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Reproductive traits of rabbits fed *Ipomea asarifolia* Leaf Meal (IALM) levels in Semi-Arid Zone of Nigeria

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Abstract

Purpose: This study aimed to determine the reproductive traits of rabbit fed varying levels of Ipomea asarifolia leaf meal in the semi-arid zone of Nigeria.

Research methodology: Fourty (40) nulliparous composite grower rabbits of 10 - 12 weeks with an average body weight of 1,320 g + 20 g were used for the study. The rabbits were allocated to five dietary treatments. The research used a Completely Randomized Design in allocating the experimental animals with eight rabbits in each treatment.

Results: The results obtained in this study indicated that inclusion Ipomoea asarifolia leaf meal at 10% in rabbits' diet had a negative effect as it increased the gestation length. Rabbits fed a 7.5% IALM based diet yielded the best results on litter size (LS) and conception rate (CR). The post-partum performance revealed that kittens on treatment three (5% IALM) performed better in weight at day 7 (61.47 g) and day 21 (235.33 g), respectively. Whereas kittens in treatment five (10% IALM) were reported with the highest daily weight gain (10.09 g) and pre-weaning mortality (38.84%). Does fed 10% IALM based diet performed better (720.10 g) in milk yield. The results of the morphometric traits were mostly not affected by an increased level of MGLM except for tail length (TL), length of the front leg (LFL), and shoulder to tail drop (STT) that have the highest value in rabbits fed 5% MGLM based diet, and nose to shoulder (NTS) and length of the back leg (LBL) that had highest figures in rabbits fed 10% MGLM.

Limitations: This research only focused on the effect of the test material on reproductive traits and body Morphometry, yet there might be an effect on blood parameters and serum hormones concentration.

Contribution: This research will help the farmers involved in Animal production.

Keywords: *Ipomea asarifolia, Rabbits, Reproductive, Traits*

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1. Introduction

Rabbits production contributes more by cushion the level of food shortages (Baruwa, 2014). High reproductive performance, attainment of maturity at an early age, the little size of the body, and rate growth are favourable factors of rabbits' production in comparison to broiler birds (Rao et al., 1977). Rabbit has appreciable genetic potential, feed utilization efficiency, low land space requirements, low

competition with humans for grains, and a high nutritive value of meat (Arijeniwa et al., 2000). It can cater the needs of an average family and is a suitable and affordable alternative of protein source to households in Nigeria (Ogbonna, 2015).

Reproductive potentials and kits survivability determine the profitability of rabbits (Castellini et al., 2010). Kits kindles per parturition are the reproductive and economic traits considered most in the rabbit industry (Belhadi 2004; Nofal et al., 2005). According to Moce and Santacreu (2010), litter size at weaning is used in selecting maternal lines as it reflects the fecundity and broodiness of the rabbit doe. Rabbits are commonly fed with forages like groundnut and cowpea hay, but their cost increases due to high utilization by ruminant animals (Ogbonna, 2015). Therefore, there is a need to identify alternative feedstuffs like *Ipomea asaripolia* which can be used to feed rabbits to lower its production cost.

The present shortage of monogastric animal feeds has been blamed on the ever-increasing cost of the feed ingredients (Esonu *et al*., 2001). Madubuike and Ekenyem (2001) reported 70 - 80% of the increased feed cost mainly from protein concentrates. This phenomenon is a sequel to the increasing competition between man and animals for available grains (Tegbe *et al*., 1984; Madubuike, 1988). There is inadequate production of farm crops to meet the needs of man and his livestock (Esonu *et al*., 2001). The threat of desert encroachment in many parts of the West African Sub-region had destroyed the vegetation and depleted the livestock population (Madubuike, 1992).

Reproductive activities such as regular cycling and ovulation are encouraged by adequate nutrition (Sharp *et al*., 2007). It is well documented that farm animals' reproductive well-being and performance are largely dependent on their nutritional status (Raji and Njidda, 2014). Evidence from the literature suggests that nutritional factors are the most crucial in terms of their direct effect on reproductive phenomenon and can moderate the effects of other factors (Rekwot *et al*., 1987; Alabi, 2005; Kheradmand *et al*., 2006). Body live weight is important in determining the growth rate of an animal and its price during the sales period in farms and markets at pre- andpost-weaning ages. Body measurements of animals have been extensively used to characterize and evaluate breeds of animals (Salako and Ngere, 2002).

