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# Influence of Dietary Plantain, Oil Palm and Calopogonium Foliage on Semen and Blood Chemistry of Rabbits

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***Abstract***
*This study assessed blood chemistry and semen qualityof rabbit bucks fed plantain, oil palm and Calopogoniummuconoides foliage using forty-eight animals, aged six weeks old. The animals were shared into four groups of 12 animals each. Average weights of animals per group were balanced across groups. The animal groupswere randomly allotted to four treatments. Each treatment was further divided into three replicates of four animals each. The treatments included groups $A_{CML}$(calopogonium leaves as control), $B_{PTL}$ (plantain leaves), $C_{OPL}$ (oil palm leaves) and, $D_{PTL\ +OPL}$ (50% oil palm leaves+ 50% plantain leaves). Each animal was housed individually in cages and given a fixed amount of concentrate pellets daily forthe 56-day duration.Forages and water were offered ad libitum. Completely randomized design, one-way analysis of variance was used for the study.Data were analyzed using analysis of variance procedures in Statistical Software for Social Sciences version 24.0. Significant means were separated using Least Significant Difference. Results indicated that feeding oil palm leaves alone or with plantain leaves increased ($p<0.05$)packed cell volume, platelet and neutrophil counts, ALP, percent sperm cells with normal morphology and number of active sperm cells, but,reduced ($p<0.05$) lymphocyte count and dead sperm cells.Also, feeding rabbits plantain leaves elevated ($p<0.05$) AST values. The colour and viscosity of sperm cells of all treatments were normal.Results imply that consumption of oil palm leaves by rabbits could improve blood clotting, immune response,sperm motility and viability but may increase animal dehydration and tamper with bone integrity. We conclude that though both leaves can be fed to rabbits individually or in combination, oil palm leaves seem to benefit rabbits more than plantain leaves. Nevertheless, overfeeding rabbits with either of them could pose some risks.*

***Keywords:****Dry season feeding, waste, forage*

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## I. Introduction

The rabbit, an important minilivestock, has been recommended for rearing by smallholder farmers in developing countries due to its ability to grow, reproduce and produce meat quickly [1]. The meat is needed to alleviate thelingering animal protein deficiency connected to low production and productivity of meat animals in countries such as Nigeria [2].

Increasingthe production of meat animals is hampered by high cost of livestock feeds and feedstuffs. In rabbit production, feeds constitute 60-70% of the cost of production [3].Therefore, any strategy aimed at improving animal production and productivity to supply affordable meat to those that need it, must consider as part of the strategy, a solution to the high cost of feed.

Rabbits can live oneither concentrates or forages alone, though their productivity can be enhanced if fed both[4]. Of the two kinds of feed, concentrates are the costliest. Hence, resource-poor smallholder farmersusuallyfeed their rabbits moreforages than concentrates[4]. The well-known forages preferred by rabbit farmers include *Panicum maximum*, *Aspiliaafricana*, *Calopogoniummuconoides*, *Andropogon tectorum*, *Pennisetumpurpereum*,*Gliricidiasepum*, *Tridaxprocumbens*,*Aspiliaafricana*, *Leucaenaleucocephala* and *Puereriaphaseoloides*[5]. Research on the performance, blood chemistry, safety and sperm quality of rabbits as influenced by consumption of these conventional forages alone or in combination is well documented[6, 7, 8, 9, 10, 11, 12, 13, 14, 15].But,these well-known and preferred forages usually dry-off in the dry season, hence, making the feeding of rabbits in the dry season, like that of ruminants, a big challenge for resource-poor farmers[16].

To surmount the problem of forage scarcity in the dry season, there has been a proposal for the use of foliage frommulti-purpose trees and permanent crops which grow throughout the year (rainy and dry season) tofeedherbivores, including rabbits[17].From the environmental and feed cost perspective, this is a sound argument because foliagefrom those trees is usually discarded after the trees are prunedor their fruitsare harvested[18]. Dumping of pruned biomass from these trees constitutes environmental hazardin and around the

crop plantations. Examples of those multipurpose trees are oil palm (*Elaeisguineensis*) and plantain (*Musa paradisiaca*)[18, 19].

