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Effects of *Piper nigrum* and *Piper guineense* as a feed additive in the ration on reproduction and pre-weaning growth performance in cavy (*Cavia porcellus* L.)

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ABSTRACT

Aim: The study was aimed to evaluate the effects *Piper nigrum* and *Piper guineense* as a feed additive on the reproductive and pre-weaning growth performance of cavies.

Method and materials: Four groups of 15 females and 3 males each, for a total of 72 cavies weighing 450±50 g were used. Post-*partum* growth performance was recorded in females and pre-weaning growth in pups from parturition to weaning. The control ration assigned to animals in group 1 (T0) did not contain pepper. Animals in groups 2 (T1); 3 (T2) and 4 (T3) received 0.5% Piper nigrum powder; 0.5% *Piper guineense* meal and 0.25% *Piper nigrum* meal + 0.25%*Piper guineense* meal, respectively. In addition, *Trypsacum laxum* grass associated with each ration was weighed before being served.

Results: Findings revealed that the control (T0) allowed the females to obtain the best fecundity (172.73%) and fertility (84.61%) rates. In addition, the dry matter (DM), organic matter (OM), crude protein (CP) and crude fibre (CF) intake was comparable between animals receiving T0 and T2 rations on the one hand, and between animals receiving T1 and T3 rations on the other hand. In addition, the females receiving the T0 ration had the lowest average weights throughout lactation, while the average weights of lactating females on the T1, T2 and T3 rations remained comparable and higher.

Conclusion: The use of black pepper meal in the ration can be considered at a rate of 0% for good feed intake and better reproductive performance and up to 0.5% for better growth (postpartum and preweaning of the young cavy).

Keywords: Cavy, feed additive, *piper guineense, Piper nigrum*, pre-weaning growth, reproduction.

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Introduction

The development of mini-livestock, like cavy farming, which is a real guarantee of food security and constitutes an important secondary source of income for poor populations, appears to be one of the essential solutions for combating malnutrition in developing countries. However, in Cameroon, in village farming, these animals feed on kitchen waste and crop residues that often have deficiencies in essential nutrients resulting in low production and early mortality (Nguedia *et al*., 2019).

According to Miégoué *et al*. (2016), one solution would be to maximize the contribution of forages, including legumes, in the feed of these animals. Unfortunately, these forage species are mainly composed of cellulose, hemicellulose and lignin that only the action of microorganisms can hydrolyze and then ferment if the caecal environment is healthy (Michelland *et al*., 2012).

Thus, chemicals among which antibiotics with a broad spectrum of action, used to sanitize digestive environments have developed in animals enteropathies such as diarrhea and problems of constipation or meteorism (Losson, 2013; Miégoué *et al*., 2019). In response to these dysfunctions, many additives from natural plants have seen a strong increase in their use due to their great diversity and varied biological activities (Aouadi and Salem, 2012). This is the case, among others, of the studies of Mba *et al.* (2020) and Tatsinkou *et al.* (2020), respectively with ginger (*Zingiber officinalis*) powder, Curcuma longa and avocado (*Persea americana*) kernel extracts, with direct consequences of improved female reproductive parameters with ginger and Curcuma longa

powder and improved average and total weights of animals at birth and weaning with rations containing avocado kernel extracts.

In addition to these additives, some spices such as black pepper (*Piper nigum* and *piper guineense*) contain secondary metabolites with significant selective antimicrobial activity. This property can reduce the harmful bacterial populations present in the gastrointestinal tract (Benchaar *et al.,* 2008) by causing a controlled multiplication of bacteria useful in digestion. It has been revealed that this spice contains certain alkaloids such as piperine, implicated in the improvement of fertility (Zodape *et al.* 2020). In some African countries such as Nigeria, *Piper guineense* is used as a medicine to treat stomach ache and gonorrhea, while the leaves are consumed in soups for fertility enhancement in women (Mensah *et al*., 2008). Indeed, according to a study conducted by Zodape *et al.* (2020), the fertility rate in female rats submitted to rations containing 50 mg *Piper guineense* and 100 mg *Piper nigrum* was higher than the rate obtained with animals submitted to the group not containing it. These results were justified by the fact that piperine, a natural alkaloid from these two peppers, would induce the release of epinephrines involved in the improvement of fertility.

