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Evaluation of the Pharmacological Potential of *Strychnos camptoneura* Trunk Bark Hydroethanol Extract on Reproductive Functions in Male Guinea Pigs (*Cavia porcellus*) Exposed to Cypermethrin

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Abstract

The main objective of this study was to evaluate the pharmacological potential of the hydroethanol extract of *Strychnos camptoneura* trunk bark on reproductive functions in male guinea pigs exposed to cypermethrin. The results showed that administration of the hydroethanolic extract (100 and 250 mg/kg) of *Strychnos camptoneura* trunk bark after exposure of the animals to cypermethrin induced a highly significant ($p < 0.01$) increase at 100 mg/kg and a highly significant ($p < 0.001$) increase in sperm concentration per epididymal tail at 250 mg/kg compared with cypermethrin-treated animals. Furthermore, administration of the hydroethanol extract of *Strychnos camptoneura* trunk bark produced a highly significant ($p < 0.001$) dose-dependent increase in motile and vital sperm levels, in contrast to positive controls exposed to cypermethrin with a highly significant ($p < 0.001$) decrease in motile and vital sperm levels; a highly significant decrease ($p < 0.001$) in the rate of dead sperm compared with cypermethrin-treated male guinea pigs. There was also a highly significant ($p < 0.01$) decrease in reaction time at 250 mg/kg, and a highly significant ($p < 0.001$) dose-dependent increase in serum testosterone levels in

male guinea pigs exposed to cypermethrin, compared with animals treated with distilled water and those exposed to cypermethrin. These results suggest that the hydroethanol extract of *Strychnos camptoneura* trunk bark may have protective effects against cypermethrin-induced male infertility due to its androgenic, spermatogenic and antiradical properties.

Keywords

Strychnos Camptoneura, Guinea Pig, Males, Cypermethrin, Reproductive Function

1. Introduction

Africa is one of the continents where toxic products (pesticides) cause the most damage to people and the environment, particularly in rural areas [1]. Humans and animals are exposed to a multitude of pesticides in varying doses, either chronically or acutely. Low-level exposure, but over a longer or shorter period, can lead to harmful effects [2].

Endocrine disruptors are another pesticide-related health hazard. Out of 800 pesticides identified, 650 are believed to be endocrine disruptors [3]. This can lead to reproductive disorders such as unbalanced sex ratios, various forms of infertility and cancer [4]. For decades, developments in medicine in general, and in reproductive biology in particular, have established the responsibility of the male in a couple's infertility. A male factor, therefore contributes to infertility in 20% to 30% of couples [5]. In livestock farming, direct or indirect exposure to pesticides through chemically contaminated feed or water can threaten animal health and lead to production restrictions [6]. Several studies into the effects of pesticides on reproduction, and in particular on male fertility, have shown that male germ cells are highly sensitive to environmental factors (pesticides and heavy metals). [7]-[10] with adverse effects on animal and human health, resulting in the production of large quantities of free radicals that cause oxidative stress [11]. A number of research studies have been carried out on plants with androgenic, spermatogenic and antioxidant potential for treating male infertility. One such plant is *Strychnos camptoneura. Strychnos camptoneura* is a species of the Loganiaceae family, widely used in traditional Congolese pharmacopoeia to treat malaria, ulcers and inflammations [12]. This plant has been the subject of several research studies confirming its aphrodisiac, androgenic, spermatogenic and antiradical potential [13]-[15]. The main aim of this study was to evaluate the pharmacological potential of the hydroethanol extract of *Strychnos camptoneura* trunk bark on reproductive functions in male guinea pigs (*Cavia porcellus*) exposed to cypermethrin.

2. Material and Methods

2.1. Plant Material

The plant material consisted of bark from the trunk of *Strychnos camptoneura*.

The bark was cleaned and dried in the dark at room temperature. After cleaning, they were ground with a wooden mortar and sieved to obtain a powder which was used to prepare the extract.

2.2. Animal Material

Twenty-four (24) guinea pigs (*Cavia porcellus*) with an average live weight (LW) of 497 grams (g), divided into four (4) lots of animals per lot, were the subject of this study. The animals were housed in wire-board cages equipped with drinkers and feeders. The cages were lined with bedding, which was changed twice a week. The animals were fed a complete feed supplemented with forage on a daily basis.

