Testosterone level, oxidative stress markers, toxicity indicators, growth and carcass characteristics of male guinea pig (*Cavia porcellus*) fed with feed containing mango (*Mangifera indica*) leaf powder

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1 ABSTRACT

Farm animals are exposed to oxidative stress from both external and internal sources leading to hindrance in their growth and reproduction. To remedy this, antioxidants are being used but certain sources and forms of these antioxidants have been shown to have undesirable consequences. The principal aim of this work is to determine in male guinea pigs, the influence of powder from the leaves of mango on testosterone level, markers of oxidative stress, biochemical indicators of toxicity as well as growth and carcass characteristics. For this, Forty male guinea pigs (*Cavia porcellus*) of 2 months old averagely weighing 257.65±11.28 g were randomly divided into 4 groups of 10 animals each as follows:- control: experimental diet only, T1: experimental diet + 0.50% mango leaf powder (MLP), T2: experimental diet + 0.75% MLP, and T3:experimental diet + 1% MLP; for a period of 45 days after which the subjects were dissected for collection of data. Statistical analyses showed the highest testosterone level at 0.75% and lowest cholesterol at 0.5% mango leaf powder. The lowest values of Malondialdehyde, alanine aminotransferase and kidney weight and volume were recorded in these guinea pigs that received mango leaves powder-diet in comparison to the control groups. It may be concluded from these results that MLP in feed of guinea pigs may be a potential natural means to combat oxidative stress thereby improving male guinea pigs reproduction.

RÉSUMÉ
Les animaux d'élevage sont exposés à un stress oxydatif d'origine externe et interne, ce qui entrave leur croissance et leur reproduction. Pour remédier à ce problème, des antioxydants sont utilisés, mais certaines sources et formes de ces antioxydants se sont avérées avoir des conséquences indésirables. L'objectif principal de ce travail était donc de déterminer, chez les cobayes mâles, l'influence de la poudre de feuilles de manguier sur le taux de testostérone, les marqueurs du stress oxydatif, les indicateurs biochimiques de toxicité ainsi que la croissance et les caractéristiques de la carcasse. Pour cela, quarante cobayes mâles (*Cavia porcellus*) âgés de 2 mois pesant en moyenne 257,65 ± 11,28 g ont été répartis au hasard en 4 groupes de 10 animaux chacun comme suit : témoin : régime expérimental uniquement, T1 : régime expérimental + 0,50 % de poudre de feuilles de manguier (PFM), T2 : régime expérimental + 0,75 % (PFM) et T3 : régime expérimental + 1 % (PFM) ; Pendant 45 jours, les sujets ont été disséqués pour la collecte de données. Les analyses statistiques ont montré que le taux de testostérone le plus élevé était de 0,75 % et le cholestérol le plus bas à 0,5 % de poudre de feuilles de manguier. Les valeurs les plus faibles de malondialdéhyde, d'alanine aminotransférase et de poids et volume des reins ont été enregistrées chez les cobayes ayant reçu un régime à base de poudre de feuilles de manguier par rapport aux groupes témoins. Nous pouvons conclure de ces résultats que la PFM dans l'alimentation des cobayes pourrait être un moyen naturel potentiel de lutter contre le stress oxydatif, améliorant ainsi la reproduction des cobayes mâles.