Ipomea asarifolia belongs to the family *Convolvulaceae*, also called morning glory. It's a succulent perennial plant trailing on the ground. In Nigeria, the traditional names of *Ipomea asarifolia* is known in the Hausa language as "Duman Karda" (Kaduna), "Duman rafi" (Kano) and "Woba boje" or "Daadi mayo" (Adamawa), and "Gboro Ababa" in Yoruba language (Jegede et al., 2009). In Nigeria, the leaf of *Ipomea asarifolia* is not generally consumed by either humans or livestock. It mostly grows like a weed and is popularly used as compost materials, ethnoveterinary and human medicine practice and mulch (Nasir et al., 2018).

2. Review on the effects of *ipomea asarifolia* on the performance of rabbits

Nasir *et al*. (2018) reported higher feed intake and body weight gain in rabbits fed with 0% and 5% of morning glory (Ipomea asarifolia) than those fed 10 and 15%, respectively. Similarly, the feed conversion ratio (FCR) of the control diet and that of 5% inclusion level was better when compared with those fed 10 and 15% morning glory (*Ipomea asarifolia)*, this is an indication that animals can only utilize *Ipomea asarifolia* at lower inclusion level (Nasir *et al*., 2018). Ekenyem and Madubuike (2006) reported similar results of higher feed conversion ratio in chickens fed with 0 and 5% morning glory (*Ipomea asarifolia)* compared to those fed 10 and 15%. The research also reported that rabbits that consumed the highest level of morning glory *(Ipomea asarifolia)* (10 and 15%) had the highest mortality rate of 29%. Compared to those that consumed 0 and 5%, which survived more with 0% mortality as reported by (Nasir *et al*.,2018).

The carcass characteristics such as live weight, slaughter weight and dressing percentage values of those fed control diet and 5% morning glory *(Ipomea asarifolia)*were significantly different ($P<0.05$) from those fed 10 and 15% morning glory *(Ipomea asarifolia)* (Nasir *et al*., 2018). Ekenyem and Madubuike (2006) also reported a decreasing value in carcass characteristics of chickens with

increasing values of Morning glory *(Ipomea asarifolia)* leaf meal. Ekenyem and Madubuike (2006) reported apparent alopecia and stunted growth in chickens fed 15% morning glory leaf meal, but no mortality was recorded. Yellow pigmentation was also noticed on the shanks, beaks and skin of the experimental birds with the increased concentration level of morning glory leaf meal. Nasir *et al.* (2018) reported increased weight of the liver in rabbits fed 10 and 15% levels of supplemented morning glory *(Ipomea asarifolia),* showing significant effects of antinutritional factors contained in *Ipomea asarifolia* on the experimental animals. The liver enlarged in order to cope with detoxification of the phytochemicals in the morning glory (Ekenyem and Madibuke, 2006).

3. Research methodology

Site of the experiment

The experiment was carried out at the Rabbitry unit of the Department of Animal Science, Kano University of Science and Technology, Wudil, Kano State, Nigeria. The area lies between the longitude and latitude of 8^0 51" East and 11^0 49" North, with an average altitude of 403 meters above sea level. The mean rainfall ranges from 850 - 870 mm annually, while the temperature is 26 ^{0}C and 33 ^{0}C at the minimum and maximum levels, as reported by Olofin *et al.* (2008). The environment is conducive for different species of livestock and is favored with abundant grassland for grazing.

Preparation of Ipomea asarifolia leaf meal

Fresh and blooming Morning Glory (*Ipomoea asarifolia*) leaves were harvested from the bush section of Kano University of Science and Technology Wudil premises and environs. The leaves were dried in a well-ventilated area for 3 - 5 days while retaining their normal green colour. After drying, the leaves were then grounded to produce the leaf meal.

Source and composition of the experimental diet

The concentrate feed ingredients used for the experiment were purchased from Albarka commercial feed suppliers in Kano. The ingredients include soybean meal, wheat offal, bone meal, salt, vitamin premix, methionine, and lysine.

Diets used in the experiment

Five (5) diets were formulated for the experiment; T_1 with non-inclusion of *Ipomea asarifolia* leaf meal (IALM), while T_2, T_3, T_4, and T_5 contained 2.5, 5, 7.5, and 10% inclusion level of *Ipomea asaripolia* leaf meal (IALM), respectively as shown in Table 1 below. According to the National Research Council recommendation, the diet has met the nutrients required by the rabbits (NRC,1998).