In view of the numerous properties mentioned above, the use of *Piper nigrum* and *Piper ganeense* could boost fertility and growth in guinea pigs. As very little information exists for this effect, the present study was initiated with the objective to evaluate the effects of the inclusion of black pepper powder in the ration, on the reproductive and growth performance of the guinea pig.

Materials and Methods

Study area

The study was conducted between May and July 2022 at the Animal Production and Nutrition Research Unit (URPRONAN) of the Faculty of Agronomy and Agricultural Sciences (FASA) of the University of Dschang, with the following characteristics: 15th degree of the eastern meridian, 5° 36'- 5° 44' north latitude and 09° 85'- 10° 06' east longitude. The climate is equatorial of Cameroonian type modified by the altitude. In the locality, rainfall varies between 1500 and 2000 mm per year with an average annual temperature of around 20°C.

Plant material

The plant material consisted of two types of pepper (*Piper nigrum* and *piper guineense*) purchased from the town of Bafoussam in the West Cameroon region. These peppers (Figure 1) were ground using a mechanical machine and the powder was stored in hermetically sealed plastic bags until it was gradually incorporated into the food rations.

Fig 1: Peppers (A= *Pipernigrum* et B= *piper guineense*)

The fodder (*Tripsacum laxum*) was harvested the day before in the forage field of the University of Dschang Research and Application Farm, stored in one of the boxes in the rearing building and pre-milled before being served to animals for next day. 100 g of the powder of each spice was taken for chemical composition analysis (Table 1) performed in the biochemistry laboratory of the University of Dschang.

Table 1: Phytochemical screening of *Piper nigrum* and *Piper guineense* powder

Photochemical screening	*Piper nigrum*	*Piper guineense*
Alkaloids	+	+
Flavonoids	+	+
Saponins	+	+
Tannins	+	+
Polyphenols	+	+
Terpenoids	+	+
Steroids	+	+

Animal material and housing

Animals (72 guinea pigs, 60 females and 12males) with an average weight of 450 ± 50g were used. They were placed in boxes located in a building made of permanent materials. Four boxes (1.25 m x 0.60 m x 0.30 m each) made of plywood were used. Each of them was covered with a wire mesh cover, preventing any threat to the animals by predators. The floor was covered with dry, untreated white wood shavings about 5 cm thick, which were replaced every seven days to prevent the

accumulation of feces and urine. Each lodge was equipped with a heating bulb to reduce humidity, two wooden feeders and two concrete drinkers.

Preparation of rations

The proportions of the different ingredients purchased from dealers for the compound feed and their nutritional values are presented (Table 2). The feed formula was based on the theoretical requirements of guinea pigs reported by Numbela and Valencia (2003). The formulation of the rations was preceded by the preparation of the pepper powder. The pepper powder was obtained from the pepper seeds, which were previously ground with a mechanical machine to obtain a powder that was introduced at different rates as a feed additive in the compound feed in order to constitute the different experimental rations.

The control ration given to the animals of group 1 (T0) did not contain pepper powder. The animals in groups 2 (T1), 3 (T2) and 4 (T3) received 0.5% *Piper nigrum powder*, 0.5% *Piper guineense* powder and 0.25% *Piper nigrum* powder + 0.25% *Piper guineense* powder respectively in their rations. The compound and pelleted feed as well as the *T. laxum* grass were weighed before serving to the animals.