2 INTRODUCTION

Androgens are steroid hormones that bring about differentiation and development of male reproductive system, supporting the emergence and maintenance of sex (e.g. development, voice change) and spermatogenesis (Pader, 2006). The most representative of male hormones are dihydroepiandrosterone, androsstenedione and testosterone (Pineda, 2003). Testosterone is the most important male hormone secreted into blood and it is synthesized from cholesterol in the Leydig cells that are in the interstitial spaces of the seminiferous tubules (Tang *et al.,* 2004). It has a great effect on spermatogenesis (Lee *et al.,* 2001). In seminiferous tubules, for the different germ cells generations to be produced continuously; testosterone is very important. In vertebrates, male sexual behaviour or sexuality is largely dependent on testosterone production (Neave and O'Connor, 2009) which is of great importance in reproduction in some species, higher testosterone levels predict better relationships (Monaghan and Glickman, 1992). However, the concentration of blood testosterone varies with respect to species, age, nutrition, season, chemical agents like pesticides (Zamiri and Khodaei, 2005; El-Kon *et al.,* 2011; Vemo *et al.,* 2018) as well as oxidative stress (OS) which may be from the environment. This happens when reactive oxygen species (ROS) production and other radical species exceed the antioxidants (AO) scavenging capacity of an organism. It has been reported that OS has damaging effects on farm animal reproduction and growth including their products. It is known that AO fight against OS bringing about equilibrium in the system. To reduce these effects of OS, farmers use synthetic antioxidants but they have been shown to have undesirable effects and are therefore being restricted by government; added to their high cost which make them difficult to afford by developing countries. Therefore, using medicinal plants as natural sources of antioxidants are gradually gaining grounds (Neelesh *et al.,* 2011) as a solution to health problems, particularly reproductive disturbance. This may be justified by the fact that medicinal plants are less expensive, readily available and have less secondary effects. Numerous tropical plants and their products like extracts, essential oils and powder have shown useful therapeutic activities as well as fertility enhancement, aphrodisiac, antioxidant and anti-microbial activities (Petrovska, 2012). Thus, plant extracts like aqueous extract of green tea (Abshenas *et al.,* 2011), guava leaves (Ravi *et al.,* 2012) and ethanolic extract of *B. engleriana* (Vemo *et al.,* 2017) have been proven to possess antioxidant properties. Based on these authors, the administrations of such extracts to stressed animals greatly improved the concentration, mobility and morphology of spermatozoa as well as oxidative stress markers. Meanwhile, studies are focused only on some medicinal plants and a greater number are *in vitro* studies. However, many other plants (e.g. *Mangifera indica*) may be potential candidates to exploit as natural sources of antioxidants to ameliorate reproduction and growth in farm animals. *M. indica* (mango) tree is a big ever green tree found all over the tropics of the world and used as horticultural and medicinal plants (Somkuwar and Kamble, 2013). *M. indica* leaves have many bio-active compounds like phenols, terpenoids, flavonoids, steroids, saponins, tannins and mangiferin (Fernandez-Ponce *et al.,* 2013), giving its extracts medicinal characteristics such as an aesthetic and anti-inflammatory effects (Islam *et al.,* 2010) and hypoglycemic effects (Morsi *et al.,* 2010). Mada *et al.,* 2012 equally reported that extracts of *M. indica* leaves and stembark possess anti-oxidative as well as anti-microbial properties. With regards to all these active substances and pharmacological capacities, the powder of *M. indica* leaves could play a protective role against oxidative stress on hormonal level and growth. So far in our investigations, data related to the protective role of *M. indica* leaves against growth and reproductive toxicity in male exposed to environmental and endogenous conditions is still limited. This work was therefore done with the aim of bringing forth other means of enhancing farm animal production through the use of medicinal plants.

3 MATERIALS AND METHODS

3.1 Animal material: Forty (40) 2-months-old male guinea pigs (*Cavia porcellus*) averagely weighing 257.65±11.28 g were used for this study. The male guinea pigs were obtained from an animal farm in Dschang. For a period of 45 days, the animals were kept in a building in the University Research Farm with wooden boxes of 100 cm long, 80 cm wide and 60 cm deep each, on the floor with lighting source. The boxes contained wood shavings that served as litter being changed every 3 days of usage. They were equally equipped with a feeding trough of 60cm x 10cm x 5cm, and a drinking trough of 50 cl, each.

3.2 Feeding: Throughout the experimental period, the guinea pigs were given drinking water *ad libitum*, and a complete diet with composition and bromatological characteristics summarized in table 1.

