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CONTRIBUTION TO THE STUDY OF PIG REPRODUCTION: EFFECT OF THE INCORPORATION OF COCOA MEAT IN PIGS' FEED RATION ON LACTATION PERFORMANCE

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ABSTRACT

This study was conducted to evaluate the impact of using cocoa meal waste in feed rations on the performance of lactating sows. Twenty-one gilts, crossbred (Large White x Pietrain) x Duroc, were selected at 10 months of age, bred, and divided into three groups of seven animals each. After farrowing, these animals were fed ad libitum with specific feeds formulated with cocoa meal waste. These feeding treatments took place over a six-week period, and the three groups of animals received feeds L0, L9, and L12 containing 0%, 9%, and 12% cocoa meal waste, respectively. During lactation, the incorporation of cocoa meal waste into the feed had a significant effect on the animals' performance. The use of 12% cocoa meal waste in feed rations during lactation significantly increased the number of piglets weaned by 1.6 ($P<0.05$).

Keywords: Sow, Cocoa Meal, Lactation, Reproductive Parameter.

1 INTRODUCTION

Feed provides the nutritional components necessary for the proper functioning and development of animals. It therefore plays an essential role in animal growth and reproduction. In pig farming, for example, the use of new feed sources such as cashew nuts in the diets of lactating sows has significantly increased piglet production (Yao, 2015[1]; Yao et al., 2019[2]). The incorporation of flaxseed (Protein = 25%; Fat = 36.2%; Energy = 1.58 UFL) during gestation and lactation has also increased piglet survival rates at the udder, thanks to improved passive transfer of antibodies (Farmer

et al., 2008)[3]. With this in mind, cocoa meal by-products, which are relatively inexpensive (100 CFA francs per kg), will be used in animal feed in Côte d'Ivoire to reduce feed costs and address protein and energy deficiencies in feed rations. This introduction was made without any prior study on its effects on pig growth and reproduction. Furthermore, its use remains limited by the presence of theobromine, an antinutritional substance. However, new cocoa meal production techniques have reduced its presence (0.01-0.04%). What might be the impact of these cocoa meals on sow lactation performance if they were introduced into feed rations? Nutritional analysis of these excrements revealed significant proportions of protein (24.50%), fiber (8.37%), iron (216.72 mg/kg), magnesium (9421.76 mg/kg), and zinc (31.89 mg/kg) (LANADA, 2022)[4]. This study will be used to evaluate the effect of these oilseed cakes on certain reproductive parameters of lactating sows.

2 MATERIALS AND METHODS

The objective of this study is to determine the impact of cocoa meal excretion on the reproductive performance of lactating sows. Three groups of animals were selected and fed formulated diets based on cocoa meal.

2.1 Grouping and Feeding

2.1.1 Feed Formulation

Three types of feed were formulated for the sows: L0, L9, and L12, containing 0, 9, and 12% cocoa meal waste, respectively, for lactating sows. The feeds were analyzed for their chemical composition (Table 1) and weighed using a NAKKO® balance with a 500 kg capacity and 1 g precision.

2.1.2 Experimental Animals and Grouping

The experimental animals were crossbred (Large White x Pietrain) x Duroc and came from the Kone farm in Bouaké. These animals consisted of 21 gilts (females that had never given birth). The 10-month-old gilts, with an average live weight of 100 kg, had never been bred. These sexually mature females were presented to boars. These boars had an average live weight of 150 kg and were over two years old. After mating, which took place twice a day for two days using a randomly selected boar, the gilts were randomly divided into three groups of seven. Each animal was housed individually in a 3 m^2 pen.

Table 1: Composition of reproductive diets (g/100 g)

	Lactation		
Ingredients	L_0	L_9	L_{12}
Chemical composition (%)			
Dry matter	91,4	92,4	92,5
Protein	16,85	16,75	16,86
Fat	4,44	5,12	5,23
ADF (Fibers)	4,30	6,82	8,95
Calcium	0,95	0,98	0,97
Total Phosphorus	0,65	0,63	0,68
Metabolizable energy	3055,8	3045,67	3060,7

Feeding: The trials lasted six weeks after farrowing, during lactation. Two feedings were carried out each day. The first feeding took place at 8:00 a.m. after the first pen cleaning, and the second at 2:00 p.m., following the second cleaning of the day. No supplemental feed was given until weaning in order to establish the link between the piglets' growth rate and the sow's milk production. The feed was weighed before feeding, as were any refusals from the previous feeding. Feed intake was determined by the difference between the quality of feed provided and the amount refused. Water was provided ad libitum. The animals' weight was monitored by regular weighings using a 500 kg capacity NAKKO® scale.

2.2 Measurement of Reproductive Performance

Feed intake of lactating sows was determined. For each feeding treatment, prolificacy, productivity, and sex ratio were calculated. Prolificacy is the number of piglets born alive. Productivity is the number of piglets weaned, and the sex ratio is the ratio of the number of female piglets to the number of male piglets at farrowing (Hoha et al., 2010)[5].

Piglets were individually weighed at birth, at 7, 14, and 21 days of age, and at weaning. Average daily gains (ADG) during the first 3 weeks of age (ADG0-21) and at weaning were calculated for each individual. Litter sizes were standardized to 12 piglets whenever possible in each experimental group of lactating sows (Vega et al., 2012)[6].

2.3 Health monitoring during gestation and lactation

During lactation, sows received preventive treatment with an antibiotic (Oxytetracycline 20%) and vitamins (Provit) at the beginning of lactation.

2.4 Statistical analyses

Statistica 7.1 software was used to evaluate factorial effects by analysis of variance (ANOVA) of the zootechnical data. Means were compared to assess the impact of cocoa meal on lactation performance using Tukey's Honest Significant Difference (HSD) test. Results were presented as mean plus standard deviation. Least-squares means for the different experimental groups were compared at a probability of 0.05.