Oil palm foliage are by-products of fruit harvest and tree pruning and are plentiful in oil palm plantations in southern Nigeria[20, 21]. In Nigeria, oil palm is produced by millions of smallholders that cultivate up to 360,000 hectares of the plantations in the Niger Delta alone [22]. Oil palm foliage constitutes more than 50% of biomass generated by oil palm industry [23] and 100 kg DM/hectare of oil palm fronds are generated daily [24]. Globally, 164 million tonnes (DM basis) of oil palm fronds were produced inthe year 2009[25]. This biomass is usually discarded by burning, hence, causing environmental pollution and destruction [18]. These leavescan be used as feed for herbivores as a way of recycling the nutrients[18].

Oil palm leaves contain 91.32% dry matter and,on dry matter basis, the foliage contains 93.0% organic matter, 7.02% crude protein, 0.96% ether extract, 28.21% crude fiber, 56.81% nitrogen free extract and 7.0% ash [26]. Extracts from oil palm frond have cardiovascular, liver, kidney, neuroprotective, vaso-dilative, phyto-estrogenic, and bone mass enhancing properties [27]. The main challenge to the use of oil palm foliage is the high content of silica and the slow response of the fiber to fermentation. These demerits eventuallyminimize thevolatile fatty acid content, needed for proper nutrition of ruminants [21] Oil palm foliage are acceptable as feed by goats, sheep, cattle and rabbits [21, 28] and have been used to produce goat meat [21]. Fermented oil palm foliage has been used to replace elephant grass with supplementation by mineral additives [29].Thirty percent of oil palm foliage combined with 70% concentrates, yielded more milk than onlyfresh oil palm foliage and grass [21].

Plantain(*Musa paradisiaca*)is a permanent crop. It is tall, sturdy and having a pseudo-stem that reaches 2-9 meters in height and a fruit that is amajor food in West and Central Africa. The plant loves hot humid climates having 1000 mm rainfall per year or more, 27°C temperature, abundant sunlight with deep soil, richin organic matter, well-drained, ventilated and pH of 5.5-7.0 [30, 31].

Plantain leaves have large broad blades with noticeable midrib and veinsgrowing continuously to about 1-4 m long by 0.7-1 m wide[18]. The plant yields about 13 tonnes/hectare/year of biomass whose potential as livestock feed is not in doubt [19].Matured leaves contain 96.78 % DM, 13.13 % crude protein, 15.91 % crude fiber, 10.05 % ether extract, 12.35 % ash, 46.31 % nitrogen free extract and 3311.57 kcal ME/kg [32]. The leaf is high in tannin which reduces protein and dry matter digestibility.Hence,the use of the leaves as feed for herbivores may need supplementation with high protein and energy concentrates to address the low digestibility [33].

Banana leaves have been used to enhance cattle milk yield [34] andfeed rabbits [35]. Incombination with *Desmodiumspp* foliage, they have been used to supplement poor quality grass [36].Studies have been done on the performance, organ and meat sensory value of rabbits fed leaves of plantain [35] and oil palm[26]. But, little is known about the effect of plantain and oil palm leaves on blood chemistry and sperm qualityof rabbits consuming them.Being that the biomass of these crops is not conventional forage for rabbits, there is need to know how their consumption might affect the health and reproductive ability of rabbits. This is important because male fertilityin rabbitscan beinfluenced by nutrition [37] and blood chemistry values can indicate most diseases [38]. Hence, the objective of this study was to assess the blood chemistry and sperm quality of rabbit bucks fed plantain, oil palm and *Calopogoniummuconoides* foliage.

## II. Materials and Methods

**Location of the Study**

The experiment was carried out at Department of Animal Science Teaching and Research Farm, University of Port Harcourt, Rivers State, Nigeria. The farm is located at latitude 4.89437$^{o}$N and longitude 6.91053$^{o}$E, at 16m altitude, 28$^{o}$C mean annualtemperature, and 2500 mm mean annual rainfall spread from March to October [39, 40]. Blood chemistry and sperm analysis were done at Animal Physiology Laboratory of the Department of Animal Science, University of Port Harcourt, Port Harcourt.