2.3. Preparation of *Strychnos camptoneura* Trunk Bark Hydroethanol Extract

The hydroethanolic extract of *Strychnos camptoneura* trunk bark was obtained using the maceration technique. One hundred grams (100 g) of *Strychnos camptoneura* powder were mixed with four hundred grams (400 g) of distilled water plus five hundred milliliter (500 ml) of 90˚ ethanol, and the mixture was left to macerate for 72 hours under a "model L-73" magnetic stirrer. After filtration on absorbent cotton, the filtrate was placed on a Pierron thermal evaporator. The extract collected in powder form was stored in a hermetically sealed glass bottle to avoid any denaturation of the product.

2.4. Preparation of the Pesticide (Cypermethrin 36%)

The pesticide used was Cypermethrin 36% (360 g/L). The dose of 80 mg/Kg was chosen to induce toxicity. The pesticide was diluted in distilled water to reduce its concentration so that it was less harmful and could induce toxicity without harming the health and life of the animals, *i.e.* 50 mL of pesticide for 225 mL in distilled water.

2.5. Evaluation of the Pharmacological Effects of the Hydroethanol Extract of *Strychnos camptoneura* Trunk Bark on Reproductive Functions in Male Guinea Pigs (*Cavia porcellus*) Exposed to Cypermethrin

To evaluate the pharmacological effects of the hydroethanol extract of *Strychnos camptoneura* trunk bark on reproductive functions in male guinea pigs (*Cavia porcellus*) exposed to cypermethrin, 24 guinea pigs were fasted 24 hours before the experiment and randomly divided into four (4) lots of six (6) guinea pigs each, then treated as follows:

- Lot 1: negative control, treated with distilled water at 1 ml/Kg;
- Lot 2: positive control, treated with cypermethrin 80 mg/Kg;
- Lot 3: treated with cypermethrin 80 mg/Kg and *Stychnos camptoneura* extract 100 mg/Kg;
- Lot 4: treated with cypermethrin 80 mg/Kg and *Stychnos camptoneura* extract 250 mg/Kg.

Products were administered daily by oral gavage for 60 days.

2.6. Effect of Hydroethanol Extract of *Strychnos camptoneura* Bark on Food Consumption in Male Guinea Pigs Exposed to Cypermethrin

As feed is an essential factor influencing reproductive performance, during our study we fed guinea pigs a complete feed every day, combined with forage. Six (6 g) feed per 100 g body weight per day was distributed, including water ad libitum. To assess feed intake, the quantities of feed distributed and refused were weighed daily on a scale.

Food consumption was determined by the formula:

$$IFC = QFD - QFR$$

IFC: Individual Food Consumption;
QFD: Quantity of food distributed/day;
QFR: Quantity of Food Refused/ day.

2.7. Effect of Hydroethanol Extract of *Strychnos Camptoneura* Bark on Weight Development in Male Guinea Pigs Exposed to Cypermethrin

The body weight of guinea pigs in each lot was measured once a week for 8 weeks using an ADAM balance (5000 g capacity, 1 g accuracy) to monitor weight trends.

2.8. Effect of Hydroethanol Extract of *Strychnos camptoneura* Bark on Sexual Behavior in Male Guinea Pigs Exposed to Cypermethrin

Libido is the time it takes for a male to react in the presence of a female. Two days before sacrifice, the males were placed in the presence of adult females to determine the time it took them to act; the time was taken when the male began to hunt, smell the female's anogenital region or when the male attempted to mount the female. The maximum reaction observation time was three (3) minutes.

2.9. Effect of Hydroethanol Extract of *Strychnos camptoneura* Bark on Androgen-Dependent Organ Weights in Male Guinea Pigs Exposed to Cypermethrin

After 60 days of treatment with hydroethanol extract of *Strychnos camptoneura*, guinea pigs per b lot were sacrificed by decapitation. Testes, epididymides, vas deferens, seminal vesicles and penis were removed, cleared of fatty material and weighed using a precision balance.