3.3 Plant material: Fresh mango leaves at mature age were harvested within the University environs. They were identified at the Cameroon National Herbarium as referred to the specimen number 18646/SRFCam. After washing carefully, the leaves were shade-dried and ground at the mill to obtain powder, later used.

3.4 Studied parameters and data collection

3.4.1 Growth performance evaluation

3.4.1.1 Feed intake: The weight of feed was taken each morning and the feed was served to animals. The weight of left-overs for each group was taken on daily basis with the help of an electronic balance of capacity 5 kg and 1g accuracy. Feed intake (FI) of cavies was evaluated by subtracting the left-overs (LO) from the feed served (FS) for the considered duration. That is:

FI= FS- LO

3.4.1.2 Evolution of weight: The cavies were weighed at the commencement of each week with the help of an electronic scale as earlier described, till the end of the experiment.

Table 1: Composition of experimental diet

Ingredients (kg)	**Quantity**
Maize	22
Trypsacum laxum	26
Soybean cake	04
Cotton seed cake	03
Palm kernel cake	09
Fish meal	08
Bone meal	01
Wheat bran	22
Premix 2%	02
Shell	01
Molasses	02
Total	100
Chemical composition of rations	
Digestible energy (kcal/kg DM)	2803
Dry matter (%)	89.56
Organic matter (%DM)	75.14
Crude protein (%DM)	17.82
Gross cellulose (%DM)	17.60
Ash (%DM)	24.86
Lipids (%DM)	1.47

3.4.1.3 Body Weight gain (BWG): The BWG of the subjects was evaluated by subtracting the live weight of the previous week (LWn-1) from that of the week taken into account (LWn). That is:

BWG=LWn - LWn-1

3.4.1.4 Average daily weight gain (ADWG): The average daily weight gain was determined from the relation between the weight gain and the considered -duration in days.

ADWG = Weight gain/Duration (days)

3.4.1.5 Feed intake index: Feed consumption index (FCI) was evaluated by considering the relation between the quantity of feed intake during a given period and the weight gain within that same period.

FCI= Feed consumption/Weight gain

3.4.1.6 Feed efficiency (FE): The FE was calculated by relating weight gain to the amount of consumed feed over a period.

FE = Weight gain/Feed consumption

3.4.1.7 Evaluation of carcass characteristics

- Carcass yield number 1: To obtain carcass yield number 1 (CY1), the forty animals were left on empty stomach for 1 day, then dissected. Internal organs were removed and the carcass weight was measured and presented as a percentage of live weight.

CY1 (%) = (Entire Gutted Carcass Weight) / (Live Weight of Animal) × 100

- Carcass yield number 2: To determine carcass yield number 2 (CY2), adding to the removal of internal organs, other parts (head, ends of legs and skin) were equally removed.

CY2 (%) = (Dressed and eviscerated carcass weight) / (Live weight of animal) × 100

- Organs relative weight (ORW): The relative weight of skin, head, legs, liver, kidney, caecum was evaluated as follows:

ORW (%) = Weight of organ (g)/ Slaughter live weight (g)) × 100

3.4.2 Serum testosterone concentration: Serum testosterone concentration was measured with the help of the ELISA kit from Omega Dianostic (Scotland, United Kingdom), according to the description of the notice of the kit. The testosterone concentration was determined by projecting the optical density read on the ELISA meter on the calibration curve.