**Source of Commercial Pellets and Forages and their Proximate Analyses**

Resource-poor rabbit farmers do not formulate concentrate diets butpurchase commercial growers' mash for their rabbits. Pelleted Vital® feed growers mash was used for the study. Proximate analysis results of the diet and that of plantain, oil palm and *Calopogoniummuconoides* foliage used for the study are presented in Table 1. The foliage was obtained from Institute of Agricultural Research and Development farm, University of Port Harcourt. We analyzed for dry matter, crude protein, crude fiber, nitrogen free extract, ash and ether extract and energy using procedures of [41].

**Table 1:** Proximate composition of plantain, oil palm and calopogonium foliage with concentrate diets

| Component (%) | Composition (percent dry matter) | | | |
|---|---|---|---|---|
| | **PTL** | **OPL** | **CML** | **CCD** |
| Dry matter | 94.50±2.11 | 96.39±1.65 | 93.44±1.30 | 89.17±4.20 |
| Crude protein | 12.71±1.20 | 4.90±0.92 | 25.11±1.50 | 13.48±1.45 |
| Crude fiber | 15.38±0.07 | 38.40±2.12 | 22.56±0.02 | 7.79±0.23 |
| Ether extract | 9.71±0.01 | 2.30±0.01 | 3.32±0.002 | 5.95±0.24 |
| NFE | 44.77±0.33 | 47.80±0.56 | 32.27±0.02 | 64.01±2.34 |
| Ash | 11.93±0.02 | 2.99±0.01 | 10.18±0.05 | 8.77±0.27 |

*[a, b, c] Means in the same row with different superscripts are significantly different (p<0.05); [NS] Not significantly different (p>0.05); **PTL**=plantain leaves; **OPL**=oil palm leaves; **CML**=Calopogoniummuconoides leaves; **CCD**=Commercial concentrate diets;*Dry matter as percent of 100 g sample*

**Animals and Experimental Management**

The rabbits were housed individually in cages according to the treatments. Each animal was fed a fixed amount of concentrate ration (15g/animal/day) while the forage and water were offered *ad libitum*. Concentrate diet was fed in the morning at 8.00 hours while forage was fed in the evening at 16.00 hours. The duration of the study was 56 days.

**Experimental Design**

Forty-eight (48) weaner rabbit bucks, six weeks of age were used for the study. They were randomly allotted to four treatment groups of twelve (12) animals each. Each treatment was subdivided into three replicates of four animals each. Average initial weight of treatments were balanced across the groups. The treatment groups were: Group $A_{CML}$ (calopogonium leaf as control); Group $B_{PTL}$ (plantain leaf); Group $C_{OPL}$ (oil palm leaf) and; Group $D_{PTL+OPL}$(50% oil palm leaf + 50% plantain leaf). All groups were given a fixed and equal amount of concentrate pellets per day throughout all the days of the study. Completely randomized design, one-way analysis of variance was used for the study.

**SemenCollection and Analysis**

Two weeks before the semen was obtained, three bucks per treatment were trained to service artificial vagina using a teaser doe. Bucks were placed in semen collection schedule twice a week on Tuesdays and Fridays for three consecutive weeks. On the last day of the study, semen ejaculated was collected from each of the rabbits between 08:00 to 10.00 hours,Nigerian time.Semen collection was performed with an English type artificial vagina following the methods of [42]. Semen samples were collected from each animal with the aid of artificial vagina (AV) using a matures non-gravid doe as a teaser as described by [43]. As the buck mounts and make a thrust on the teaser doe before intromission, the AV was applied from the rear toprovoke ejaculation in a few seconds. The ejaculate obtained from the collecting tubes was read directly on the glass tubule to determine the semen volume before being sent forspeedy microscopic examination and assessment.