Table 1. Diets' composition used in the experiment

Ingredients	**T1 (0%)**	**T2 (2.5%)**	**T3 (5%)**	**T4 (7.5%)**	**T5 (10%)**
Maize grain	36.13	34.88	33.63	32.38	31.13
Soybean meal	14.72	13.47	12.23	10.99	9.72
Morning glory	0.00	2.50	5.00	7.50	10.00
Groundnut hay	25.00	25.00	25.00	25.00	25.00
Wheat offal	20.00	20.00	20.00	20.00	20.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Salt	0.30	0.30	0.30	0.30	0.30
Vitamin premix	0.50	0.50	0.50	0.50	0.50
Methionine	0.60	0.60	0.60	0.60	0.60
Lysine	0.75	0.75	0.75	0.75	0.75
Total	**100**	**100**	**100**	**100**	**100**
Calculated Analysis					
Crude protein (%)	18.00	17.72	17.43	17.16	16.63
ME Kcal/kg	2,479.78	2,438.64	2,397.38	2,356.65	2,314.87
Crude fibre (%)	29.01	27.31	26.97	26.66	26.31
Ether extract (%)	1.66	1.64	1.61	1.58	1.50

Experimental animals and their management
Forty (40) nulliparous composite grower female rabbits' age are 10 - 12 weeks, with a mean body's weight of 1,320 g $\pm$ 20 g were used for the study. The animals were sourced from the Department of Animal Science, Kano University of Science and Technology, Wudil. Each rabbit was housed individually in a separate wire-mesh cage in an indoor pen. They were injected with Ivermectin (Kepromec®) for treating parasites at a recommended dosage by the manufacturer. They were also given anti-coccidial prophylaxis using Embazin - Forte at a dose rate of 30 g / 50 liters of drinking water for 3 days and Oxytetracycline powder (Samoxine) for protection against disease-causing organisms. The rabbits were fed control diets *ad libitum* for one (1) week of physiological adjustment. Fresh, clean, and cool water was provided for the period of the experiment.

On the 25th day of pregnancy, nest boxes were supplied to help the does in preparing a warm, comfortable nest for receiving their litter. Kits were handled with disposable nylon hand gloves to prevent rejection of the kits by the dams.

Design and procedure used
Forty (40) experimental rabbits were divided into five (5) treatments of eight (8) rabbits in each treatment using Completely Randomized Design (CRD).
The Statistical Model:-
$Yi = \mu + Tij + eij$
Where: Yi = the effect of the jth observation in the ith treatment
μ = population mean
Ti = ith treatment effect where i = 1,2, …..
eij = random error associated with jth observation in the ith treatment

Duration of the research
After balancing for weight and a one (1) week physiological adjustment, the rabbits were assigned randomly to the five dietary treatments of eight rabbits in each treatment in a feeding trial that lasted for 15 weeks.

Mating of the does
According to the mating plan, each doe was transferred to the cage of the assigned buck to be mated and returned to its own cage. Abdominal palpation was conducted on the 14th day after successful mating to ascertain the pregnancy. Non - pregnant does were put up for re-mating until conception is achieved.

Data collection
Female reproductive trait
After successful mating, the conceived does were maintained to full gestation and the following parameters were determined:

i. Gestation Length (GL): Counted in days from the date of successful mating to the date of kindling.
ii. Litter size (LS): Is the number of kittens kindles at a single birth.
iii. Litter weight at birth (LBW): This is the cumulative weight of the kittens at birth.
iv. Average kit weight (AKW): This is the average weight of an individual kit at birth.
v. Total litter weight (TLW): This is the cumulative weight of litter in each treatment.
vi. Conception rate (%): Were recorded as the percentage of the does conceive in each treatment after mating.

Post-partum performance of the kittens
The female does were maintained on their respective diet through a period of gestation to 21 days of postnatal period where weight of the kittens at 7th, 14th and 21st days were determined, respectively. Daily weight gains of the kittens, pre-weaning mortality (%), and milk production of does were also determined.

Doe's milk yield determination
The milk yield of the doe was estimated using the equation drawn by Fortun - Lamothe and Sabater (2003).
Milk yield 0 - 21 d (g) = 1.69 X weight gain of litter 0 - 21 d (g) + 362 (r = 0.91)

Determination of morphometric traits
Ten (10) biometric traits were measured on each rabbit doe. The anatomical reference points were in accordance with standard zoometrical procedures (Gueye *et al.*, 1998; Teguia *et al.*, 2008). The measurements were taken using a measuring tape in a centimeter.

Body length (BL)
This is described as the distance between the most cranial palpable spinous process of the thoracic vertebrae and either sciatic tubers or the distance between the tops of the pelvic bone.

Ear length (EL)
This is measured from the base of the ear to the zygomatic arch.

Tail length (TL)
This is obtained from the base of the tail to the tip (coccygeal vertebrae).

Chest circumference (CC)
This is referred to the body circumference and was determined by just behind the forelegs.

Nose to shoulder (NS)
It is the distance from the nose to the point of the shoulder.

Shoulder to tail-drop (STT)
This is the distance covered from the point of the shoulder to the pin bone (otherwise called coccygeal vertebrae).

Height at withers (HW)
This was taken using a graduated measuring stick in a centimeter (cm).