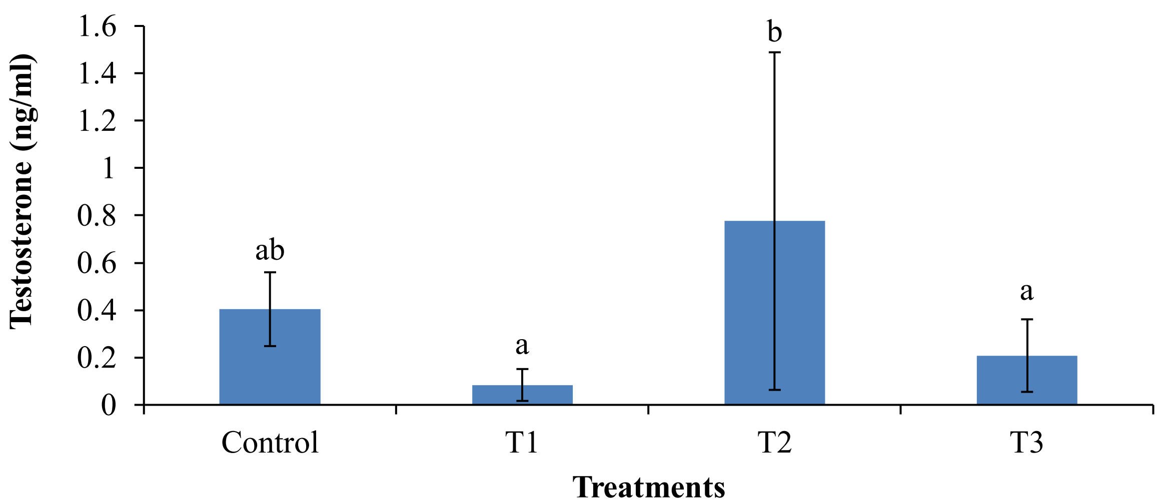
3.4.3 Analyses of biochemical indicators of toxicity: The collection of blood samples was done by cardiac puncture. Blood was collected into tubes without anticoagulant and later used for biochemical dosages like creatinine, urea, total cholesterol, alanine aminotransferase and aspartate aminotransferase with the use of appropriate commercial Chronolab kit.

3.4.4 Markers of oxidative stress (OS): Superoxide dismutase was determined according to Misra and Fridovich (1972**)**, Catalase as described by Aebi (1984**)**, Total peroxidase activities as proposed by Moron *et al.* (1979**)** and the level of malondialdehyde was measured with the use of protocols proposed by Botsoglou *et al.* (1994).

3.5 Statistical analyses: Data obtained at the end of this study, were subjected to the one factor analysis of the variance, to test the influence of the various rates of incorporation of *Mangifera indica* leaves powder on characteristics studied in male guinea pigs. Where the difference was significant, means were separated using Duncan's test and the threshold for these tests was fixed at 5%. Results were presented as mean ± standard deviation and the software used was SPSS 26.0.

4 RESULTS

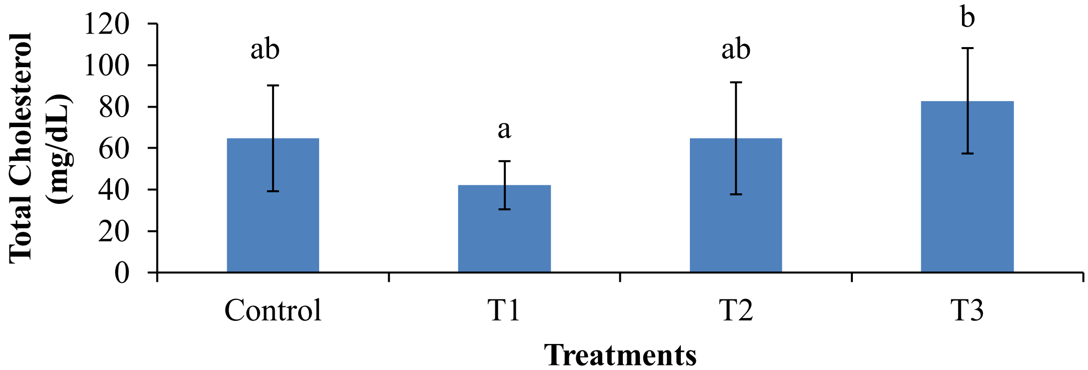
4.1 Effects of mango leaf powder (MLP) on testosterone in male guinea pigs: Figure 1 illustrates the effects of mango leaf powder on serum concentration of testosterone in guinea pigs. Cavies that received the diet with 0.75% MLP recorded significantly (P<0.05) higher levels of testosterone as compared to the other mango leaf powder-treated groups. However, all the treatment groups were comparable to the control group.



