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GROWTH AND REPRODUCTIVE PERFORMANCE OF RABBIT DOES FED *Moringa oleifera* LEAF MEAL BASED DIETS SUPPLEMENTED WITH GARLIC, GINGER OR BLACK PEPPER

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ABSTRACT

This experiment was carried out to evaluate the weight changes, blood chemistry and reproductive performance of rabbit does fed *Moringa oleifera* leaf meal (MOLM) supplemented with garlic (GR), ginger (GG) or black pepper (BP). Five diets were formulated to contain no MOLM, 6% MOLM and 6% MOLM with supplementation of either garlic, ginger or black pepper at 700g/100kg diet. Twenty five mature cross bred rabbit does were randomly allocated to the treatments in a completely randomized design. The experiment lasted for two parities. Kit weight at kindling was significantly (P<0.01) high in rabbit does fed MOLM + BP. Increased daily feed intake at 3 to 6 weeks lactation was obtained in the MOLM + diet. GR fed. Kits survival rate was significantly (P < 0.05) higher in the MOLM + GR and MOLM + GG. Total milk yield was significantly (P< 0.05) high from rabbit does fed MOLM + GG and MOLM + BP. It was concluded that 6% MOLM + 700g GR increased doe and kits average daily feed intake from 3 weeks after kindling to weaning, litter weight at kindling, at 3 weeks lactation and total milk yield. Adding 700g GR to 6% MOLM increased litter weight at weaning, kit weight at kindling and kit survival rate over 6% MOLM. 6% MOLM + 700g GG increased litter weight at 3 weeks lactation and kit weight at kindling. 6% MOLM + 700g BP, decreased litter weight at kindling and kit weight at kindling. Adding 700g BP to 6% MOLM increased total milk yield, kits survival rate and decreased litter weight at 3 weeks lactation and at weaning over 6% MOLM. Adding 700g GG to 6% MOLM increased litter weight at weaning, total milk yield and kits survival rate over 6% MOLM. It is therefore recommended that 6% MOLM + 700g GR should be fed to cross bred rabbit does in order to improve litter weight at kindling and litter weight at 3 weeks lactation by 15.4 and 3.6% respectively.

Keywords: Phytogenics, Reproduction, Does, Litter, Kits

INTRODUCTION

Rabbit is one of the most fertile mammalian farm animals capable of reproduction at the age of 17-19 weeks of life (Foldesiova *et al*., 2013). Rabbit can breed all the year round, but their reproductive performance varies with season (Iyeghe-Erakpotobor, 2001). The profitability of rabbit production as an enterprise depends on the number of rabbits kindled per doe per year and the pos natal survival of the kids (Odeyinka *et al*., 2008). Since production directly depends on reproduction, the reproductive performance of rabbits becomes an important aspect in determining the profitability of commercial rabbit breeding (Odeyinka *et al*., 2008).

Nutrition plays a major role in the optimum expression of reproduction (Sudhir *et al*., 2010). Nutrition is one of the factors that could

limit productivity especially during pregnancy and lactation (Odeyinka *et al*., 2008). Phytochemicals are natural bioactive and non-nutritive plant chemicals that have protective or disease preventive properties (Adesuyi *et al.*, 2012). *Moringa* leaves contain a wealth of essential amino acids, vitamins and minerals with higher values in their dried form than in its fresh form, except for vitamin C which is high in its fresh leaves (Fuglie, 2001). The compatibility status of garlic, ginger, black pepper and their mixtures with other feed ingredients in the diet may affect their effectiveness (Yang *et al*., 2009).

New initiatives in the livestock and pharmaceutical industries are seeking to promote the use of alternative materials that combine the effects of nutritional and medicinal properties, simultaneously (Esiegwu *et al*., 2014). There is an increasing interest in the use of natural feed additives from whole or extracts of some herbs and edible plants as safe supplements instead of chemically produced compounds. Natural antioxidants have been recognized to be better than synthetic antioxidants due to their lower cytotoxicity and tissue residue (Gupta and Sharma, 2006; Sen *et al*., 2010).