Viscosity is a measure of seminal fluid resistance to flow. It wasestimated by gently aspirating into a wide-bore (approximately 1.5 mm of diameter) plastic disposable pipette, allowing the semen to drop by gravity and observing the length of any thread. A normal sample leaves the pipette in small discrete drops. If viscosity is abnormal, the drop will form a thread more than 2 cm long[44].Sperm viability (live: dead ratio %) was calculated by counting the number of live cells (without colour) and dead cells (pink) using optical microscopy (400x), after combining one drop of semen with one drop of eosin-nigrosin[45].Morphology attributes were measured by staining an aliquot of each ejaculate with eosin/negrosin stain and counting 200 sperm cells at 100× under oil immersion. Sperm cells were identified as alive or dead and classified as either normal or having head, mid-piece and tail defects[45].Semen volume and appearance (colour) were determined according to methods of [46]. Volume was read-off directly in milliliters from a calibrated glass collection tube attached to the artificial vagina [46]. The pH was assessed immediately after semen collection using a pH cooperative paper ranging from 7 to 12 with 1 grade (Dual-Tint).

**Blood Collection andAnalyses**

At the end of the study at 56 days, blood was drawn from one animal per replicate or three animals per treatment (12 samples in all) to be used for haematological and biochemical analysis. Blood was drawn from the marginal ear vein after being securely restrained according to methods described by [47]. The blood samples for each animal per group were shared into two parts. First part of 5ml was collected over labeled sterile universal bottles having 1.50 mg/ml ethyldiaminetetraacetic acid (EDTA). This was used for haematological indices analysis [48, 49]. The second part of 7.0 ml was collected over labeled sterile sample bottles without the anti-coagulant (EDTA) for biochemical indices analysis [50, 51, 48]. Pooled results were used to find the average for each group.

**DataAnalysis**

Data were analyzed using analysis of variance procedures of Statistical Software for Social Sciences (SPSS) version 24 [52]. The significant means were separated using Least Significant Difference.

## III. Results and Discussion

**Haematological Indices of Rabbits Fed Plantain and Oil Palm Leaves**

Table 2 shows the haematological indices of rabbits fed oil palm and plantain leaves. Results indicatedsignificant differences ($p<0.05$) among PCV (%) values. Group $D_{PTL+OPL}$ (40.0±1.15) had the highest value, followed by group $C_{OPL}$ (36.0±1.0) while group $A_{CML}$ (28.67±1.76) was the least. However, group $C_{OPL}$ value was not different ($p>0.05$) from that of group $B_{PTL}$ (35.0±1.73). Consumption of oil palm and plantain leaves singly or in combination had higher PCV than calopogonium-fed rabbits and normal values reported for rabbits in the tropics[53]. PCV measures anaemia and hydration in animals. Higher than normal PCV could be due to dehydration [54]. In this case,it could be attributed to high ambient temperature during the dry season when the experiment took place(February-March), the forage consumed or both.

**Table 2:** Haematological indices of rabbits fed plantain and oil palm leaves

| | Treatments | | | |
|---|---|---|---|---|
| **Parameters** | **$A_{CML}$** | **$B_{PTL}$** | **$C_{OPL}$** | **$D_{PTL+OPL}$** |
| PCV [%] | $28.67±1.76^{c}$ | $35.0±1.73^{b}$ | $36.0±1.0^{b}$ | $40.0±1.15^{a}$ |
| Haemoglobin [g/dl] | $9.98±0.59^{NS}$ | $11.00±0.57^{NS}$ | $11.03±0.33^{NS}$ | $11.33±0.3^{NS}$ |
| RBC [$\times10^6$/mm$^3$] | $4.80±0.20^{NS}$ | $4.93±0.34^{NS}$ | $5.30±0.20^{NS}$ | $5.40±0.20^{NS}$ |
| WBC [$\times10^6$/mm$^3$] | $5.83±0.77^{b}$ | $6.23±1.12^{ab}$ | $7.00±1.3^{a}$ | $3.50±0.28^{c}$ |
| Platelet [$\times10^9$/l] | $283.33±4.03^{c}$ | $343.33±3.79^{b}$ | $427.33±1.56^{a}$ | $440±3.05^{a}$ |
| Neutrophils [$\times10^9$/l] | $37.33±0.71^{c}$ | $54.33±1.99^{b}$ | $59.33±2.26^{a}$ | $60.00±2.8^{a}$ |
| Lymphocytes [$\times10^9$/l] | $61.0±2.08^{a}$ | $51.66±0.40^{b}$ | $40.00±1.66^{c}$ | $38.99±0.33^{c}$ |
| Eosinophils [%] | $0.98±0.02^{NS}$ | $1.20±0.07^{NS}$ | $0.99±0.00^{NS}$ | $1.00±0.01^{NS}$ |
| Monocytes [%] | $1.97±0.00^{NS}$ | $2.00±0.10^{NS}$ | $1.98±0.01^{NS}$ | $2.30±0.20^{NS}$ |