Table 2: Centesimal composition and nutritional value of the experimental ration

Ingredients	**T0**	***Trypsacumlaxum***
Corn	26	
Wheat bran	48	
Soybeanmeal	6	
Cotton cake	3	
Palm kernel cake	7	
Fish meal	6	
Bonemeal	2	
Table salt	1	
Premix	1	
Total	**100**	
Chemical composition		
Dry matter (%)	93,97	94,28
Organic matter (%DM)	88,83	84,63
Crude protein (%DM)	19,30	13,26
Crude Fibber (%DM)	9,00	37,77
Ash (%DM)	09,17	10,28
Digestible energy (kcal/kg MS)	2870	405,10

* Premix 1% flesh: Vit. A=30000 IU/kg, Vit. D3=600000 IU/kg, Vit. E=4000mg/kg, Vit. K3=500mg/kg, Vit. B1=200mg/kg, Vit. B2=1000mg/kg, Vit. B3=2400mg/kg, Biotin=10mg/kg, Vit. PP=7000mg/kg, Folic Acid=200mg/kg, Choline chloride=10000mg/kg, Ferrous Sulfate=8000mg/kg, Cupric (II) Sulfate=2000mg/kg, Manganous Oxide=1400mg/kg, Calcium Iodate=200mg/kg, Basic Cobalt Carbonate=200mg/kg, Sodium Selenite=20mg/kg, Methionine=20000mg/kg, Lysine=78000mg/kg, DM: Dry Matter,OM: organic matter; CP: crude protein; CF; crude Fiber.

Reproductive Assessment

A total of 72 cavies, including 60 females and 12 males, were used in this trial. At the beginning of the trial, the number of breeding females and their fasting weight (for 12 hours) were recorded. The females were then distributed evenly (20 per group) in each pen where they followed several successive stages: mating - gestation - parturition - lactation - weaning of the young. During gestation, the number of females having aborted was noted. The number of females that gave birth and the date of parturition were then recorded. At birth, the number of stillborn and live-born pups was recorded. The number of cavies that died before weaning and the number of weaned guinea pigs were also recorded. The amounts of feed assessed daily and served between 7:00 and 9:00 a.m. were maintained in pregnant and lactating pups until weaning 21 days after birth.

At birth, each newborn was identified with numbered ear tags. In addition, at farrowing, the mothers and their pups were weighed and then weekly until weaning. The recorded weights allowed us to determine the postpartum weight evolution of the females and pre-weaning of the pups.

- The calculated breeding parameters were as follows:
- Fertility or parturition rates= $\frac{\text{females that gave birth}}{\text{females put to stud}} \times 100$
- Size of litter= (young born)/(females having given birth)
- Weaning Viability or Weaning Rate= (weaned)/(live-born)×100
- Pre-weaning mortality rate= (piglets dead before weaning)/(piglets born alive)×100
- Fertility rate= (number of stillborn pups + number of live pups)/(females bred)×100
- Net fertility rate= (number of pups born alive)/(females mated)×100
- Viability at birth= (number of live births)/(number of births)× 100

The growth parameters calculated from the collected data were:

- Feed consumption
- Weekly weight change;
- Total weight gain (TWG) (g) = Weight of animal at the end of the period considered
- Weight at the beginning of the same period;
- Average daily weight gain (ADWG) (g/d) =TWG/(duration of the period considered).

Statistical analyses

The collected data were subjected to one-factor analysis of variance, following the General Linear Model (GLM). Means were separated using Duncan's test at the 5% significance level (Steel and Torrie, 1980). The analysis software used was SPSS 20.0.

Results and Discussion

Effects of pepper powder (Piper nigrum and piper guineense) on feed intake in female breeders

The inclusion of the different peppers in feed revealed that, the intake of nutrients was higher in the animals subjected to the control ration, compared to that of the animals subjected to the other rations (Table 3).

Effects of pepper powder (Piper nigrum and Piper guineense) on reproductive performance

The average reproductive performance of the females according to the type of spice incorporated in the ration (Table 4) revealed that the T0 ration allowed the females to obtain the best fertility rates. On the other hand, the lowest abortion rate was obtained with the T3 ration, while the highest was obtained with the T0 (control) ration.

