sup>P< .05 significant compared to high dose.

Also, increase in values was observed when High-Dose was compared to both Low-Dose and Medium-Dose in SOD and MDA levels (Table 4).

3.5 Effect of Camphora on Sperm Count, Sperm Motility and Sperm Morphology of Adult Male Sprague-Dawley Rats

The seminal analysis for this study showed a regular pattern in concentration, motility and morphology. There was a significant decrease in concentration, motility and morphology of normal sperms when Treatment and Vehicle groups were compared to Control group. There was significant reduction in concentration, motility and morphology of normal sperms when Medium-dose and High-dose groups were compared to Low-dose and control groups; with a decrease when High-dose was compared to Medium-dose groups. Also, the concentration, motility and morphology of normal sperms in Vehicle group increased significantly when compared to the treatment groups (Medium and High Dose). The sperm count in the group treated with olive oil had a similar count when compared to the low dose group. However, the motility and morphology scores were significantly higher when compared to the low, medium and high dosed-groups. (Table 5).

3.6 Effect of Camphora on Histology of Adult Male Sprague Dawley Rats

Plate 1a-b shows histological parameters for control rats; Plates 2a-4b for treatment groups and Plates 5a-b shows for the vehicle group.
Table 5. Effect of camphora on sperm count, sperm motility and sperm morphology of adult male sprague-dawley rats

<table>
<thead>
<tr>
<th>Group</th>
<th>Count (x10^6/ml)</th>
<th>Motility (%)</th>
<th>Morphology (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>77.50±2.07</td>
<td>98.80±.58</td>
<td>92.60±1.54</td>
</tr>
<tr>
<td>Low-dose</td>
<td>60.56±.32</td>
<td>67.38±2.25</td>
<td>77.40±1.57</td>
</tr>
<tr>
<td>Medium-dose</td>
<td>57.18±.72</td>
<td>48.40±.64</td>
<td>56.60±1.75</td>
</tr>
<tr>
<td>High-dose</td>
<td>48.50±.36</td>
<td>30.66±1.64</td>
<td>25.80±1.88</td>
</tr>
<tr>
<td>Vehicle (olive oil)</td>
<td>61.12±.41</td>
<td>81.18±1.08</td>
<td>86.40±.93</td>
</tr>
</tbody>
</table>

Values are expressed as Mean ± Standard Error of Mean (SEM). *P< .05 significant compared to Control; **P< .05 significant compared to Low-dose; ***P< .05 significant compared to Medium-dose and ****P< .05 significant compared to high dose

Plate 1a. Photomicrograph of Control groups showing normal seminiferous tubules (ST) with normal spermatogonia cells (Sg), normal germ cell layer (GC) with normal maturation stages, the lumen(L) appear normal with presence of spermatozoa (Sz). The interstitial spaces (I) and Leydig cells appear normal (x100)

4. DISCUSSION

There is a continuously growing concern in male reproductive science on how effective and healthy reproductive states can be achieved and maintained. However, several researchers have reported adverse effects of several agents on the physiological states of male reproductive system [18,19].

In this present study, we analyzed the LH, FSH and Testosterone plasma concentrations of male rats by oral administration of camphora in various concentrations. This study showed that camphora significantly increased LH in adult Sprague-Dawley male rats, and significantly decreased FSH; the hindrance in maturation of germ cells into spermatozoa as found in the treatment groups may be as a result of this decrease in FSH level. However, there was an insignificant irregular pattern in activity level of Testosterone when treatment groups were compared to control group, but a significant increase was observed when the vehicle group was compared to both control group and treatment groups. The increase in LH may be as a result of paracrine effects exerted on testosterone levels by impact of camphora on male gonadal nerves, which is independent of Hypothalamus – Pituitary – Gonad (HPG) axis.
There is sparse distribution of these catecholamine fibres in the testis, interstitium, capsule and Vasculature, as stated by Zellforsch [20].