*$^{a, b, C}$Means on the same row with different superscripts are significantly different ($p<0.05$);$^{NS}$ Not significantly different ($p>0.05$); PCV=packed cell volume; WBC=white blood cell; RBC=red blood cells*

The haemoglobin (g/dl) and RBC ($\times10^6$/mm$^3$) values ranged from 9.98±0.59 ($A_{CML}$) to 11.33±0.3 ($D_{PTL+OPL}$) and 4.80±0.20 ($A_{CML}$) to 5.40±0.20 ($D_{PTL+OPL}$), respectively. There were no significant differences ($p>0.05$) among the values for these two parameters. The values were, however, within normal range for rabbits in the humid tropics [53].

There were differences ($p<0.05$) in the WBC ($\times10^6$/mm$^3$) values with group $D_{PTL+OPL}$ being the least (3.50±0.28) while group $C_{OPL}$ had the highest (7.00±1.3). However, group $C_{OPL}$ value was not different ($p>0.05$) from that of group $B_{PTL}$ (6.23±1.12) while that of group $B_{PTL}$ was also not different ($P>0.05$) from that of group $A_{CML}$ (5.83±0.77).Elevated leukocyte valuesindicate infections or inflammations in animals [54]. Groups $C_{OPL}$ and $B_{CML}$values were elevated but within normal range for rabbits in humid tropics[53].

The platelet ($\times10^9$/l) values showed significant differences ($p<0.05$) among the treatment means with group $A_{CML}$ (283.33±4.03) having the least value while group $D_{PTL+OPL}$ (440±3.05) had the highest. Nevertheless, the highest value was similar ($p>0.05$) to that of group $C_{OPL}$ (427.33±1.56). Platelets initiate blood clotting and physically plug defects [54]. Feeding plantain and oil palm leaves singly or in combination increased platelet counts, especially for oil palm leaves. This indicates that oil palm leaves consumption improves blood clotting in rabbits.

The neutrophils ($\times10^9$/l) were significantly different ($p<0.05$) among treatment means. Group $A_{CML}$ (37.33±0.71) recorded the least value while group $D_{PTL+OPL}$ (60.00±2.8) had the highest value which was not different from that of group $C_{OPL}$ (59.33±2.26).All the values except that of group $A_{CML}$ were higher than values reported for rabbits fed gmelina leaf meal[55] and differences could be due to type of leaf. Neutrophils are the first immune cell responders to body invasion by disease pathogens [54]. Consumption of plantain and oil palm leaves, especially, oil palm leaves, increases neutrophils count of rabbits. This agrees with [27] that oil palm leaves contain functional phytochemicals that boost immune response of cells to foreign body invasion.

There were significant differences ($p<0.05$) in the lymphocyte ($\times10^9$/l) counts. Group $D_{PTL+OPL}$ (38.99±0.33) had the least value which was not different ($p>0.05$) from that of group $C_{OPL}$ (40.00±1.66) while group $A_{CML}$ (61.0±2.08) recorded the highest value. The values were within the range reported for New Zealand White rabbits [56]. Inclusion of plantain and oil palm leaves singly or in combination reduced lymphocyte count, especially with oil palm leaves. Lymphocytes function in cell-mediated immune response or production of antibodies[54]. A reduced lymphocyte count could indicate improved healthiness of the animal.

The eosinophils and monocytes values ranged from 0.98±0.02 ($A_{CML}$) to 1.20±0.07 ($B_{PTL}$) and 1.97±0.00 (A) to 2.30±0.20 ($D_{PTL+OPL}$). There were no differences ($p>0.05$) in the eosinophils and monocytes values. Also, the values were within the normal range reported for these parameters in rabbits[55].