Effects of pepper powder (Piper nigrum and piper guineense) on the weight evolution of lactating females

The variation in the average weight of lactating females during the lactation period shows that the percentage of weight loss of females fed the pepper diet (T1, T2 and T3) remained low compared to that of animals fed the ration without pepper (T0) (Fig 2). Indeed, lactating females fed the T1 ration were the heaviest and those fed the T0 ration the weakest.

Effects of pepper powder (Piper nigrum and Piper guineense) on weight development of pre-weaned cavies

The weight variation of pre-weaned guinea pigs according to the type of spice included in the ration (Fig 3) revealed that pups receiving T0 and T2 rations showed the lowest average weights throughout the trial, while the opposite trend was observed with pups submitted to T1 and T3 rations. Effects of spices (*Piper nigrum* and *Piper guineense*) on the weight of the young cavies from birth to weaning were presented (Table 5). It can also be observed that incorporation of different peppers in guinea pig diet significantly affected the weight of pups from birth to weaning but had no significant effect on total gains and average daily weight gains.

Table 3: Effects of peppers (*Piper nigrum* and *piper guineense*) on feed intake in cavies during gestation.

Ingestions (g DM/day/animal)	Treatments				p
	T0	**T1**	**T2**	**T3**	
Dry matter (DM)	83.91±11.17^{a}	72.09±5,52^{bc}	80.04±6.94^{ab}	64.89±7.27^{c}	0.01
Organnic matter (OM)	73.22±9,8 ^{a}	62.98±4,85^{bc}	69.84±6.14^{ab}	56.69±6,36^{c}	0.01
Crude protein (CP)	11.67±1.55^{a}	10.03±0.77^{bc}	11.13±0.96^{ab}	9.03±1.01^{c}	0.01
Crude Fiber (CF).	20.86±2.40^{a}	17.55±1.23^{b}	19.85±1.42^{a}	15.79±1.75^{b}	0.01

p: probability, T0: ration without pepper (control), T1: ration containing 0.5% of Piper nigrum, T2: ration containing 0.5% of piper guineense, T3: ration containing 0.25% of Piper nigrum + 0.25% of piper guineense

Table 4: Effects of peppers (*Piper nigrum* and *Piper guineense*) on average reproductive performance of cavies.

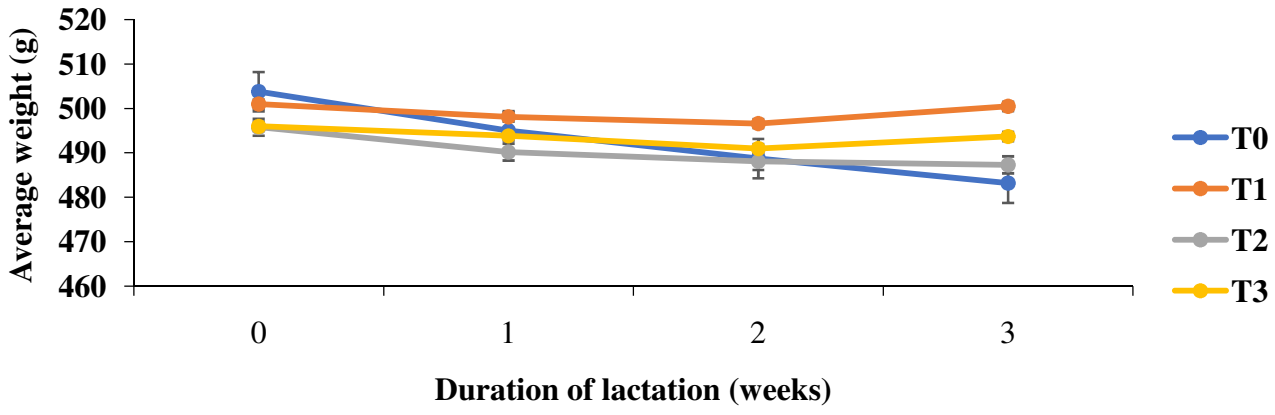
Reproductive characteristics	**Treatments**			
	T0	**T1**	**T2**	**T3**
Fertility rate (%)	84.61	66.67	69.23	66.67
Litter size	1	1	1	1
Fertility rate (%)	172.73	116.67	130.77	108.33
Net fertility rate (%)	154.54	100.00	115.38	100.00
Viability at birth (%)	100	100	100	100
Viability at weaning (%)	82.35	83.33	80.00	83.33
Abortion rate (%)	18.18	16.67	15.38	08.33
Pre-weaning mortality rate (%)	17.64	16.67	20.00	16.67