2.10. Effect of Hydroethanol Extract of *Strychnos camptoneura* Bark on Some Microscopic Characteristics of Sperm in Male Guinea Pigs Exposed to Cypermethrin

The effects of the hydroethanolic extract of *Strychnos camptoneura* on some microscopic characteristics of semen were studied in order to assess the effects of the

extract on sperm function (motility, concentration and vitality). After dissection of the guinea pig by decapitation and removal of the organs, the tail of the right epididymis of each guinea pig was excised and weighed. Sperm was obtained by grinding the right epididymis in 2 ml of physiological water to obtain a fixed volume of sperm in suspension. Several further dilutions of this same suspension, in formalin and physiological water, were then necessary to determine the guinea pig's sperm parameters (vitality, motility and count).

Semen volume:

The volume of sperm used in guinea pigs corresponded to the apparent or working volume set at 2 ml. It was obtained by first grinding the right epididymides in 1 ml of physiological water, then adding the same volume of physiological water after discarding the epididymides so as to obtain sperm suspended in 2 ml of physiological water [16].

2.11. Sperm Vitality (or Percentage of Live Sperm)

This was assessed using a multi-stage methodology:

The first step was to prepare the slide used to count live and dead spermatozoa. The slide was prepared in a way not described in the literature, using nigrosine to obtain a blue background [16]. The procedure used was as follows:

- Using a blue marker, a new slide was marked with an identifying number.

- A blue background was then created by using the same marker to draw several more or less pronounced lines on the slide, roughly parallel to the two longitudinal edges of the slide. The slide was prepared in such a way that the stained spermatozoa were visible against a blue background.

The second step involved staining the spermatozoa as follows:

- 200 µl of the sperm suspension was removed from the working volume and placed in a dry hemolysis tube also containing 200 µl of 2% eosin.

- After 5 - 10 seconds of homogenization, this 1/2 dilution was allowed to stand for 10 minutes.

- After 10 minutes, the 1/2 dilution was further diluted 1/25 in physiological water: 20 µl of the "sperm suspension - 2% eosin" mixture was rapidly diluted in 480 µl of physiological water.

- After 5 to 10 seconds of homogenization, 10 to 15 µl of the 1:25 dilution was taken to make a smear on the slide surface previously stained with blue marker lines as described above.

The third and final step involved reading 200 spermatozoa under a light microscope (objective ×40). On the smear, living spermatozoa were stained red with 2% eosin, while dead spermatozoa were not stained [16].

2.12. Sperm Motility

The mobility or percentage of motile spermatozoa was assessed using the following method: First, the initial sperm suspension was diluted 1:50 in physiological saline. Next, 50 µl of this 1/50 dilution was taken and placed between slide and coverslip, then observed under the microscope at objective × 40 for motility

studies. Finally, whatever dilutions the guinea pig's sperm had undergone from the time it was obtained to the time it was read, the motility study was carried out as with human sperm.

2.13. Statistical Analysis of Collected Data

Statistical analysis of the data collected was carried out using analysis of variance (ANOVA), Student's t-test and Mann-Whitney test to compare test and control groups. Results are expressed as mean ± standard error with $p < 0.05$ as the significance threshold.

3. Results

3.1. Effect of Hydroethanol Extract of *Strychnos Camptoneura* Bark on Food Consumption in Male Guinea Pigs Exposed to Cypermethrin

Figure 1 shows the effect of hydroethanol extract of *Strychnos camptoneura* trunk bark (100 and 250 mg/kg) on food consumption in male guinea pigs exposed to cypermethrin. The figure shows that oral administration of the hydroethanol extract of *Strychnos camptoneura* trunk bark at the doses studied stimulated food consumption compared with male guinea pigs given distilled water. However, a decrease in food consumption was observed in animals exposed to cypermethrin alone.

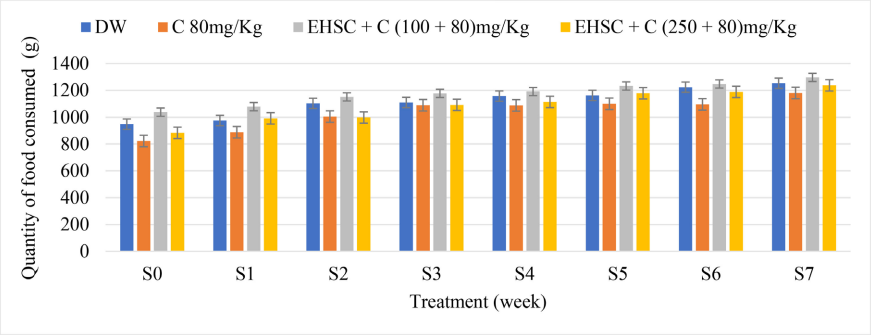

Figure 1. Effect of hydroethanol extract of *Strychnos camptoneura* bark on food consumption in male guinea pigs exposed to cypermethrin. Values are means ± MSE, with n = 6; HESC: hydroethanolic extract of *Strychnos camptoneura*; DW: distilled water; C = cypermethrin.