**Biochemical Indices of Rabbits Fed Plantain and Oil Palm Leaves**

Table 3 shows biochemical indices of rabbits as influenced by consumption of plantain, oil palm and calopogonium leaves. Results indicate that there were significant differences ($p<0.05$) in the AST (IU/L) values. Group $A_{CML}$ (31.33±1.65) was the least while group $D_{PTL+OPL}$ (62.66±3.95) was the highest. But, the least value was not different ($p>0.05$) from that of group $C_{OPL}$ (35.33±1.17).AST values of rabbits fed only plantain leaves and plantain leaves plus oil palm leaves were elevated. Elevated AST could be due to liver disease or muscular damage. However, since creatinine kinase was not evaluated alongside, we cannot definitively associate the elevated AST values to a specific issue [38].

The ALT (IU/L) values ranged from 29.00±2.64 ($A_{CML}$) to 30.33±2.36 ($B_{PTL}$). There were no differences in the ALT values among the treatment groups. Also, the values were within the normal range reported for New Zealand rabbits[57].

There were differences ($p<0.05$) among the ALP (IU/L) values across treatment groups. Group $A_{CML}$ value (26.00±2.71) was the least while group $D_{PTL+OPL}$ value (48.66±2.23) was the highest. However, group $D_{PTL+OPL}$ value was not different ($p>0.05$) from that of group $C_{OPL}$ (47.33±2.52).All the values were higher than normal values for New Zealand rabbits reported by [58] but lower than normal values for same breed of rabbits elsewhere [57]. Differences may be due to climatic factors as reported by [38]. Alkaline phosphatase is in bones, kidney, intestine and liver. Disruption of bone causes elevations of ALP more than other sources[38]. Values for oil palm leaves-fed group and those fed oil palm leaves combined with plantain leaves were the most elevated, followed by those fed plantain leaves alone. It may be interpreted that feeding oil palm leaves to rabbits may erode ALP synthesis and negatively affect bone integrity.

**Table 3:** Biochemical indices of rabbits fed plantain and oil palm leaves

| | **Treatments** | | | |
|---|---|---|---|---|
| **Parameters** | **$A_{CML}$** | **$B_{PTL}$** | **$C_{OPL}$** | **$D_{PTL+OPL}$** |
| AST [IU/L] | $31.33±1.65^{c}$ | $54.00±3.24^{b}$ | $35.33±1.17^{c}$ | $62.66±3.95^{a}$ |
| ALT [IU/L] | $29.00±2.64^{NS}$ | $30.33±2.36^{NS}$ | $29.93±1.76^{NS}$ | $30.00±2.30^{NS}$ |
| ALP [IU/L] | $26.00±2.71^{c}$ | $36.00±2.57^{b}$ | $47.33±2.52^{a}$ | $48.66±2.23^{a}$ |
| Total protein [g/L] | $69.99±1.45^{NS}$ | $69.88±2.69^{NS}$ | $68.96±2.48^{NS}$ | $71.33±2.52^{NS}$ |
| Albumin [g/L] | $35.99±2.02^{NS}$ | $36.33±2.18^{NS}$ | $36.00±2.05^{NS}$ | $37.03±1.45^{NS}$ |
| Globulin [g/L] | $29.98±0.66^{NS}$ | $30.51±1.50^{NS}$ | $30.66±1.45^{NS}$ | $31.00±2.08^{NS}$ |
| Total cholesterol [mg/dL] | $61.98±0.08^{NS}$ | $62.00±0.24^{NS}$ | $61.94±0.08^{NS}$ | $62.10±0.28^{NS}$ |
| Triglycerides [mg/dL] | $91.46±0.01^{NS}$ | $91.48±0.10^{NS}$ | $91.49±0.05^{NS}$ | $91.50±0.11^{NS}$ |
| HDL [mg/dL] | $17.78±0.14^{NS}$ | $17.80±0.02^{NS}$ | $17.79±0.02^{NS}$ | $17.82±0.02^{NS}$ |
| LDL [mg/dL] | $8.39±0.09^{NS}$ | $8.41±0.18^{NS}$ | $8.38±0.02^{NS}$ | $8.40±0.13^{NS}$ |