Control: experimental diet only, T1: experimental diet + 0.50% mango leaf powder, T2: experimental diet + 0.75% mango leaf powder, and T3: experimental diet + 1% mango leaf powder;

Figure 1: Effects of mango leaf powder on the testosterone level in male guinea pigs

4.2 Influence of mango leaf powder in the diet on serum cholesterol level in guinea pigs: The lowest level of cholesterol was obtained in males that received 0.5% of mango leaf powder as compared to the other treatment groups, as illustrated by figure 2. However, all the groups showed results that were comparable (P>0.05) to the control males.



control: experimental diet only, T1: experimental diet + 0.50% mango leaf powder, T2: experimental diet + 0.75% mango leaf powder, and T3: experimental diet + 1% mango leaf powder;

Figure 2: Influence of mango leaf powder on cholesterol level in male guinea pigs

4.3 Influence of mango leaf powder on oxidative stress markers in male guinea pigs: The influence of mango leaf powder on oxidative stress markers in male guinea pigs is summarized by table 2. It is observed that all the treatment groups recorded no significant differences (P>0.05) in values of oxidative stress markers. Nevertheless, lower levels of MDA were obtained in all the guinea pigs which were fed with mango leaf powder diet, in comparison to the control group.

Table 2: Influence of mango leaf powder on oxidative stress markers in male guinea pigs

Oxidative stress markers	Control (n=10)	Doses of *Mangifera indica* leaf powder			*P*
		T1 (n=10)	T2 (n=10)	T3 (n=10)	
MDA (µM)	1.67±0.82	1.61±1.45	0.68±0.34	0.80±0.64	0.21
CAT (µM/min/g TP)	5.83±3.42	6.72±3.23	5.57±1.76	5.60±3.65	0.93
SOD (U/min/g TP)	0.98±0.52	0.81±0.32	0.78±0.25	0.66±0.30	0.60
POX (mM/min/g TP)	43.31±14.69	43.33±16.45	56.24±28.47	41.58±9.09	0.58

MDA: Malondialdehyde ; SOD: Superoxide Dismutase; CAT: Catalase; POX: Total Peroxidase; TP: Total proteins. n: n: number of subjects in each group, control: experimental diet only, T1: experimental diet + 0.50% mango leaf powder, T2: experimental diet + 0.75% mango leaf powder, and T3: experimental diet + 1% mango leaf powder, P: probability

4.4 Influence of the incorporation of mango leaf powder on toxicity markers in male guinea pigs

4.4.1 Biochemical markers of nephrotoxicity and the weight and volume of kidney in male guinea pigs: It appears from table 3 which represents the influence of mango leaf powder on biochemical markers of nephrotoxicity and the weight and volume of kidney in male guinea pigs that; the values for these characteristics were similar (P>0.05) to each other whatever the group considered. Despite this, the lowest values for kidney weight and volume were noted in animals that received the highest dose of mango leaf powder.

Table 3: Effects of mango leaf powder on biochemical markers of nephrotoxicity and the weight and volume of kidney in male guinea pigs

Toxicity indicators	Control (n=10)	Doses of *Mangifera indica* leaf powder			*P*
		T1 (n=10)	**T2 (n=10)**	**T3 (n=10)**	
Relative weight of the kidney (%)	0.44±0.09	0.43±0.09	0.41±0.09	0.34±0.07	0.27
Volume of the kidney (dm^3)	1.42±0.14	1.50±0,01	1.50±0.50	1.37±0.32	0.87
Creatinine (mg/dL)	1.02±0.23	0.96±0.08	1.08±0.10	1.32±0.56	0.31
Urea (mg/dL)	41.89±7.26	61.17±17.66	61.40±11.68	62.12±18.80	0.12

n: n: number of subjects in each group, control: experimental diet only, T1: experimental diet + 0.50% mango leaf powder, T2: experimental diet + 0.75% mango leaf powder, and T3: experimental diet + 1% mango leaf powder, P: probability.