3.2. Effect of Hydroethanol Extract of *Strychnos Camptoneura* Trunk Bark on Weight Growth in Male Guinea Pigs Exposed to Cypermethrin

Figure 2 below illustrates the effect of hydroethanol extract of *Strychnos camptoneura* trunk bark on weight growth in male guinea pigs exposed to cypermethrin. This figure shows that administration of the hydro-ethanolic extract of *Strychnos camptoneura* trunk bark (100 mg/kg and 250 mg/kg) to male guinea pigs exposed to cypermethrin produced a non-significant ($p > 0.05$) increase in

live weight, comparable to that of animals treated with distilled water. Furthermore, weight growth was non-significantly reduced ($p > 0.05$) in cypermethrin-treated animals compared to negative controls and extract-treated animals (100 mg/kg and 250 mg/kg).

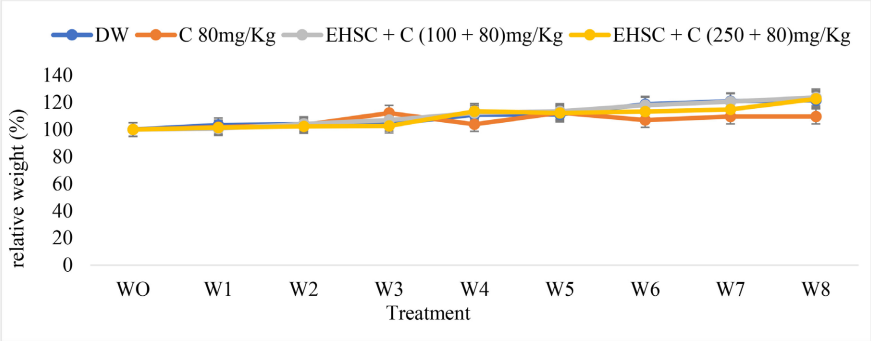

Figure 2. Effect of hydroethanol extract of *Strychnos camptoneura* trunk bark on weight gain in male guinea pigs exposed to cypermethrin. Values are means ± MSE, with n = 6: ns $p > 0.05$ non-significant difference from negative control; EAPY: aqueous extract of *Strychnos camptoneura*; ED: distilled water; C = cypermethrin.

3.3. Effect of hydroethanol Extract of *Strychnos camptoneuras* Trunk Bark on Androgen-Dependent Sex Organ Weights in Male Guinea Pigs Exposed to Cypermethrin

Table 1 shows the effect of *Strychnos camptoneura* trunk bark hydroethanol extract on androgen-dependent sex organs in male guinea pigs exposed to cypermethrin. The table shows that administration of the hydroethanol extract of *Strychnos camptoneura* trunk bark after exposure of the animals to cypermethrin caused no significant ($p > 0.05$) change in the weight of sex organs (testes, epididymides, prostate, penis and seminal vesicles) compared with negative and positive controls.

Table 1. Effect of *Strychnos camptoneuras* trunk bark hydroethanol extract on androgen-dependent sex organs in male guinea pigs exposed to cypermethrin.

Parameters	Group 1: Control Lots		Group 2: Treated lots	
	DW (1 mL/kg)	C (80 mg/kg)	*HESC* + C (100 mg/kg + 80 mg/kg)	*HESC* + C (250 mg/kg + 80 mg/kg)
Testes	0.20 ± 0.00	0.18 ± 0.02 ns	0.21 ± 0.00 ns	0.21 ± 0.01 ns
Epididymides	0.04 ± 0.00	0.03 ± 0.02 ns	0.004 ± 0.00 ns	0.04 ± 0.01 ns
Seminal vesicles	0.17 ± 0.00	0.17 ± 0.02 ns	0.18 ± 0.00 ns	0.20 ± 0.01 ns
vas deferens	0.019 ± 0.00	0.018 ± 0.00 ns	0.019 ± 0.00 ns	0.019 ± 0.00 ns
Prostate	0.11 ± 0.01	0.10 ± 0.00 ns	0.09 ± 0.01 ns	0.11 ± 0.01 ns
Penis	0.15 ± 0.01	0.15 ± 0.00 ns	0.14 ± 0.01 ns	0.17 ± 0.01 ns

Values are means ± MSE, with n = 6: ns $p > 0.05$ non-significant difference from negative control; HESC: *Strychnos camptoneura* aqueous extract; DW: distilled water; C: cypermethrin.