*$^{a, b, c}$Means on same row with different superscripts are significantly different ($p<0.05$); $^{NS}$ Not significantly different ($p>0.05$); A=control; B=Plantain leaves; C=Oil palm leaves; D=50% plantain leaves + 50% oil palm leaves; AST=Aspartate amino transferase; ALT=Alkaline amino transferase; ALP=Alkaline phosphate; HDL=High density lipoprotein; LDL=Low density lipoprotein*

Total protein (g/L), albumin (g/L) and globulin (g/L) values ranged from 68.96±2.48 ($C_{OPL}$) to 71.33±2.52 ($D_{PTL+OPL}$), 35.99±2.02 ($A_{CML}$) to 37.03±1.45 ($D_{PTL+OPL}$) and 29.98±0.66 ($A_{CML}$) to 31.00±2.08 ($D_{PTL+OPL}$), respectively. There were no differences ($p>0.05$) among the treatment means for the three parameters. All values for all parameters were within the normal ranges for New Zealand rabbits [57, 58].

The total cholesterol (mg/dL), triglycerides (mg/dL), HDL (mg/dL), and LDL (mg/dL) values ranged from 61.94±0.08 ($C_{OPL}$) to 62.10±0.28 ($D_{PTL+OPL}$), 91.46±0.01 ($A_{CML}$) to 91.50±0.11 ($D_{PTL+OPL}$), 0.78±0.14 ($A_{CML}$) to 0.82±0.02 ($D_{PTL+OPL}$), and 0.38±0.02 ($C_{OPL}$) to 0.41±0.18 ($B_{PTL}$), respectively.There were no differences ($p>0.05$) in the treatment means across the groups for these indices. All the values were within the normal ranges for New Zealand rabbits[57, 59] and rabbits fed evergreen tropical browse plants[60].

**Semen Indices of Rabbit Bucks Fed Plantain and Oil Palm Leaves**

Semen indices values of rabbit bucks as influenced by consumption of oil palm, plantain and calopogonium leaves are presented in Table 4. Results show that semen from alltreatment groups appearedmilky, the normal colour for semen[44].

The values for semen volume (%) and viability (%) ranged from 0.66±0.02 ($A_{CML}$) to 0.73±0.04 ($B_{PTL}$) and 67.00±2.26 ($B_{PTL}$) to 67.89±2.77 ($A_{CML}$), respectively. The pH for all the treatments was 8.00 while the viscosity for all the treatment groups was normal. There were no differences ($p>0.05$) among the treatment groups for all these parameters. Also, the values were within acceptable rangesfor rabbits [61, 62, 63].

**Table 4:**Semenindices of rabbit bucks fed plantain and oil palm leaves

| Parameters | Treatments | | | |
|---|---|---|---|---|
| | $A_{CML}$ | $B_{PTL}$ | $C_{OPL}$ | $D_{PTL+OPL}$ |
| Appearance | Milky | Milky | Milky | Milky |
| Volume [%] | $0.66\pm0.02^{NS}$ | $0.73\pm0.04^{NS}$ | $0.69\pm0.06^{NS}$ | $0.70\pm0.05^{NS}$ |
| Ph | $8.00\pm00^{NS}$ | $8.00\pm00^{NS}$ | $8.00\pm00^{NS}$ | $8.00\pm00^{NS}$ |
| Viability [%] | $67.89\pm2.77^{NS}$ | $67.00\pm2.26^{NS}$ | $67.33\pm2.35^{NS}$ | $67.66\pm2.33^{NS}$ |
| Viscosity [%] | Normal | Normal | Normal | Normal |
| Normal morphology [%] | $60.00\pm1.52^{b}$ | $59.77\pm1.33^{b}$ | $69.30\pm1.40^{a}$ | $60.33\pm2.96^{b}$ |
| Abnormal [%] | $40.00\pm1.52^{NS}$ | $39.23\pm2.33^{NS}$ | $36.80\pm2.35^{NS}$ | $39.67\pm2.90^{NS}$ |
| Active [%] | $54.33\pm2.96^{b}$ | $41.66\pm1.66^{c}$ | $71.06\pm2.26^{a}$ | $57.66\pm3.33^{b}$ |
| Sluggish [%] | $10.66\pm0.00^{NS}$ | $10.96\pm1.66^{NS}$ | $9.98\pm1.44^{NS}$ | $10.00\pm0.00^{NS}$ |
| Dead [%] | $35.00\pm0.88^{a}$ | $36.66\pm1.01^{a}$ | $11.33\pm0.92^{c}$ | $21.66\pm1.40^{b}$ |
| Sperm concentration [$x10^{8}$mL spermatozoa] | $20.98\pm0.05^{NS}$ | $21.00\pm0.27^{NS}$ | $21.09\pm0.31^{NS}$ | $21.10\pm0.08^{NS}$ |