Plate 1b. Photomicrograph of Control groups showing normal seminiferous tubules with normal spermatogonia cells (Sg), normal germ cell layer with normal maturation stages, the lumen (L) appear normal with presence of spermatozoa (Sz). The interstitial spaces (I) and leydig cells appear normal. (x400)

Plate 2a. Photomicrograph of Low-dose animals showing seminiferous tubules with normal spermatogonia cells (Sg), with the lumen (L) having few numbers of spermatozoa (Sz). There is atrophy of interstitial leydig cell (I). (x100)
Plate 2b. Photomicrograph of Low-dose animals showing seminiferous tubules with normal spermatogonia cells, with the lumen having few numbers of spermatozoa. There is atrophy of interstitial leydig cell. (x400)

Plate 3a. Photomicrograph of Medium-dose section severe abnormal atrophied seminiferous tubules (ST), some tubules show epithelial sloughing and arrest in the maturation of epithelium is of evidence. Disintegration of the interstitial (I) tissue can also be observed. (x100)
Plate 3b. Photomicrograph of Medium-dose section severe abnormal atrophied seminiferous tubules, some tubules show epithelial sloughing and arrest in the maturation of epithelium is of evidence in the Lumen (L). Disintegration of the interstitial tissue can also be observed. (x400)

Plate 4a. High dose groups show abnormal seminiferous tubules. There is severe seminiferous tubule (ST) degeneration with necrosis, with empty lumen (L) and, arrest in the maturation of epithelium is evident with complete absence of viable spermatids (Sd) and spermatozoa (Sz). (x100)
Plate 4b. High-dose groups show abnormal seminiferous tubules. There is severe seminiferous tubule (ST) degeneration with necrosis, with empty lumen (L) and, arrest in the maturation of epithelium is evident. Spermatogonia (Sg) is present, with partial absence of viable spermatids (Sd) and and complete absence of spermatozoa (Sz) in the lumen (L). (x400)

Plate 5a. Photomicrograph of vehicle groups showing normal seminiferous tubules (ST) with normal spermatogonia cells (Sg), normal germ cell layer with normal maturation stages, the lumen (L) appear normal with presence of spermatozoa (Sz). There is mild disintegration of the interstitial leydig tissue (I). (x100)
There is an indication that substances that affect brain monoamine levels can also have an effect on reproductive systems [21,22]. Camphora has been reported to inhibit catecholamine secretion by blocking nicotinic acetylcholine receptors. This could have resulted in the adverse effect reported in our study.

Young-Guang, et al. [23] also explained that Leydig cells can be dependent on testicular innervations for survival in vivo. Sima, et al. [24] also explained in their study of effect of camphora on sex hormone levels in rats how LH was significantly increased, while FSH was significantly decreased and Testosterone levels were significantly unchanged [24].

Also, we recorded in the semen analysis for this study a regular pattern in concentration, motility and morphology. It was observed that as concentration of the camphora solution increased, there was decrease in concentration, motility and viability of sperms. A similar study, though in humans, by Jadhav, et al. also explained in their study how sperm motility and morphology reduced with increasing concentration of camphora [25]. However, a decrease in concentration, motility and morphology was observed in vehicle group. This raises a suggestion for further studies on the mechanisms responsible for the decreasing effect of olive oil on concentration, motility and morphology of sperms. Perhaps, it seems camphora has an inhibitory effect on catecholamine secretion in nerves of the testis, which results in leydig cells having reduced functions testosterone level may decrease. However, suggestions may arise that the decrease in testosterone level may produce a negative feedback while acting on the H-P-G axis. As a result of this, LH level can be increased.

Furthermore, analysis on oxidative stress revealed how camphora reduced SOD levels in treatment groups while MDA levels were increased in treatment groups when compared with the control. Fawzia, et al. reported a similar process in their study that camphora reduced SOD and MDA levels [26].

In this study as well, histological plates showed pathogenic effects of camphora on spermatogenic cells and spermatozoa in
treatment groups. A regular pattern was observed that as the dose increased, the more the seminiferous tubules and surrounding interstitial tissues were affected.

5. CONCLUSION

In conclusion, this study suggested that camphora has adverse effects on the testis as well as LH and FSH secretions and sperm quality. Though, with no significant adverse effect of olive oil observed in the seminiferous tubules, olive oil had a slight negative effect on the concentration, motility and morphology of sperms.

CONSENT

It is not applicable.

ETHICAL APPROVAL

All authors hereby declare that “Principles of laboratory animal care” (NIH publication No. 85-23, revised 1985) were followed, as well as specific national laws were applicable. All experiments have been examined and approved by the appropriate ethics committee.

ACKNOWLEDGEMENT

We acknowledge the assistance of Adebajo Oluwaseye, Agbaje Michael and Ighofose Agnes.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES


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Peer-review history:
The peer review history for this paper can be accessed here:
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