3.4. Effect of Hydroethanol Extract of *Strychnos camptoneuras* Trunk Bark on the Microscopic Characteristics of Sperm in Male Guinea Pigs Exposed to Cypermethrin

Table 2 summarizes the effect of *Strychnos camptoneura* trunk bark hydroethanol extract on sperm microscopic characteristics in male guinea pigs exposed to cypermethrin. The table shows that oral treatment with hydroethanol extract of *Strychnos camptoneura* trunk bark (100 and 250 mg/kg) in male guinea pigs exposed to cypermethrin (80 mg/kg) produced a highly significant increase ($p < 0.01$) at 100 mg/kg and highly significant ($p < 0.001$) increases in sperm concentration per epididymal tail at 250 mg/kg compared with cypermethrin-treated animals, which also showed highly significant ($p < 0.001$) decreases in sperm count per epididymal tail. Furthermore, administration of the hydroethanol extract of *Strychnos camptoneura* trunk bark resulted in a highly significant ($p < 0.001$) dose-dependent increase in vital and motile sperm counts, in contrast to positive controls exposed to cypermethrin, which showed a highly significant ($p < 0.001$) decrease in vital and motile sperm counts. Administration of the hydroethanol extract of *Strychnos camptoneura* trunk bark at the doses studied in male guinea pigs exposed to cypermethrin (80 mg/kg) resulted in a highly significant decrease ($p < 0.001$) in the rate of dead spermatozoa compared with male guinea pigs treated with cypermethrin, or a highly significant increase ($p < 0.001$) in the rate of dead spermatozoa.

Table 2. Effect of hydroethanol extract of *Strychnos camptoneura* trunk bark on the microscopic characteristics of sperm in male guinea pigs exposed to cypermethrin.

Parameters	Group 1: Control lots		Group 2: Treated lots	
	DW (1 mL/kg)	C (80 mg/kg)	*HESC* + C (100 mg/kg + 80 mg/kg)	*HESC* + C (250 mg/kg + 80 mg/kg)
Number of spermatozoa/epididymal tail ($\times 10^6$/mL)	16 ± 0.40	10.4 ± 0.28***	14 ± 0.40**	15.5 ± 0.28***
Vitality (%)	78.75 ± 2.39	43.75 ± 1.25***	68.75 ± 2.39***	75 ± 3.53***
Mass mobility (%)	68.75 ± 3.75	32.5 ± 1.44***	61.25 ± 1.25***	62.5 ± 1.44***
Dead sperm (%)	25 ± 8.15	56.25 ± 1.25***	31.25 ± 2.39***	25 ± 3.53***

Values are means ± MSE, with n = 6. **p < 0.01 highly significant difference; ***p < 0.001 highly significant difference; HESC: *Strychnos camptoneura* aqueous extract; DW: distilled water; C: cypermethrin.

3.5. Effect of Hydroethanol Extract of *Strychnos camptoneura* Trunk Bark on Sexual Behavior in Male Guinea Pigs Exposed to Cypermethrin

Figure 3 below shows the effect of hydroethanol extract of *Strychnos camptoneura* trunk bark on sexual behavior in male guinea pigs exposed to cypermethrin. The figure shows that administration by gavage of the hydroethanol extract of *Strychnos camptoneura* trunk bark resulted in a non-significant ($p > 0.05$)

decrease in reaction time at 100 mg/kg in male guinea pigs exposed to cypermethrin, compared with animals treated with distilled water and cypermethrin-exposed positive controls. However, at 250 mg/kg, there was a highly significant ($p < 0.01$) decrease in reaction time compared with negative and positive controls. On the other hand, reaction time increased significantly ($p < 0.05$) in guinea pigs treated exclusively with cypermethrin, compared with animals given distilled water and the various extract doses studied.