Thigh circumference (TC)
This refers to the circumference of the thigh.

Length of front and back leg (LFL and LBL)
This is achieved by measuring the length of the front and back legs.

Data analysis
The obtained data were subjected to one - way analysis of variance (ANOVA) using the general linear model procedure of System Analytical Software (SAS, 2003), where a significant difference between the means exists, Tukey's Studentized Range (HSD) test was used to separate the means. Pearson moment correlation analysis was determined using the SAS CORR procedure of SAS 9.0 (2003).

4. Results and discussions

Reproductive traits of the does
Table 2 indicated the effect of IALM on the reproductive traits of female rabbits. The gestation length was significantly higher ($P<0.05$) in animals fed with a 10% IALM based diet than rabbits on the other treatments. The gestation length recorded in this study agreed with Farghly et al. (2016), who reported 31 days as a gestation length of rabbits. Rabbits on 10% IALM had the highest (38 days) gestation length, probably caused by the antinutritional factors present in the diet. With regards to that, Holm (1967) reported that ingestion of toxic shrubs prolong pregnancy.

Litter size was higher significantly (P<0.05) in rabbits on 7.5% IALM based diet compared to other treatments but statistically similar (P>0.05) with those on 5%, 2.5%, and control diets (0%). The litter size (4.17 - 5.17) recorded in this stud concurred with the finding of Odeyinka et al. (2008), who reported a range of 4.06 - 5.8. This implies that IALM can increase ovulation, thereby resulting in increased conception rate and litter size.

The average kittens' weight (AKW) was significantly higher (P<0.05) when 5% IALM based diet was included in comparison with the rest of the treatments but statistically similar (P>0.05) to the rabbits on treatments 1 and 5. There was no significant difference (P>0.05) in litter birth weight among all the treatments. The litter birth weight ranged between 93.11 - 112.89 g. This disagreed with the results of Hassanat et al. (2006), who recorded a litter birth weight of 137.19 - 180.30 g. More so, total litter weight was significantly higher (P<0.05) in rabbits fed with 2.5% IALM based diet but statistically similar (P>0.05) to the rabbits on treatment 1 and 4.

The present study showed that the kit's birth weight was inversely affected by its litter size. This may be due to the maternal nutrients distributed to a small number of young is sufficient for each young to achieve optimum intrauterine growth rate than when distributed on much litter. This means that the decrease of nutrients supplied to each kit negatively affects its intrauterine growth rate, leading to eventually small birth weight. It may also be due to the crowdiness of large litter inside the uterus, which might also affect growth. Mahmoud (2013) reported a similar trend with regards to kit birth weight.

The conception rate (Fig. 1) was reported to be at the apex (100%) in rabbits fed with a 7.5% IALM based diet, while the lowest (66.67%) was recorded in rabbits fed with a control diet (0% IALM). Oshibanjo et al. (2018) reported a 100% conception rate in rabbits fed 10% Moringa leaf meal.

Table 2. Reproductive traits of female rabbits

Parameters	**T1(0%)**	**T2(2.5%)**	**T3(5%)**	**T4(7.5%)**	**T5(10%)**	**SEM**
GL (days)	31.17^{b}	31.67^{b}	31.34^{b}	31.33^{b}	38.00^{a}	0.84
LS	4.33^{ab}	4.50^{ab}	4.67^{ab}	5.17^{a}	4.17^{b}	0.43
LBW (g)	101.94	112.89	89.06	105.71	93.11	13.30
AKW (g)	23.09^{ab}	21.13^{b}	25.77^{a}	21.41^{b}	24.39^{ab}	1.90
TLW (g)	611.67^{a}	677.34^{a}	534.27^{b}	634.27^{a}	461.58^{b}	37.34
CR (%)	66.67	83.33	83.33	100	83.33	-
SB (%)	0.00	0.00	0.00	0.00	0.00	-

^{abc} Means in the same raw with different superscript are the significant difference (P<0.05), SEM= Standard error of means, GL= Gestation length, LS=Litter size, LBW= Litter birth weight, AKW=Average kit weight, TLW= Total litter weight, CR= Conception rate, SB= Still birth.