*$^{a, b, c}$ Means in the same row with different superscripts are significantly different ($p<0.05$); $^{NS}$ Not significantly different ($p>0.05$)*

Percent sperm cells with normal morphology were different ($p<0.05$) among treatment groups. Group $C_{OPL}$ had the highest value (69.30±1.40) while group $B_{PTL}$ had the least (59.77±1.33). However, there were no differences between group $B_{PTL}$ value and those of groups $A_{CML}$ (60.00±1.52) and $D_{PTL+OPL}$ (60.33±2.96). All the values were above minimum acceptable percentage normal [63] except $B_{PTL}$which was marginally below. Oil palm leaves feeding may have increased normal sperm cells.

Percent abnormal sperm cells ranged from 36.80±2.35 ($C_{OPL}$) to 40.23±2.33 ($B_{PTL}$). There were no differences ($p>0.05$) among treatment groups for percentage of abnormal sperm cells.Morphological defects are associated with increases in DNA fragmentation, structural chromosomal aberrations, immature chromatin, and aneuploidy. In this study, the abnormality values werewithin acceptable limits for sperm cells [63].

Active sperm cells (%) showed significant differences ($p<0.05$) among treatment means. Group $C_{OPL}$ had the highest value (71.06±2.26)while group $B_{PTL}$ had the least (41.66±1.66). However, group $D_{PTL+OPL}$ value was not different ($p>0.05$) from that of group $A_{CML}$ (54.33±2.96). These values were below those reported for four breeds of rabbit, including New Zealand White breed in Nigeria[62] but within the range for rabbits fed *Azadiractaindica* leaves [7]. Active sperm cells of less than 10% is a problem that could be due to ultrastructural defects and subsequently, male infertility[63]. In this case, the least value was 41.66% for rabbits fed only plantain leaves. Values indicate that feeding oil pam leaves to rabbits may improve sperm motility and male fertility, followed by those fed calopogonium and combination of oil palm leaves and plantain leaves.

The percentage of sluggish sperm cells ranged from 9.98±1.44 ($C_{OPL}$) to 10.96±1.66 ($B_{PTL}$). There were no differences ($p>0.05$) among these values across treatment groups. The values were also within the range reported for rabbits in Nigeria[62].

There were significant differences in the percentage dead sperms. Group $C_{OPL}$ had the lowest number (11.33±0.92) while group $B_{PTL}$ had the highest number (36.66±1.01). Nevertheless, the value of group $B_{PTL}$ was not different ($p>0.05$) from that of group $A_{CML}$ (35.00±0.88). Compared to values obtained from supplementing seaweed in rabbit diets, these values were high. Differences may be due to type of forage used. In this study, oil palm leaves fed rabbits had the least dead sperm cells while plantain leaves and calopogonium fed rabbits had the most. Differences may be due high polyphenols and antioxidants in oil palm leaves [27]that may have improved the livability of the sperm cells.

Sperm concentration (x $10^{8}$/mL spermatozoa) ranged from 20.98±0.05 ($A_{CML}$) to 21.10±0.08 ($D_{PTL+OPL}$). There were no differences ($p>0.05$) in sperm concentration among treatment groups. The values were also within normal range for New Zealand rabbits in Nigeria[62].

## IV. Conclusion

Blood chemistry and semen quality of rabbit bucks fed plantain, oil palm and *Calopogoniummuconoides* foliage were assessed. Blood clotting, immune response,sperm motility and viability, male fertility may improve if rabbit bucks are fed oil palm leaves alone or combined with plantain leaves. But, the practice may increase dehydration and tamper with bone integrity. Hence, though both leaves could be fed singly or in combination, overfeeding with either of them should be avoided.

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