Excessive production of reactive oxygen species however, may overpower the body's natural antioxidant defense system, creating an environment unsuitable for normal physiological reactions (Al-Gubory *et al*., 2010). Antioxidants may mitigate or prevent generation of free radicals or reactive oxygen species (El-Demerdash *et al*., 2005; Ahmad *et al*., 2006; Ali *et al*., 2008).

The thermo-comfort zone for rabbits is 15 to 20 °C (Sabah *et al*., 2016). Rabbits are more susceptible to high than to low ambient temperatures especially in the tropics (Dyavolova *et al*., 2014). Temperature above the comfort zone can cause oxidative stress which can affect the fertility and other physiological traits of rabbits (Askar and Ismail, 2012). Furthermore, hypertharmia impairs cellular function (Wolfenson, *et al*., 2000) and is detrimental to the productivity and reproduction of animals (Fuquay, 1981; Morrison, 1983; Marai *et al*., 2001). High ambient temperature in the tropics decreases rabbit feed intake which leads to retardation in growth and impairment of reproduction (Oseni and Popoola, 2013).

Antioxidant supplements are observed to improve rabbit reproduction (Mangiagili *et al*., 2012). *Morinaga oleifera* leaf meal (MOLM) acts as a natural antioxidant (Anwar *et al.*, 2005). Garlic (GR) increases antioxidant defence mechanism in animals (Mansouri and Abdennour, 2011). Ginger (GG) (BP) is a strong anti-oxidant substance and may either mitigate or prevent generation of free radicals (Ahmad *et al*., 2006; Ali *et al*., 2008). Black pepper stimulates the digestive enzymes of pancrease and intestines and also increases biliary bile acid secretion as such enhances the bio availabilty of nutrients like amino acids, vitamins, beta-carotene and selenium (Ahmad *et al*., 2006). Increased antioxidant status of the reproductive tract may improve competence of oocyte or embryo development (Cerri *et al*., 2009), pregnancy and fetal development (Volpato *et al*. 2008).

This study therefore aims to determine the growth and reproductive performance of rabbit does fed *Moringa oleifera* leaf meal based diets supplemented with garlic, ginger or black pepper.

MATERIALS AND METHODS

Experimental Site

The study was carried out at the Rabbitry Unit of the National Animal Production Research Institute (NAPRI), Shika, Zaria. NAPRI is located in the Northern Guinea Savanna ecological zone (10°11´ N, 7°8´E, 650 m above sea level). The area has an annual rainfall of 1100 mm, spread from April to October (wet season). The mean minimum and maximum temperatures are 20 and 34°C (Iyeghe-Erakpotobor *et al*., 2006). The mean relative humidity during the rainy season (May - October) is 72% and during the dusty harmattan period (December – February) it drops to 21% (Tanko *et al*., 2012).

Source and Processing of Dietary Test Ingredients

Fresh *Moringa* leaf, GR and BP were obtained from Sokoto central market, while GG was obtained from Sabon Gari market, Zaria metropolis. The fresh GR, GG and BP were then chopped into small pieces with the aid of a sharp knife. The *Moringa* leaf, GR, GG and BP were then spread separately on clean fabric mats in the sun. They were constantly dried until they became crispy to touch (considered dry). The dried test ingredients were then separately grind using a milling machine. Each of the grind test ingredient was then packed in in air tight polythene bag and kept at room temperature until when used for feed formulation.

Phytochemical Analyses

Phytochemical properties were determine according to the methods of the following authors as follows; Alkaloids Harborne, (1973)., Flavonoids (Kumaran and Karunakaran, (2006)., phenols (Hagerman *et al*. 2000). Saponins (Obdoni and Ochuko, 2001) and tannins (Van-Burden and Robinson, 1981). The phytochemical components of the test ingredients is shown in Table 2

Management of Rabbit Does before the commencement of the Experiment

The rabbits were quarantined for two weeks before the onset of the experiments. During the quarantine period 1g Oxytetracycline antibiotic powder and 1 g Vitalyte powder (vitamins, micro-minerals and some essential amino acids mixture) were mixed and dissolved per litre of water and administered to the rabbits via drinking water for five days against possible bacterial infections and to alleviate stress. Thereafter, 3 mg of ivermectin tablet per rabbit was dissolved in 5 ml of clean water and a 5 ml syringe was used to administer to each rabbit against internal and external parasites. Embaxin Forte ® (Sulphaquinoxaline B.P- 9.4g; Diveridine B.P- 0.98g and vitamin K- 0.053g) was then given against coccidiosis at 0.6g per litre of water for three days and repeated after one day interval for another 3 days according to the manufacturer's instructions.