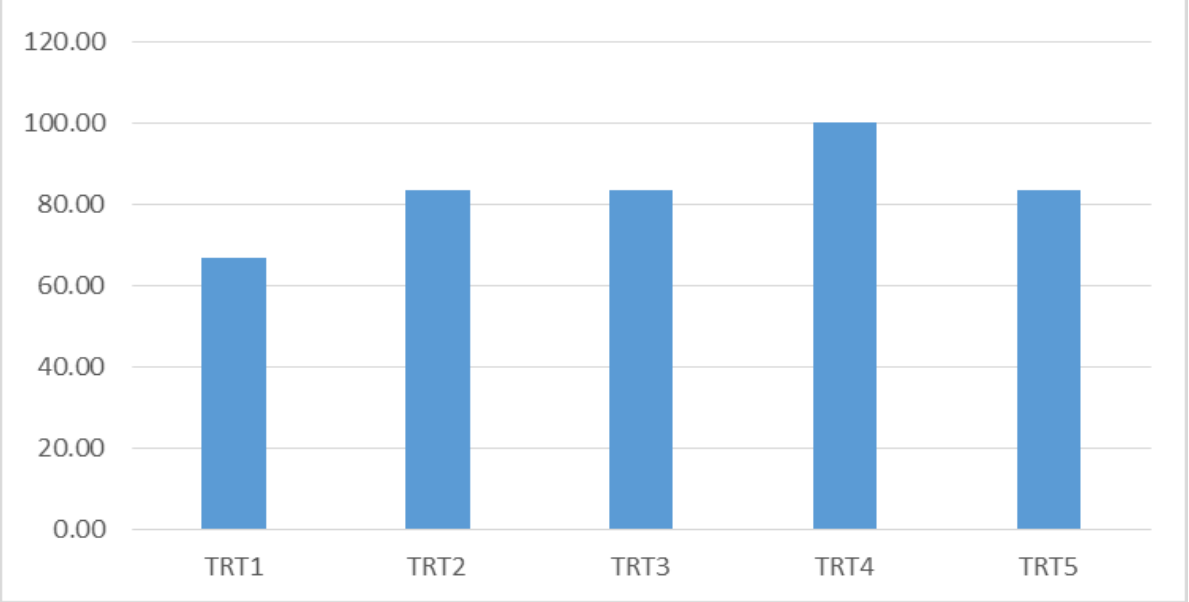

Figure 1. Conception rate (%) of rabbits fed varying levels of IALM based diet

Post-partum performance of the kittens and doe milk yield

The results of the post-partum performance of kittens and doe milk yield are presented in Table 3. The weight of the kittens was measured on days 7, 14, and 21. The weight of the kittens at day 7 ranged between 36.89 - 61.74 g and was significantly ($P<0.05$) higher in treatment three (5% IALM) but similar ($P>0.05$) to those on treatment one (0% IALM), two (2.5% IALM), and five (10% IALM). This disagreed with Akinmuyisitan et al. (2015), who reported 90.74 - 98.63 g as the kittens' weight on the 7th day. Moreso, kittens on treatment three (5% IALM), had significantly ($P<0.05$) higher weight on day 14 compared with kittens on the other treatments but similar ($P>0.05$) with kittens on treatments two (2.5% IALM) and five (10% IALM). However, the weight of the kittens at day 21 was significantly higher ($P<0.05$) in kittens on treatment two (2.5% IALM) but similar ($P>0.05$) with kittens on treatment three (5% IALM) and five (10% IALM), respectively.

The daily weight gains of kittens in treatment five (10% IALM) was higher significantly ($P<0.05$) than those in treatment one (0% IALM) and four (7.5% IALM) but similar ($P>0.05$) with those in treatment two (2.5% IALM) and three (5% IALM). Akinmuyisitan et al. (2015). The result on daily weight gain of the kittens of this research was inconsistent with Guo et al. (1993), who reported that the dietary rare earth element caused an increase in daily weight gain by about 8 - 10% and 4 - 8% in pigs and chickens, respectively. Adu et al. (2009) reported an improvement of 4.4 - 13.5% in rabbits' daily weight gain fed diet supplemented with the rare earth element. Xu et al. (1999) recorded the same results in growing pigs. The weight gain from kindling to 21 days post-partum could be caused because IALM improves the utilization of nutrients in the diets and increases digestive fluid secretion, which leads to an increased digestibility and thereby influences the gain in live weight.

Does milk yield was significantly higher ($P<0.05$) in rabbits fed with a 10% IALM based diet in comparison to those in treatment one (0% IALM) and four (7.5% IALM), though statistically similar ($P>0.05$) with rabbits on 2.5 and 5% IALM based diets? The doe milk yield was within the range of 580.02 - 720.1 g. The result of this study is lower than that of Odeyinka et al. (2008), who reported a milk yield of 646 - 836 g in rabbits but higher than that of Akinmuyisitan et al. (2015), who reported milk production of 116.61 - 136.73 in doe fed rare earth element.