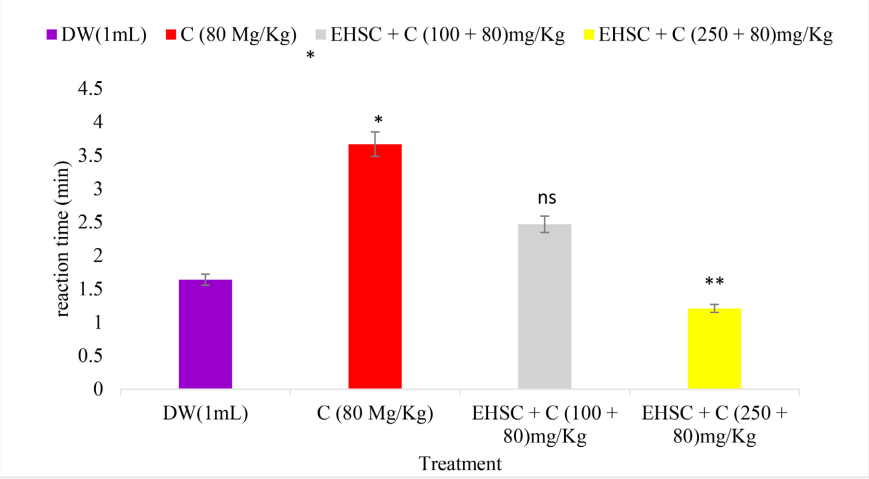

Figure 3. Effect of *Strychnos camptoneura* trunk bark hydroethanol extract on sexual behavior in male guinea pigs exposed to cypermethrin. Values are means ± MSE, with n = 6: ns $p > 0.05$ non-significant difference from control; *$p < 0.05$ significant difference; **$p < 0.01$ highly significant difference; EHSC: *Strychnos camptoneura* aqueous extract; ED: distilled water; C: cypermethrin.

3.6. Effect of hydroethanol Extract of *Strychnos camptoneuras* Bark on Serum Testosterone Levels in Male Guinea Pigs Exposed to Cypermethrin

Figure 4 shows the effect of *Strychnos camptoneura* trunk bark hydroethanol extract on serum testosterone levels in male guinea pigs exposed to cypermethrin. The figure shows that administration of the hydroethanol extract of *Strychnos camptoneura* trunk bark (100 and 250 mg/kg) produced a highly significant ($p < 0.001$) dose-dependent increase in serum testosterone levels in male guinea pigs exposed to cypermethrin compared with those treated with distilled water and exposed to cypermethrin. In addition, a highly significant decrease ($p < 0.01$) in serum testosterone levels was observed in male guinea pigs exposed to 80 mg/Kg cypermethrin compared with guinea pigs treated with distilled water and the various extract doses.

4. Discussion

The main objective of this study was to evaluate the pharmacological potential of the hydroethanol extract of *Strychnos camptoneura* trunk bark on reproductive functions in male guinea pigs (*Cavia porcellus*) exposed to cypermethrin.

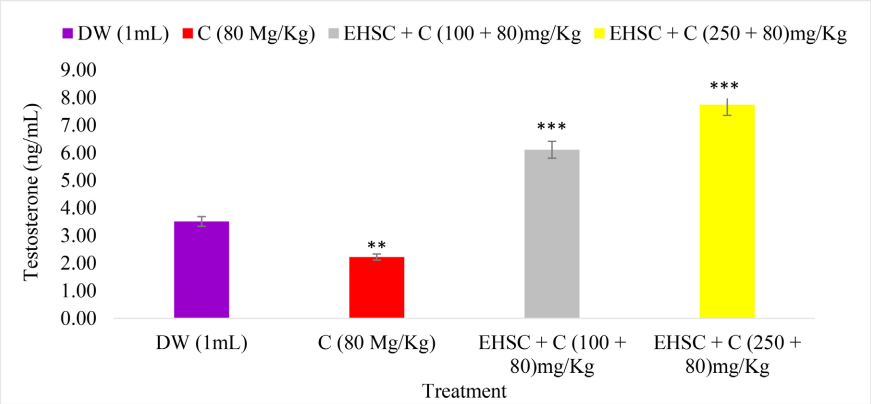

Figure 4. Evaluation of *Strychnos camptoneura* trunk bark hydroethanol extract on testosterone levels. Values are means ± MSE, with n = 6. **p < 0.01 highly significant difference; ***p < 0.001 highly significant difference; EHSC: aqueous extract of *Strychnos camptoneura*; ED: distilled water; C: cypermethrin.