Experimental Animals, Housing and Experimental Design

Twenty five mature cross bred (age between 7 and 8 months) rabbit does with average weight (1915 ± 115 g) were used for the experiment. Each doe was housed in an individual metal cage with dimensions of 1.1m x 0.6m x 0.5m. There were five treatments with five replicates per treatment. Each doe served as a replicate in a completely randomized design. Ten mature cross bred rabbit bucks of similar weight fed the control diet were kept in separate hutches for the experiment and alternately used to serve the does. The mating was carried out within three days and no buck was allowed to mate more than twice a day. The does were alternately taken for service at the bucks hutches. Each doe was offered to a buck for service between 8 and 10a.m. The rabbits were carefully monitored to see if mating took place. After mating each doe was taken back to their hutch. The rabbits were kept under observation for two parities with a weaning period of 6 weeks respectively. Two parities with a weaning period of 6 weeks were monitored for the experiment.

Experimental Diet

Five diets were formulated with diet one having no *Moringa oleifera* leaf meal (MOLM) or spices, diet two had 6% MOLM as a complement or supplement of the diet, diet three had 6% MOLM and 700g garlic (GR), diet four had 6% MOLM and 700g ginger (GG) and diet five had 6% MOLM and 700g black pepper (BP). Table 1 shows the gross composition and calculated chemical composition of the experimental diets.

Data Collection

Growth Performance Parameters

Feed intake

The feed intake of the rabbit does was calculated by subtracting the weight of the left over feed from the weight of the feed given daily. The feed given per doe from breeding to kindling was 150g, 200g was served during lactation and 250g served to the doe and her kittens of 3 weeks to 6 weeks lactation.. In addition, a weighed quantity (50g/doe or 150g/doe and kittens) of grass hay (*Brachiaria decumbens*) was also given to the rabbits. The

feed intake of the rabbit does was monitored for two parities

Weight of Does

The rabbit does were weighed at breeding, at kindling, at 3 weeks lactation and at 6 weeks lactation.

Reproductive Performance of Does

Gestation Period and Litter Size

The number of days from service to kindling was considered as the gestation period. After kindling the kits were observed for mortality and their number counted using hand gloves.

Table 1: Feed Ingredient(s) Composition and Calculated Nutrient Analyses for Single Phytogenics Supplementation

Ingredients (%)	**Control**	**MOLM**	**MOLM+GR**	**MOLM+GG**	**MOLM+BP**
Maize	48.00	50.50	50.50	50.50	50.50
Wheat Offals	30.20	22.20	22.20	22.20	22.20
MOLM	0.00	6.00	6.00	6.00	6.00
Soya cake	18.00	17.50	17.50	17.50	17.50
Salt	0.25	0.25	0.25	0.25	0.25
Bone meal	2.80	2.80	2.80	2.80	2.80
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
*Mineral&Vitamin Premix	0.25	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100** *+700g GR*	**100** *+700g GG*	**100** *+700g BP*
Calculated Analyses					
ME (Kcal/Kg)	2649	2705	2705	2705	2705
CP (%)	18.35	18.46	18.46	18.46	18.46
Ether Extract (%)	3.61	4.10	4.10	4.10	4.10
Crude Fibre (%)	4.70	4.58	4.58	4.58	4.58
Calcium (%)	1.08	1.15	1.15	1.15	1.15
Available P (%)	0.66	0.67	0.67	0.67	0.67
Methionine (%)	0.52	0.52	0.52	0.52	0.52
Lysine (%)	1.13	1.13	1.13	1.13	1.13

*Bio-mix Broiler starter premix supplied per kg of diet: vitamin A: 5,000 I.U.; Vit D3: 1,000 I.U.; Vit E: 20mg; Vit K3: 1mg; Vit B1: 0.2mg; Vit B2: 2.4mg; Vit. B6: 2.4mg; Niacin: 16mg; Calcium Pantothenate: 4mg; Biotin:0.032; Vit B12: 0.01mg; Folic acid: 0.4mg; Choline Chloride: 120mg; Manganese: 40mg; iron: 5mg; Zinc: 18mg; Cobalt: 0.1mg; Iodine: 0.62mg; Selenium: 0.04mg. MOLM= *Moringa oleifera* leaf meal; GR= Garlic; GG= Ginger; BP= Black pepper. P= Phosphorous.