Pre-weaning mortality (Fig. 2) was recorded to be higher (38.84%) in rabbits fed 10% IALM, while the lowest value (14.76%) was recorded in 7.5% IALM inclusion level. The pre-weaning mortality in this research was lower than that of Mostari et al. (2006), who recorded 26 - 45%, and Chrystosome et al. (2011), who reported a mortality rate in Hyla rabbit of 25% in Benin republic. Higher pre-weaning mortality has been reported by Tuma et al. (2010). Similarly, losses experienced during the rearing

may result from young freezing, pulled out from the nest by some active does, or diseases. Higher (38.86%) pre-weaning mortality recorded on 10% IALM might also be caused by a low maternal transfer of immunoglobulin G into the foetus during gestation, which virtually might have led to low immunity in the kittens and predisposed them to disease attack.

Table 3. Postpartum performance of the kittens and does milk production

Parameters	T1 (0%)	T2 (2.5%)	T3 (5%)	T4 (7.5%)	T5 (10%)	SEM
Wt at 7 (g)	58.29^{a}	57.74^{a}	61.47^{a}	36.89^{b}	56.01^{a}	5.24
Wt at 14 (g)	100.15^{bc}	160.25^{a}	146.91^{a}	89.44^{c}	146.68^{ab}	24.66
Wt at 21 (g)	187.80^{bc}	229.79^{ab}	235.33^{a}	176.34^{c}	234.77^{a}	21.29
DWG (g)	7.78^{bc}	9.85^{ab}	9.91^{a}	7.56^{c}	10.09^{a}	1.08
DMY (g)	580.02^{b}	712.65^{a}	716.79^{a}	630.28^{b}	720.10^{a}	39.94
PWM (%)	28.67	16.36	25.71	14.76	38.84	-

^{abc} Means in the same row with different superscript are significantly different (P<0.05), SEM= Standard error of means, Wt at7= Weight at day 7, Wt at 14= Weight at day 14, Wt at 21= Weight at day 21, DWG= Daily weight gain, DMY= Doe milk yield, PWM= Pre-weaning mortality.

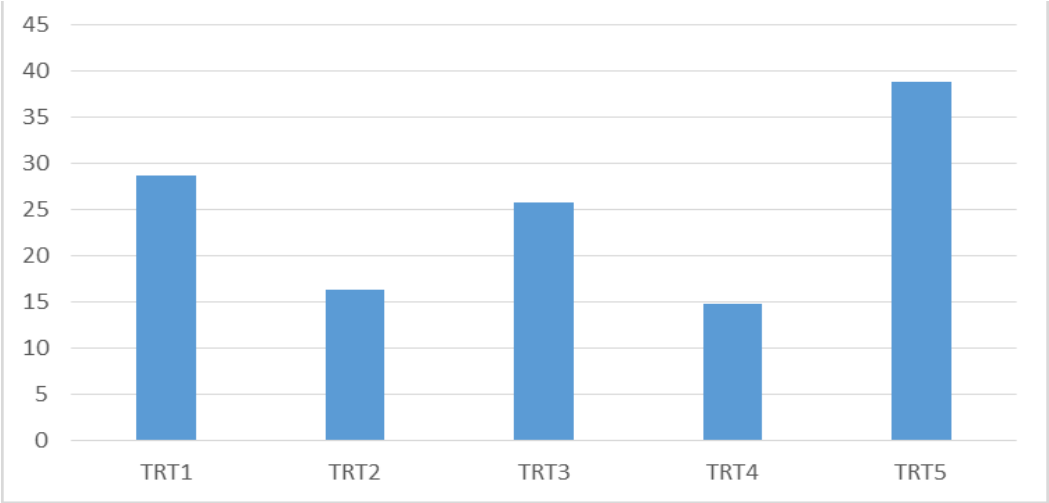

Figure 2. Pre-weaning mortality (%) of kittens under varying levels of IALM based diet

Body weight and morphometry of rabbits

The results of body morphostructural traits of rabbits fed varying levels of MGLM based diet are presented in Table 4. No significant (P>0.05) effects were recorded in body weight (BW), body length (BL), ear length (EL), chest circumference (CC), height at wither (HW), and thigh circumference (TC) between the rabbits fed different levels of MGLM based diet. The rabbits under 5% MGLM based diet had a significantly (P<0.05) higher mean value for the tail length (10.67 cm) compared to other treatments, but similar with rabbits fed 7.5% MGLM (10.23 cm). Similarly, shoulder to tail drop (STT) was significantly (P<0.05) higher (31.18 cm) in rabbits on a 5% MGLM based diet compared with rabbits on the other treatments but statistically similar (P>0.05) with rabbits on 10% MGLM based diet (28.20 cm).