4.1. Effect of Hydroethanol Extract of *Strychnos Camptoneura* Bark on Food Consumption in Male Guinea Pigs Exposed to Cypermethrin

The results show that oral administration of the hydroethanol extract of *Strychnos camptoneura* trunk bark at the doses studied stimulated food consumption compared with male guinea pigs given distilled water. However, a decrease in food consumption was noted in animals exposed only to cypermethrin. These results suggest that the aqueous hydroethanol extract of *strychnos camptoneura* trunk bark has stimulatory effects on the satiety center. These results corroborate those obtained by [13] [14] respectively in wistar rats treated with ethanolic and hydroethanolic extracts of *strychnos camptoneura* trunk bark.

4.2. Effect of Hydroethanol Extract of *Strychnos camptoneura* Trunk Bark on Weight Growth in Male Guinea Pigs Exposed to Cypermethrin

The results summarized in **Figure 2** above show that administration of *Strychnos camptoneura* trunk bark hydroethanol extract (100 mg/kg and 250 mg/kg) to male guinea pigs exposed to cypermethrin produced a non-significant increase in live weight, comparable to animals treated with distilled water. Furthermore, weight growth was non-significantly reduced in cypermethrin-treated animals compared to negative controls and extract (100 mg/kg and 250 mg/kg). The improvement in weight growth observed in animals treated with different doses of extract after exposure of guinea pigs to cypermethrin could be explained by the good food and water intake stimulated by the extract observed in this study. Our results disagree with those obtained by [17] [18] who observed a non-significant decrease in body weight in rats treated respectively with Melissa officinalis subjected to deltamethrin toxicity and with the extract of *Ephedra alataalenda* on Fenthion-induced toxicity and behavioral disturbances. This difference could be attributed either to the different chemicals or reference molecules, or to the type of solvent and

chemical composition of the different plants used. Cypermethrin reduced body growth compared with negative controls. This reduction in body weight may be explained by the anorexic phenomenon that animals may undergo with time of exposure to pesticides and the state of stress during this exposure [19].

4.3. Effect of Hydroethanol Extract of *Strychnos camptoneura* Trunk Bark on Androgen-Dependent Sex Organ Weights in Male Guinea Pigs Exposed to Cypermethrin

The results in Table 1 show that administration of the hydroethanol extract of *Strychnos camptoneura* trunk bark after exposure of the animals to cypermethrin caused no significant variation in the weight of the sexual organs (testes, epididymides, prostate, penis and seminal vesicles) compared with negative and positive controls.

Our results are contrary to those obtained by [20] [21], who noted an increase in reproductive organ weight in male guinea pigs exposed to cypermethrin and treated respectively with ethanolic extracts of *Bersamaengleriana* and *Mangiferaindica* leaves. This difference may be due to the chemical composition of each extract on the one hand, and to the duration of treatment and exposure in the different experiments on the other.

4.4. Effect of Hydroethanol Extract of *Strychnos camptoneura* Trunk Bark on Sperm Microscopic Characteristics in Male Guinea Pigs Exposed to Cypermethrin

The results in Table 2 illustrate that oral treatment with the hydro-ethanolic extract of *Strychnos camptoneura* bark had a positive effect on the microscopic characteristics of sperm. ethanolic extract of *Strychnos camptoneura* trunk bark (100 and 250 mg/kg) in male guinea pigs exposed to cypermethrin (80 mg/kg) resulted in a highly significant increase in sperm concentration per epididymal tail at 100 mg/kg and a highly significant increase at 250 mg/kg compared with cypermethrin-treated animals, which also showed a highly significant decrease in sperm count per epididymal tail. Furthermore, administration of the hydroethanol extract of *Strychnos camptoneura* trunk bark produced a highly significant dose-dependent increase in vital and motile sperm counts, in contrast to positive controls exposed to cypermethrin, which showed a highly significant drop in vital and motile sperm counts. Administration of the hydroethanol extract of *Strychnos camptoneura* trunk bark at the doses studied in male guinea pigs exposed to cypermethrin (80 mg/kg) resulted in a highly significant decrease in the rate of dead spermatozoa compared with cypermethrin-treated male guinea pigs, or a highly significant increase in the rate of dead spermatozoa. The improvement in semen characteristics observed in this study is attributed to the various chemical families contained in the extract, notably the flavonoids, renowned for their antioxidant potential, which limit the excessive production of free radicals responsible for oxidative stress [9] [10]. Our results are in line with those obtained by [20]-[22] who respectively observed a significant increase in sperm concentration and motility

in guinea pigs treated with ethanolic and methanoic extracts of *Bersamaengleriana*, *Mangiferaindica* and *Moringa oleifera* leaves respectively.