Weight and Number of Kits

The weight and number of the kits were taken immediately after kindling, three weeks after kindling and at weaning (six weeks after kindling).

Milk Yield

Milk yield was calculated at 21 days after kindling using the formular:

Milk yield (g) = 1.69 × weight gain of the litter (0-21 days) (g) + 362 (Maertens *et al*., 2006).

Percentage Survivability of Kittens

The percentage of kits survival from kindling to weaning was calculated using the formula: Number of kits alive at kindling all over the number of kits alive at weaning (6 weeks after kindling) multiplied by one hundred.

Experimental Model and Data Analyses

The following statistical model was used:

$X_{ij} = \mu + T_i + e_{ij}$.

Where: X_{ij} = individual observation on j^{th} rabbit in the i^{th} treatment.

μ = population mean

T_i = effect of the i^{th} treatment diet on the weight changes or reproductive parameters.

RESULTS AND DISCUSSION

Phytochemical Components of Moringa leaf meal, Garlic, Ginger and Black pepper.

The alkaloids, flavonoids, phenols, saponins and tannins contents of 4.17, 4.72, 1.34, 6.03 and 15.23 mg/g respectively obtained from *Moringa* leaf meal were higher than the values of 4.29 ± 0.03, 4.00 ± 0.35, 1.2 ± 0.13 , 6.80 ± 0.61 and 29.55 ± 0.42 mg/ 100g of alkaloids, phenols, tannins, flavonoids and saponins respectively obtained from *Moringa* leaf meal by Etejere *et al*. (2015). Also Ali *et al*. (2018) reported alkaloids, flavonoids, , phenols, saponins and tannin contents of 12.5% (12.5mg/g), 4.5% (45mg/g), 0.10% (1mg/g), 1.20% (12mg/g) 3.7% (37mg/g) respectively for *Moringa* leaf meal. The differences obtained among the phytochemical values in this study compared with values obtained in the literature might be attributed to the differences in analytical techniques, the ecotypes of the MOLM, garlic, ginger and BP or their methods of processing before analyses.

The values of alkaloids (1.52mg/g), flavonoids (0.78mg/g), phenols (6.6mg/g) and saponins (10.37mg/g) of garlic obtained in this study were lower than the values of 5.1, 11.3 and 45 mg/g respectively of alkaloids, flavonoids and saponins reported by Akeem et al. (2016). However tannin content of garlic (2.97mg/g) obtained in this study was higher than the value of 0.8 mg/g reported by Akeem *et al*. (2016). Ali *et al*. (2018) reported 7.2% (72mg/g), 2.18% (21.8mg/g), 0% (0mg/g), 4.3% (43mg/g) and 6.30% (63mg/g) of alkaloids, flavonoids, phenols, saponins and tannin respectively for garlic. The alkaloids, flavonoids, saponins and tannin contents of 11.1, 4.55, 2.5 and 9.4mg/g respectively obtained from ginger in this study were lower

e_{ij} = random error associated with the X_{ij}.

Data obtained from the studies were analyzed using the general linear model procedure of SAS while means separation was done using pair wise difference (Pdiff) method (SAS, 2001).

than the values of 11.3% (111.3mg/g), 5.10% (51mg/g), 0.70% (7mg/g) and 3.42% (34.2mg/g) of alkaloids flavonoids, saponins and tannins respectively reported by Akeem *et al*., (2016). Also, Otunola *et al*., (2010) reported values of 11.21% (112mg/g), 5.56% (55.6mg/g) , 0.80% (8mg/g) and 3.54% (35.4mg/g) of alkaloids, flavonoids saponins and tannins respectively for ginger. The phenols content of ginger (0.7mg/g) obtained in this study were far below the content of 42mg/g obtained by Turgay and Essen (2015).