Rabbits fed a 7.5% MGLM based diet had a significantly (P<0.05) higher value on the nose to shoulder (10.47 cm) compared to rabbits on other treatments but statistically similar to rabbits fed with 10% MGLM based diet. Length of the front leg (LFL) was significantly higher (P<0.05) in rabbits on 5% MGLM based diet (15.95) compared to other treatments but statistically similar to the rabbits on 10% MGLM based diet (15.92 cm). Length of the back leg (LBL) was significantly (P<0.05) higher in rabbits fed with a 10% MGLM based diet (24.02 cm) but statistically similar with rabbits on 2.5, 5 and 7.5% MGLM based diets.

The results obtained in this study were almost similar to that of Oludayo (2012), who reported 10.09 cm (EL), 10.99 cm (NTS), 27.83 cm (STT), 25.36 cm (BL), 7.47 cm (TC), 8.96 cm (HW), 11.63 cm (LFL), 17.69 cm (LBL), 7.11cm (TL) in rabbit, respectively. Values obtained from this study agreed

with earlier reports of Akanno and Ibe (2005), Chineke *et al*. (2001) and Kabir (2010).

Table 4. Bodyweight (g) and morphometry (cm) of rabbits fed MGLM based diets

	Treatments					
Parameters (cm)	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**SEM**
BW (g)	1357	1375	1445	1550	1421.70	122.28
BL	22.07	21.06	22.07	21.55	22.10	0.72
EL	11.13	10.63	10.97	10.93	10.70	0.30
TL	9.17^{c}	10.05^{b}	10.67^{a}	10.23^{abc}	9.47^{b}	0.31
CC	24.77	23.98	25.10	25.13	25.12	0.66
NTS	9.8^{a}	9.05^{b}	9.40^{cb}	10.47^{a}	10.05^{ac}	0.38
STT	28.10^{b}	28.73^{b}	31.18^{a}	2.20^{b}	29.00^{ab}	1.14
HW	6.65	6.7	7.15	6.28	7.33	4.02
TC	10.12	10.95	10.60	9.63	11.05	0.88
LFL	15.25^{ab}	15.28^{ab}	15.95^{a}	14.92^{b}	15.92^{a}	0.47
LBL	22.43^{b}	23.13^{ab}	23.37^{ab}	23.60^{ab}	24.02^{a}	0.64

^{abcd} Means in the same row with different superscripts are significantly different (P<0.05), SEM = Standard error of means, BW = Body weight, BL= Body length, EL = Ear length, TL = Tail length, CC = Chest circumference, NTS = Norse to shoulder, STT = Shoulder to tail drop, HW = Height at withers, TC = Thigh circumference, LFL = Length of front leg, LBL = Length of back leg.

Correlation between reproductive traits

The result of the correlations between reproductive traits is presented in Table 5. The correlation between LBW and LS was positive and significant (r = 0.48; P< 0.05). AKW was positively correlated (r = 0.20; P> 0.05) with LBW. A negative and non – significant (r = -0.11; P> 0.05) correlation was observed between GL and LS. A negative and non – significant (P> 0.05) correlation was observed between LBW and GL. More so, the correlation observed between AKW, LS, and GL was negative and non – significant (r = -0.04 to -0.09; P> 0.05). Among reproductive traits, LBW - LS recorded the highest positive correlation of r = 0.48.

Table 5. Correlation between Reproductive Traits

	LS	**GL**	**LBW**	**AKW**
LS	-			
GL	-0.11	-		
LBW	0.48**	-0.02	-	
AKW	-0.04	-0.09	0.20	-

LB= Litter birth, GL= Gestation length, LBW= Litter birth weight, AKW= average kit weight, *P < 0.05; **P <0.01

Correlations between body weight and morphometric traits of rabbits fed varying levels of IALM

The correlation between body weight Vs. morphostructural traits of rabbits fed varying levels of MGLM based diet are presented in Table 6. BW was positively and significantly (r = 0.50 to 0.56; P<0.01) correlated with EL, BL, NTS and CC. However, correlations were observed between positive and non-significant (r = 0.02 to 0.28; P>0.05) among BW, LBL, TL, HW, and LFL.

A positive and significant correlation (r = 0.46 to 0.50; P<0.01) was observed between EL, NTS, and CC. BL was significantly and positively correlated (r = 0.48 to 0.64; P<0.01) with STT, LFL, and CC. The correlation between CC, STT, and LFL was positive and highly significant (r = 0.47 to 0.50; P<0.01). A significant and positive (r = 0.41 to 0.43, P<0.05) between CC, HW and NTS while non-significant and positive (r = 0.08 to 0.29; P>0.05) between CC, TC and LBL.

Furthermore, positive and non-significant correlation (r = 0.14 to 0.28; P>0.05) was observed between NTS, LBL, STT, LFL, and HW, while negative and non-significant (r = -0.04; P>0.05) was observed

between CC and TC. A positive and significant correlation (r = 0.40 to 0.44; P<0.05) was observed between TC, LBL, and LFL, while positive and non-significant (r = 0.30; P>0.05) between LFL and LBL.