4.4.2 Biochemical markers of hepatotoxicity and the weight and volume of liver in male guinea pigs: Table 4 summarizes the influence of mango leaf powder in the diet on biochemical markers of hepatotoxicity and the weight and volume of liver in male guinea pigs. A significant (P<0.05) drop was remarked in liver volume in guinea pigs fed with the greatest dose of mango leaf powder with respect to the control animals. Lower activities were recorded for ALAT in mango leaf powder-treated groups as compared to the control, though this difference was insignificant (P>0.05).

Table 4: Effects of mango leaf powder in the diet on biochemical markers of hepatotoxicity and the weight and volume of liver in male guinea pigs

Toxicity indicators	**Control (n=10)**	**Doses of *Mangifera indica* leaf powder**			***P***
		T1 (n=10)	**T2 (n=10)**	**T3 (n=10)**	
Relative weight of the liver (%)	2.63±0.79	2.92±0.69	2.46±0.62	2.07±0.23	0.22
Volume of the liver (dm^3)	8.83±1.89^{bc}	10±1.00^{c}	7.50±2.18^{ab}	6.50±0.87^{a}	0.02
ALAT (U/L)	71.24±16.00	66.35±5.89	62.33±9.13	70.01±15.71	0.67
ASAT (U/L)	74.73±20.03	67.74±15.49	76.47±10.54	77.70±18.22	0.78

ASAT: aspartate aminotransferase, ALAT: alanine aminotransferase, n: n: number of subjects in each group, control: experimental diet only, T1: experimental diet + 0.50% mango leaf powder, T2: experimental diet + 0.75% mango leaf powder, and T3: experimental diet + 1% mango leaf powder, p: probability.

4.5 Effects of different doses of mango leaf powder on growth characteristics in male guinea pigs : The effects of different doses of mango leaf powder on male guinea pigs' characteristics of growth are represented on table 5. Generally, no matter what the dose of mango leaf powder considered; it appears that all the values of growth characteristics were comparable in all the treatments.

Table 5: Effects of mango leaves powder on growth characteristics in **male guinea pigs**

Growth characteristics	**Control (n=10)**	**Doses of *Mangifera indica* leaf powder**			***P***
		T1 (n=10)	**T2 (n=10)**	**T3 (n=10)**	
Initial body weight (g)	264.20±47.09	268.30±69.30	269.70±71.93	269.90±29.47	1.00
Feed consumption (g)	745.20	753.80	749.40	737.20	/
Final body weight (g)	346.90±55.82	364.50±83.56	347.10±74.84	345.10±31.41	0.96
Body weight gain (g)	82.70±9.85	96.20±36.40	77.40±22.69	75.20±23.00	0.55
Daily body weight gain (g)	2.36±0.28	2.75±1.04	2.21±0.65	2.15±0.70	0.55
Feed conversion ratio	9.11±1.04	8.95±3.82	10.33±2.79	10.42±2.59	0.75
Feed efficiency	0.11±0.01	0.13±0.05	0.10±0.03	0,10±0.03	0.60

n: n: number of subjects in each group, control: experimental diet only, T1: experimental diet + 0.50% mango leaf powder, T2: experimental diet + 0.75% mango leaf powder, and T3: experimental diet + 1% mango leaf powder, P: probability

4.6 Effects of mango leaves powder on relative weights of some male guinea pigs' organs and characteristics of carcass: The influence of mango leaf powder on characteristics of carcass and relative weights of some organs in male guinea pigs are presented by table 5. It shows that no major differences were observed among treated and control groups.