4.5. Effect of Hydroethanol Extract of *Strychnos camptoneura* Trunk Bark on Sexual Behavior in Male Guinea Pigs Exposed to Cypermethrin

Gavage administration of the hydroethanol extract of *Strychnos camptoneura* trunk bark resulted in a non-significant decrease in reaction time at 100 mg/kg in male guinea pigs exposed to cypermethrin, compared with animals treated with distilled water and cypermethrin-exposed positive controls. However, at 250 mg/kg there was a very significant decrease in reaction time compared with negative and positive controls. On the other hand, reaction time increased significantly in guinea pigs treated exclusively with cypermethrin compared with animals given distilled water and the various extract doses studied. Our results are similar to those of [20] [21], who also observed a significant reduction in reaction time in guinea pigs treated with ethanolic extracts of *Bersamaengleriana* and *Mangiferaindica* leaves, respectively. The improvement in libido observed in this study confirms the aphrodisiac potential of the hydroethanolic extract of *Strychnos camptoneura* trunk bark to induce sexual appetite, which is reflected in the reduction in reaction time. In fact, several studies have demonstrated the efficacy of this plant in improving sexual performance in wistar rats [23].

4.6. Effect of Hydroethanol Extract of *Strychnos camptoneura* Bark on Serum Testosterone Levels in Male Guinea Pigs Exposed to Cypermethrin

The results presented in **Figure 4** show that administration of the hydroethanolic extract of *Strychnos camptoneura* trunk bark (100 and 250 mg/kg) induced a highly significant, dose-dependent increase in serum testosterone levels in male guinea pigs exposed to cypermethrin compared with those treated with distilled water and exposed to cypermethrin. Consequently, there was a highly significant decrease in serum testosterone levels in male guinea pigs exposed to 80 mg/Kg cypermethrin compared with guinea pigs treated with distilled water and the various extract doses. The reduced concentration of testosterone in cypermethrin treated group recorded in the present study is close or similar to the report of earlier researchers [24] [25]. This reduction can be attributed to the inhibitory action of cypermethrin on the secretion of pituitary gonadotropins. The reduced level of testosterone can also be caused by the antiepileptic drug's ability to increase the activity of the aromatase enzyme in the liver, which transforms testosterone to estradiol, the hormone that further decreases the level of testosterone [26]. Similar results were also obtained by [23], who noted no variation in serum testosterone levels in wistar rats exposed to carbamazepine and treated with the methanoic (methanolic) extract of *Moringa oleifera* leaves. Our results are similar to those reported by [20] [21], who noted a significant increase in serum testosterone levels in male guinea pigs treated with ethanolic extracts of *Bersamaengleriana* and

Mangiferaindica leaves respectively. The highly significant increase in serum testosterone levels observed in this experiment proves that the hydroethanolic extract of *Strychnos camptoneura* trunk bark possesses steroidogenic activity and probably acts on the hypothalamic-pituitary-testicular complex, stimulating testosterone synthesis via specific Leydig cell receptors. Previous studies have shown that the hydroethanol extract of *Strychnos camptoneura* contains a number of phenolic compounds (flavonoids, polyphenols, etc.) [14]. The increase in serum testosterone levels would therefore be attributed to the presence in the extract of phenolic compounds and flavonoids endowed with androgenic properties [14].

5. Conclusion

Our results showed that administration of the hydroethanol extract of *Strychnos camptoneura* trunk bark to male guinea pigs (*Cavia porcellus*) exposed to cypermethrin improves growth parameters and reproductive functions. These results suggest that the hydroethanol extract of *Strychnos camptoneura* trunk bark has protective effects against cypermethrin-induced male infertility, due to its androgenic, spermatogenic and antiradical properties. This justifies its use in Congolese pharmacopoeia for the treatment of male infertility.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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