T0: ration without pepper (control), T1: ration containing 0.5% of Piper nigrum, T2: ration containing 0.5% of piper guineense, T3: ration containing 0.25% of Piper nigrum + 0.25% of piper guineense

Table 5: Effects of spices (*Piper nigrum* and *Piper guineense*) on weight development of young cavies from birth to weaning

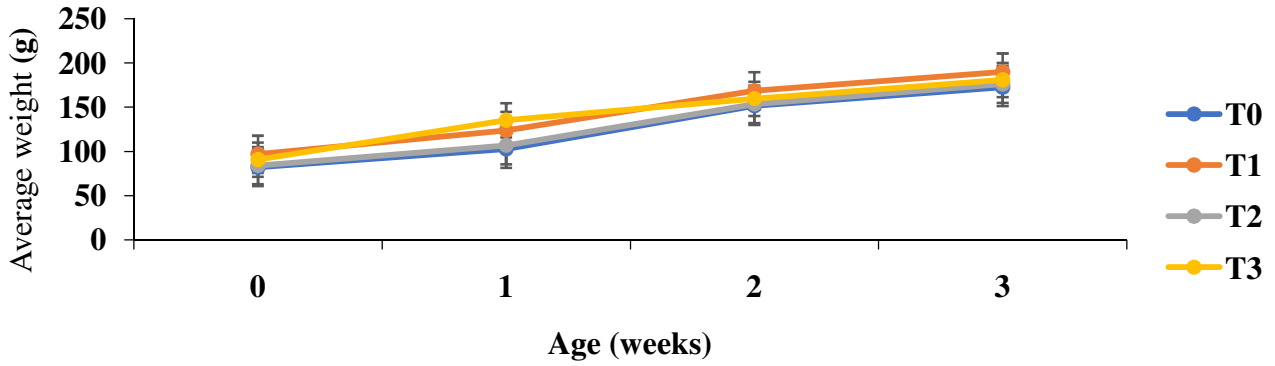
Characteristics	Treatments				p
	T0 (14)	T1 (10)	T2 (12)	T3 (10)	
Birthweight (g)	82.21±9.06[b]	97.10±6.49[a]	84.17±7.44[b]	91.00±11.03[a]	0.01
Weaningweight (g)	172.57±8,50[b]	190.00±11,54[a]	176.17±13,19[b]	181.00±12,24[a]	0.05
Total gains (g)	90.36±8.09	92.90±6.03	92.00±10.93	90.00±3.62	0.80
GMQ ADG (g/d)	4.30±0.38	4.42±0.92	4.38±0.52	4.28±0.17	0.80

[a,b] :Means with the same letters on the same line are not significantly different at the 5% level, ADG: Average daily gain, p: Probability; T0: Ration without spice (control), T1: Ration containing 0.5% Piper nigrum, T2: Ration containing 0.5% Piper guineense, T3: Ration containing 0.25% Piper nigrum + 0.25% Piper guineense, ( ): Number of young guinea pigs.