Table 6: Effects of mango leaves powder on relative weights of some male guinea pigs organs and characteristics of carcass

Carcass and organs	Control (n=10)	Doses *Mangifera indica* leaf powder			P
		T1 (n=10)	T2 (n=10)	T3 (n=10)	
Carcass yield 1 (%)	76.32±3.43^{b}	67.47±8.36^{a}	68.76±6.54^{ab}	69.62±1.17^{ab}	0.04
Carcass yield 2 (%)	40.90±5.07	39.85±6.11	38.80±5.60	37.55±1.66	0.74
Relative weight of the fifth quarter (%)	35.42±5.77^{b}	27.62±2.43^{a}	29.96±3.08^{a}	32.07±2.38^{ab}	0.03
Relative weight of the stomach (%)	3.40±1.12	3.23±0.73	2.66±0.83	2.34±0.39	0.17
Large intestine Relative weight (%)	3.74±1.36	3.80±0.97	3.11±0.58	2.59±0.33	0.15
Small intestine Relative weight (%)	3.80±0.75	3.74±0.93	2.98±0.71	3.57±0.26	0.24
Relative weight of the caecum (%)	8.60±3.95	9.24±1.92	9.25±1.86	5.82±1.02	0.12
Large intestine Length (cm)	68.17±8.95^{ab}	70.77±5.35^{b}	62.23±3.80^{ab}	60.83±6.82^{a}	0.04
Small intestine Length (cm)	132.03±5.24	135.40±13.60	132.87±8.73	132.63±13.29	0.96
Large intestine Density (g/cm)	18.84±4.68^{b}	18.90±1.22^{b}	15.49±1.77^{ab}	14.49±1.56^{a}	0.04
Small intestine Density (g/cm)	9.88±1.17^{b}	9.87±1.03^{b}	8.71±0.62^{ab}	7.65±0.17^{a}	0.00

n: number of subjects in each group, control: experimental diet only, T1: experimental diet + 0.50% mango leaf powder, T2: experimental diet + 0.75% mango leaf powder, and T3: experimental diet + 1% mango leaf powder, P: probability