The values of 6.26, 2.64, 9.03 and 2.49 mg/g of alkaloids, flavonoids, phenols, and tannins respectively obtained in this study for black pepper were below the values of 13.10% (131mg/g), 5.25% (52.5mg/g), 0.70% (7mg/g) and 2.2% (22 mg/g) of alkaloids, flavonoids, phenols and tannins obtained by Ali *et al*. (2018). The saponin content of 9.03mg/g obtained in this study from black pepper was however higher than the value of 0.06% (0.6mg/g) reported by Ali *et al*. (2018). Also, Ajuru et al. (2017) reported alkaloids, flavonoids, phenols, saponins and tannin contents of 0.67% (6.7mg/g), 0.57% (5.7 mg/g), 0.45% (4.5 mg/g), 0.36% (3.6mg/g) and 0.15% (1.5 mg/g) of alkaloids, flavonoids, phenols, saponins and tannins respectively from black pepper. Amongst these values, the alkaloids and flavonoids values obtained by Ajuru *et al*. (2017) were higher than the valuess obtained in this study. The saponins and tannins content obtained in this study from black pepper were higher than the values of saponins and tannins contents obtained by Ajuru *et al*. (2017). The phenols content of 4.5mg/g obtained from black pepper was however the same with the value of 0.45% (4.5mg/g) of phenols in black pepper obtained by Ajuru *et al*. (2017).

Table 2: Phytochemical Components of MOLM, GR, GG and BP (mg/g)

Parameters	MOLM	Garlic	Ginger	Black Pepper
Alkaloids	4.17	1.52	11.1	6.26
Flavonoids	4.72	0.78	4.55	2.64
Phenols	1.34	2.60	0.77	4.50
Saponins	6.03	10.37	2.5	9.03
Tannins	15.23	2.97	9.4	2.49

Growth and Reproductive Performance of Rabbit Does fed MOLM, MOLM Supplemented with Garlic, Ginger or Black Pepper

The weight changes, feed intake and reproductive performance of rabbit does fed MOLM, MOLM supplemented with garlic, ginger or black pepper is shown in Table 3. MOLM significantly ($P<0.05$) lower weight of the does at 3 and 6 weeks lactation compared to the control. This result is in contrast to the report of EL-Tazi, (2014) who reported that MOLM increased body weight of animals. This disparity might be attributed to the species of animal used or the differences in other dietary feed ingredients fed to the rabbits. MOLM + BP also significantly ($P>0.05$) reduced body weight of the does at 3 weeks lactation. This result did not agree with the report of Abou-Elkhair *et al*. (2014) and Safa *et al*. (2014) who reported that black pepper increases body weight in animals. This variation may be as a result of the differences in species and the physiological status of the animals used. On the reproductive performance of the does, it was observed that MOLM significantly ($P>0.05$) increased gestation length of does compared with the control fed does. This result is contrary to the reports of Amao *et al*., (2014) who reported no significant differences in gestation length among rabbit does fed various levels of MOLM. This could be as a result of the differences in the levels of MOLM used or the synergy among other spices ingredients in the diets used. The gestation length observed is however, within the normal gestation period of 29 to 35 days reported for rabbit does (Mc Nitt *et al*., 2013). A significantly ($P>0.05$) low milk yield was obtained from the MOLM fed does compared to the control and other treatments. This finding is contrary with the reports of Iyabode *et al*. (2014) who recorded an increased milk yield in MOLM diet. The low milk yield obtained in this experiment may be attributed to the high tannin that the MOLM of this experiment is having. Phytochemical analyses showed MOLM to have the highest quantity of tannins. Though, the tannin content was not classified into hydrolysable or condensed. Milk yield had been reported to reduce in lactating animals fed condensed tannins diet (Grainger *et al*., 2009). The significantly higher total milk yield obtained for the MOLM + GR, MOLM + GG or MOLM + BP fed diets showed that these spices have beneficial effect on milk yield probably because of their antioxidant properties, as antioxidants have been reported to increase milk yield of rabbit does (Abdel-Khalek *et al*., 2008; Abdel- Azeem, 2010). Feed intake at 3 - 6 weeks lactation was significantly ($P<0.05$) higher in the MOLM + GR does and kittens compared with does and kittens fed MOLM and MOLM supplemented with ginger or black pepper.