Table 6. Correlations between body weight and morphometry of rabbits fed varying levels of MGLM

	BW	EL	BL	TL	CC	NTS	STT	HW	TC	LFL	LBL
BW	-										
EL	0.50**	-									
BL	0.50**	0.33	-								
TL	0.15	0.03	-0.07	-							
CC	0.56**	0.50**	0.64**	0.09	-						
NTS	0.51**	0.46**	0.21	-0.10	0.43*	-					
STT	0.43*	0.27	0.48**	0.26	0.47**	0.19	-				
HW	0.21	0.29	0.12	0.04	0.41*	0.28	0.12	-			
TC	-0.03	0.17	0.32	0.09	0.08	-0.04	0.05	-0.10	-		
LFL	0.28	0.46*	0.49**	-0.24	0.50**	0.27	0.26	0.09	0.44*	-	
LBL	0.02	0.23	0.33	0.29	0.25	0.14	0.30	0.31	0.40*	0.30	-

BW = Body weight, BL = Body length, EL = Ear length, TL = Tail length, CC = Chest circumference, NTS = Norse to shoulder, STT = Shoulder to tail drop, HW = Height at withers, TC = Thigh circumference, LFL = Length of front leg, LBL = Length of back leg, *P < 0.05; **P <0.01.

Correlations between reproductive traits and body morphometry of rabbits fed varying levels of MGLM

The correlations among reproductive traits and body morphometry are presented in Table 7. A positive and non-significant correlation (r = 0.01 to 0.23; P>0.05) was observed between LS, LFL, CC, TC, LBL, EL and TL. The correlation between GL and TL was positive and significant (r = 0.42; P<0.05), while positive and non-significant (r = 0.08 to 0.22; P>0.05) between GL, BL, LFL and TC. Moreso, a negative and non-significant correlation (r = -0.04 to -0.32; P>0.05) was observed between GL, LBL, STT, CC, HW, BW, NTS and BL.

However, LBW was positively and non-significantly (r = 0.01 to 0.11; P<0.05) correlated with BL, TC, LBL and TL. A negative and non-significant (r = -0.001 to -0.23; P>0.05) correlation was observed between LBW, CC, STT, HW, BW, EL, NTS and LFL. The correlation observed between AKW, LBL, NTS, EL and STT was positive and significant (r = 0.37 to 0.43; P<0.05), but positive and non-significant (r = 0.17 to 0.36; P>0.05) between AKW, CC, TL, BW, TC, LFL and BL.

Table 7. Correlations between reproductive traits and body morphometry of rabbits fed varying levels of MGLM

	BW	EL	BL	TL	CC	NTS	STT	HW	TC	LFL	LBL
LS	-0.12	0.10	-0.36	0.23	0.04	-0.10	-0.10	0.07	0.03	0.01	0.10
GL	-0.16	-0.32	0.08	0.42*	-0.09	-0.14	-0.09	-0.16	0.22	0.16	-0.04
LBW	-0.06	-0.05	0.01	0.11	-0.01	-0.17	-0.01	-0.04	0.06	-0.23	0.10
AKW	0.19	0.42*	0.36	0.18	0.17	0.41*	0.43*	-0.18	0.27	0.29	0.37*

BW = Body weight, BL = Body length, EL = Ear length, TL = Tail length, CC = Chest circumference, NTS = Norse to shoulder, STT = Shoulder to tail drop, HW = Height at withers, TC = Thigh circumference, LFL = Length of front leg, LBL = Length of back leg, LS = Litter size, AKW = Average kit weight, GL = Gestation length, LBW = Litter birth weight, *P < 0.05; **P <0.01.

5. Conclusion

The occurrence of high conception rate amongst the does and absence of mummification recorded in this study clearly indicate that there was no reproductive problem or infertility on the does in all treatments. It could be concluded that feeding growing rabbits with *Ipomea asarifolia* leaf meal (IALM) up to 7.5% inclusion level helped to enhance their reproductive performance.

Recommendations

i. It is recommended that Ipomea asarifolia leaf meal (IALM) be included in rabbits' diets at 7.5% to improve their reproductive performance and productivity.
ii. Further investigation should be carried out on feeding rabbits at 7.5, 10, and 12.5% inclusion level of Ipomea asarifolia leaf meal (IALM) over several gestation phases to assess the consistency in reproductive performance at these levels.
iii. A hormonal essay and morphological study of the female reproductive tract should be carried out on these levels to investigate whether there is severe effect of antinutritional factors to include more variables and accuracy of the investigation.

Limitations

This study worked on female doe reproductive traits. Male reproductive traits will be investigated as affected using the same test material.

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