5 DISCUSSION

Testosterone is the most important male androgen that is synthesized from cholesterol and secreted into the blood. This cholesterol in the Leydig cells is in the interstitial spaces of the seminiferous tubules (Tang *et al.,* 2004). Testosterone is very necessary in reproduction. In the present study, an increase in testosterone level was registered especially at 0.75% of mango leaf powder (MLP). Similar results were reported by Mosbah *et al.* (2017) in rat intoxicated with 27 mg/kg bw of acetamiprid and treated with 0.5 ml/kg bw of *Nigella sativa* oil; Vemo *et al.* (2017) in guinea pig co-treated with 137.50 mg/kg bw of cypermethrin and 100 or 200 mg/kg bw of ethanolic extract of *Bersama engleriana*. This increase in testosterone level could be attributed to the presence of saponins and triterpens revealed in this plant leaves powder. In fact, it is known that saponins could bind to the enzymes involved in the synthesis of testosterone and increase their production (Gauthaman and Adaikan, 2005). The level of cholesterol in the present work was highest in male guinea pigs given the highest dose of mango leaves powder. However, these were all similar to those that received feed without MLP. These results are alike in variation with testosterone levels here. This is not surprising since testosterone is produced from cholesterol in the Leydig cells. So the suggested explanation for testosterone level variation may justify that of cholesterol in this work. The state of oxidative stress is usually put to evidence through the evaluation of indicators such malondialdehyde, nitric acid, superoxide dismutase, catalase, peroxidase, gluthatione, etc (Garg *et al.,* 2008). The activities of superoxide dismutase as well as catalase constitute the primary defense position in fighting against reactive oxygen species. They are useful in the prediction of sperm fertilizing potentials (Badade and Samant, 2011). The slight drop of malondiadehyde concentration in all mango leaf powder-treated animals with respect to the control group in this work could be as a result of the action of antioxidant compounds contained in the powder of *M. indica* leaves. Indeed, the test carried out on this powder presented components like tannins, phenols, triterpenes as well as flavonoids. These phytochemical components may have played a protective role thereby, hindering the damaging effects of oxidative stress from internal and environmental sources, thus preventing membranes from lipid peroxidation and therefore reducing malondialdehyde levels. These substances may have hindered the reaction of free radicals through the transfer of protons (Hodek *et al.,* 2002) or hindering enzymes lipoxygenase, aldose reductase and phospholipase that bring about their production. (Benavente-Garcia *et al.,* 1997). Since malondialdehyde is an important indicator of oxidative stress in cells (Badade and Samant, 2011), the decrease of its concentration might explain the variation in the other oxidative stress markers which could presumably be due to antioxidant compounds contained in these extracts which might have neutralized the free radicals, thus limiting the activities of these enzymes. These results concord with the observations of Mossa *et al.* (2015) in mice administered 13.8 mg/kg bw of cypermethrin and 150 or 300 mg/kg bw of *Cedrelopsis grevei* and Vemo *et al.* (2017) in cavies administered 137.50 mg/kg bw of cypermethrin and 100 or 200 mg/kg bw of *Bersama engleriana* and Arthenice *et al.,* 2019 in cavies administered acetamiprid and co-treated with *Mangifera indica* leaves ethanolic extract at doses of 50, 100 and 200 mg/kg bw. Liver and kidneys are organs linked to the breakdown and elimination of toxic substances (Tsatsakis *et al.,* 2001). Indeed, the primary organ to face any strange substance transferred via portal circulation is the liver, thereby exposing it to the greatest destruction. The level of ALAT and ASAT in serum informs on the state of hepatic cells (Ogunlade *et al.,* 2012). Creatinine comes from the metabolism of creatine phosphate found in muscles, often secreted by the body at a fairly steady rate (Noaishi and Abdalhafez, 2016). Creatinine is chiefly filtered out of the blood by the kidneys and is known as a fairly authentic marker of renal function. Urea is produced by the liver as a final product of the metabolism of protein (Tawfik and Al-Badr, 2012). The levels of urea and creatinine indicate kidney function (Chiali, 2014). In the present study, the lowest values for kidney and liver weight and volume as well as lower activities for ALAT were recorded in animals that received the highest dose of mango leaf powder. This could indicate the non-destruction of the hepatocytes plasma membranes, consecutive to their protection by bioactive compounds such as flavonoids, phenols, terpenoids, known to have hepatoprotective and antioxidative properties. These observations concord with those of Mossa *et al.* (2015) in rats exposed simultaneously to 13.8 mg/kg bw of cypermethrin and 150 mg/kg bw of *Cedrelopsis grevei*; Dridi and Segueni (2015) in rats exposed to chlorpyriphos and treated with extracts of *Cotula cinerea*. Also, Sankar *et al.* (2012) reported that liver enzymes were significantly improved after the administration of curcumin to cypermethrin-intoxicated rats. They are equally in line with Arthenice *et al.,* 2019 in guinea pigs exposed to acetamiprid and co-treated with *Mangifera indica* leaves ethanolic extract at doses of 50, 100 and 200 mg/kg bw.The administration of *M. indica* leaves powder to guinea pigs led to an improvement in feed intake and body weight at the 0.50% though not significantly. This probably indicates that the powder of *M. indica* leaves has flavonoids which are components that generate appetite. In addition to this, components like terpenoids , steroids and saponins present in mango leaves powder put to evidence by phytochemical test possess androgenic activities (Gauthaman and Ganesan, 2008; Ahangarpour *et al.,* 2013), which may have been in favor of the building up activity at the level of tissue(Gayrard, 2007). This would have thereby led to the increment in body weight. This result is in line with those registered by Mosbah *et al.* (2014) in rats that were co-administered 1 ml/kg bw of *N. sativa* oil and 20 mg/kg bw of chlopyriphos.

6 CONCLUSION

From the observations made following the incorporation of mango leaves powder in male guinea pigs feed, it may be concluded that the dose of 1% mango leaves powder might improve animal production performance in general and male guinea pigs in particular. Thus mango leaves powder can be used as a natural source of antioxidants to hinder the undesirable effects of oxidative stress to which animals are exposed daily.

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