Litter Characteristics from Rabbit does fed MOLM, MOLM Supplemented with Garlic, Ginger or Black Pepper

The litter characteristics from rabbit does fed MOLM, MOLM supplemented with garlic, ginger or black pepper is shown in Table 4. Significantly higher litter weight at kindling obtained from the MOLM + GR, MOLM + GG or MOLM + BP fed does over the MOLM fed does could be due to the added antioxidative properties of these spices, as

antioxidants had been reported to increase litter weight at kindling possibly by increasing or maintaining the competency of oocytes produced at ovulation (Abdel- Azeem, 2010). Also, El- Kholy *et al*. (2012) reported significantly higher litter weight at kindling from rabbit does fed the spice *Cinnamomum zeylanicum*. Significantly (P>0.05) lower litter weight at 3 weeks lactation obtained from the MOLM fed does compared with the control fed does was not in agreement with the study of Eiben *et al*. (2004) who reported no significant differences of kits at 3 weeks lactation between rabbit does fed phytogenics and those on the control diet. This variation could be attributed to the differences in phytogenics used in the study. Significantly (P>0.05) higher litter weight at 3 weeks lactation obtained from does fed the MOLM + GR, MOLM + GG or MOLM + BP compared with the MOLM fed does could be due to the added antioxidative properties of these spices which might have caused the increased in total milk yield obtained from does on these treatments. Antioxidants had been reported to increase rabbit litter weight at 3 weeks lactation (Abdel- Azeem, 2010). Significantly (P>0.05) lower litter weight at weaning obtained from the MOLM fed does compared with the control fed does is not in agreement with Amao *et a*l. (2014) who reported significantly higher litter weight at weaning from rabbit does fed MOLM diet compared with the control fed does. This variation might be as a result of differences in the levels of MOLM used or differences in other ingredients that formed the rabbit feed. Significantly higher litter weight at weaning obtained from the MOLM + GR, MOLM + GG or MOLM + BP fed does might be related to the additional antioxidative properties of these spices, as antioxidants had been reported to significantly increase litter weight at weaning of rabbit does (Shaibu, 2014). Also, El- Kholy *et al*. (2012) reported significantly higher kit weight at weaning from rabbit does fed the spice *Cinnamomuum zeylanicum* compared with the control fed does. Significantly higher kit weight at kindling obtained from rabbit does fed MOLM + GR, MOLM + GG or MOLM + BP diets compared with the control fed does could be attributed to the added antioxidative properties of these spices. Antioxidants had been reported to significantly increase kit weight at kindling (Kalaba, 2012). Significantly lower kits survival rate obtained from the MOLM fed does compared with the control fed.

does is contrary to the findings of Zeweil and El-Gindy (2016) who reported significantly higher kit survival to weaning from rabbit does fed natural antioxidant. This disparity could be attributed to the differences in the phytogenics used. Significantly higher litter size at weaning which is an index of per cent kit survival to weaning was obtained from rabbit does fed MOLM (Amao *et al*., 2014). Significantly higher kits survival rate obtained for the MOLM + GR, MOLM + GG or MOLM + BP fed does compared with the MOLM fed does could be related to the added antioxidative properties of these spices, as antioxidants had been reported to significantly increase rate of weaning of rabbit kits (Kalaba, 2012). Significantly higher litter size at weaning which is an index of % kit survival rate was reported by Abdel-Azeem, (2010). Also, the findings of El- Kholy *et al*. (2012) revealed significantly higher kits survival rate from rabbit does fed the spice *Cinnamomum zeylanicum*.