T0: ration without pepper (control), T1: ration containing 0.5% of Piper nigrum, T2: ration containing 0.5% of piper guineense, T3: ration containing 0.25% of Piper nigrum + 0.25% of piper guineense, g: gram

Fig. 2: Effects of pepper powder (*Piper nigrum* and *Piper guineense*) on the evolution of lactating females



T0: ration without pepper (control), T1: ration containing 0.5% Piper nigrum, T2: ration containing 0.5% piper guineense, T3: ration containing 0.25%,*Piper nigrum* + 0.25% piper*guineense*, g: gram.

Fig 3: Effects of spice powder (*Piper nigrum* and *Piper guineense*) on the weight development of young cavies of pre-weaned cavies

Feed intake decreased with the incorporation of the different pepper powders in the feed ration. This result could be attributed to the pungent taste of the peppers, due to the presence of piperine, which caused the decrease in feed intake when they were incorporated into the cavies' diet. Compared to *Piper guineense*, the inclusion of *Piper nigrum* seed powder in cavies' diet reduces feed intake to a greater extent. This could be due to its higher piperine content. *Piper guineense* also contains higher levels of volatile oils (particularly linalool), responsible for the pleasant floral aroma, which is rather spicy and woody in *Piper nigrum* seeds (Juliani *et al.*, 2013). This result is in

agreement with that of Mba *et al.* (2021), who had noted a significant reduction in feed intake in cavies receiving 0.5; 0.75 and 1% of ginger powder in the ration, due to the pungency of this spice, this in comparison to the results obtained with animals of the control group. However, the results obtained in this study differ from those of Al-Kassie *et al.* (2012), who had noted that, in broilers, the inclusion of black pepper powder at 1% in the ration, improved feed intake. This was attributed to the presence of active compounds in pepper, such as capsaicin, rich in vitamin C, which would have a positive impact on the ingestion of nutrients by the animals. Indeed, these authors also obtained an improvement of feed intake in quails receiving rations containing 0.5, 0.75 and 1% of *Piper nigrum* meal in comparison to animals not receiving it. This difference could be explained by the fact that the ingestion of feed containing pepper varies according to the animal species.

However, regardless of the ration considered, the litter size remained comparable in all females. This would be related to the reduction in feed intake. This result is similar to those obtained by Sharma *et al.* (2007), who also noted a 0.5% inhibition of fertility and a decrease in litter size in female rats fed a diet containing 100 mg of black pepper powder, compared to those fed a diet without black pepper. However, the results obtained in the present work are contradictory to those of Zodape *et al.* (2020), who noted an increase in the fertility rate in female rats fed a diet containing 50 and 100 mg of black pepper meal. These authors justified this by the fact that piperine, a natural alkaloid derived from black pepper, would induce the release of epinephrines involved in the improvement of fertility. This difference could also be explained by the inclusion rate (higher for this trial) of pepper powder in the ration.

Females fed the ration containing 0.5% of the different black pepper meal (*Piper nigrum* and *piper guineense*) and their offspring had the highest average weights. According to Cardenas *et al*. (2017) these spices are digestive stimulants, promoting salivation and production of gastric juices. They also contain piperine, an enzyme that has antioxidant, anti-inflammatory, and antibacterial properties and also stimulates the production of endorphins by promoting the secretion of gastric juices that aid digestion. The weight gain of the animals (females and pups) fed T1, T2 and T3 rations, compared to the control group, testifies to the good nutritional value of this spice as well as its ability to promote digestion and nutrient absorption (Hosseini *et al.,* 2011). These results are in line with the observations of Abouand et *al.* (2014), who had also noted an increase in weight in broilers receiving a ration containing up to 0.5 % black pepper powder, compared to the animals in the batch without it.

Conclusion

It was concluded that food component intake was higher in the animals fed the control ration. In addition, this ration without spice meal allowed the females to obtain better average reproductive performances (fertility rate, net fertility rate, abortion rate). The T1 and T3 rations were found to be better in terms of post-partum growth performance of females and pre-weaning growth performance of pups.

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