Table 3: Weight Changes, Feed Intake and Reproductive Performance of Rabbit Does fed MOLM, MOLM Supplemented with Garlic, Ginger or Black Pepper

Parameter	Control	MOLM	MOLM+GR	MOLM+GG	MOLM+BP	SE	P
Doe Weight (g):							
At Breeding	1890 [ab]	1790 [b]	1990 [a]	1850 [b]	1820 [b]	50.64	0.04
At Kindling	2080 [ab]	2080 [ab]	2120 [a]	2000 b	2000 [b]	34.10	0.03
At 3 Weeks Lactation	1930 [a]	1780 [b]	2000 [a]	1950 [a]	1640 [c]	65.13	0.03
At 6 Weeks lactation	1900 [a]	1740 [c]	1890[ab]	1810 [bc]	1740 [c]	40.76	0.01
Gestation Length (Days)	30.80 [b]	32.30 [a]	31.00 [ab]	31.50 [ab]	31.80 [ab]	0.70	0.04
Doe Weight Change (%):							
Breeding to Kindling	10.36	16.65	6.17	8.17	10.25	5.53	0.66
Kindling to Weaning	-16.23	-14.88	-11.85	-8.75	-12.16	5.96	0.90
Doe Average Daily Feed Intake (g):							
Pregnancy	106	104	117	115	108	12.57	0.29
3 Weeks Lactation	150 [a]	133[ab]	146 [ab]	127 [b]	140 [ab]	9.69	0.02
3 – 6 Weeks Lactation (Doe & Kits)	167[b]	166[b]	206[a]	158[b]	161[b]	13.83	0.03
Total Milk Yield (g)	2001 [a]	1314 [d]	1857 [b]	1904 [b]	1590 [c]	31.32	0.03

[abcd] Means across rows with different superscripts are significantly ($P \leq 0.05$) different. SE= Standard Error; P= probability.

CONCLUSIONS:

6% MOLM + 700g GR increased doe and kits average daily feed intake from 3 weeks after kindling to weaning, litter weight at kindling, at 3 weeks lactation and total milk yield.

Adding 700g GR to 6% MOLM increased litter weight at weaning, kit weight at kindling and kit survival rate over 6% MOLM.

6% MOLM + 700g GG increased litter weight at 3 weeks lactation , kit weight at kindling.

6% MOLM + 700g BP, decreased litter weight at kindling and kit weight at kindling.

Adding 700g BP to 6% MOLM increased total milk yield, kits survival rate and decreased litter weight at 3 weeks lactation and at weaning over 6% MOLM.

Adding 700g GG to 6% MOLM increased litter weight at weaning, total milk yield and kits survival rate over 6% MOLM.

It is therefore recommended that 6% MOLM + 700g GR should be fed to cross bred rabbit does in order to improve litter weight at kindling and litter weight at 3 weeks lactation by 15.4 and 3.6% respectively.

Table 4: Litter Characteristics from Rabbit Does fed MOLM, MOLM Supplemented with garlic, Ginger or Black Pepper

Parameter	Control	MOLM	MOLM+GR	MOLM+GG	MOLM+BP	SE	P
Litter Size at:							
Kindling	5.20	5.80	6.50	5.00	4.70	2.02	0.89
3 Weeks Lactation	5.00	4.00	6.00	5.00	4.00	2.91	0.50
Weaning	5.00	3.50	5.20	4.30	4.2 0	2.71	0.21
Litter Weight (g) at:							
Kindling	207 ^{d}	213^{cd}	282^{a}	225 ^{c}	257 ^{b}	7.08	0.04
3 Weeks Lactation	1075 ^{b}	777 ^{c}	1158 ^{a}	1150 ^{a}	983 ^{b}	30.59	0.02
Weaning	2867 ^{a}	1673 ^{d}	2755 ^{b}	2263 ^{c}	2192 ^{c}	93.4	0.02
Kit Weight (g) at:							
Kindling	40 ^{cd}	36 ^{d}	44^{bc}	46 ^{b}	57 ^{a}	2.15	0.01
3 Weeks Lactation	222	251	200	243	251	41.46	0.78
Weaning	573	602	529	528	572	83.76	0.20
Average Daily Weight Gain of Kit (g) at:							
3 Weeks Lactation	9	11	8	10	9	2.05	0.85
Weaning	13	14	12	12	12	2.04	0.99
Kits Survival Rate (%)	97 ^{a}	55 ^{b}	87 ^{a}	79 ^{a}	91 ^{a}	10.46	0.02

^{abcd} Means across rows with different superscripts are significantly ($P \leq 0.05$) different. SE= Standard Error; P= probability.

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