3 RESULTS

3.1 Reproductive Performance and Health Status

Prolificacy (number of piglets born and alive) and the sex ratio did not change regardless of the feeding regimen. The average rates in the different groups were 11.4 and 1, respectively. At birth, the live weight of the piglets did not change following the introduction of cocoa meal into the diets. The average live weight of the piglets was 1.59 ± 0.5 kg in the three groups. The incorporation of cocoa meal byproducts into the rations had no significant effect on the reproductive performance of the sows.

3.2 Feed Intake, Growth, and Reproductive Performance

Feed intake at the end of lactation was 1 kg higher for the sows in the diets containing 12% cocoa meal compared to the control diet without the introduction of cocoa meal (Figure 1).

At 21 days of age, no significant difference was observed in the live weight and weight gain of piglets from the different groups. The mean live weights were 5.86 ± 1.1 kg and 14.83 ± 2.50 kg, respectively. The mean daily gains were 128 ± 11.5 g, 167 ± 11.8 g, and 226 ± 13.2 g for the 1st, 2nd, and 3rd weeks of age, respectively. At weaning, feed intake and mean daily gain (MDG) of animals fed the 12% cocoa meal diet were 1 kg and 40 g/day higher, respectively, than those fed the control diet without cocoa meal.

Also at weaning, the introduction of 12% cocoa meal waste in the feed rations of lactating sows significantly increased productivity or the number of piglets weaned by 1.6 ($P<0.05$) compared to the ration which does not contain it (Table 2).

3.3 Health Status

No mortality was observed in the sows. However, at farrowing, an average of 0.94 stillborn piglets was recorded for the three groups. A few cases of bacterial infections were observed and treated with 20% oxytetracycline. The mortality rate of piglets from the rations containing 12% cocoa meal waste was significantly lower by 0.5 ± 0.8 ($P<0.05$) compared to the rate in the ration without cocoa meal waste (Table 2). Additionally, a few cases of bacterial infections (gastroenteritis and pneumonia) were recorded and treated with 20% pen strep.

Table 2: Reproductive performance by dietary treatment

	Lactation regimen		
	L0	L9	L12
Dietary intake during lactation (kg/j)			
Week 1 (J1-J7)	4.62 ± 0.18a	4.69 ± 0.2a	4.70 ± 0.19a
Week 2 (J8-J14)	5.38 ± 0.2a	5.45 ± 0.22a	5.50 ± 0.23a
Week 3 (J15-J21)	5.78 ± 0.17a	5.84 ± 0.14a	5.97 ± 0.18a
End of lactation	6.42 ± 0.20a	6.85 ± 0.30ab	7.40 ± 0.19b
Piglet weights (kg)			
At 7 days old	2.42 ± 1.0a	2.47 ± 1.0a	2.48 ± 0.9a
At 14 days old	3.51 ± 0.9a	3.53 ± 1.1a	3.55 ± 1.0a
At 21 days old	5.56 ± 1.1a	5.88 ± 1.1a	6.15 ± 1.0a
During weaning	14.80 ± 0.28a	14.85 ± 0.50a	15.95 ± 0.45b
Piglet ADG (g/j)			
Week 1 (J1-J7)	125 ± 12.2a	128 ± 11.5a	130 ± 10.4a
Week 2 (J8-J14)	165 ± 10.4a	167 ± 12.8a	170 ± 11.8a
Week 3 (J15-J21)	221 ± 13.8a	226 ± 12.9a	232± 14.5a
During weaning	356.5 ± 14a	362.6 ± 12.2a	400.1 ± 14.6b
Productivity	09.2 ± 1.40a	10.54 ± 2.01ab	10.80 ± 1.35b
Mortality	1.0 ± 0.94a	0.70 ± 0.72ab	0.5 ± 0.80b

Means per diet, marked with different letters a and b, are significantly different (P<0.05). L0, L9, and L12 are the feeds for lactating sows containing 0, 9, and 12% cocoa meal, respectively

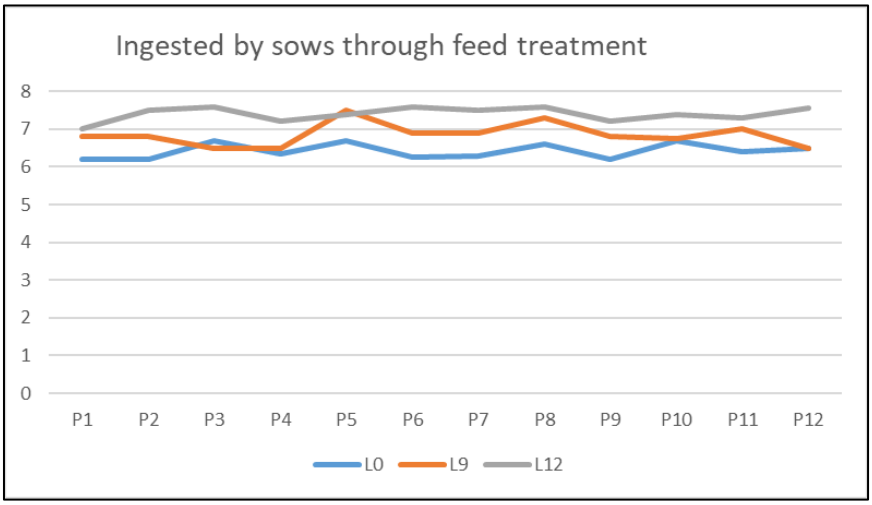


Figure 1: Change in intake per dietary treatment

4 DISCUSSION

The increased feed intake of lactating sows is thought to be linked to the relatively high levels of crude fiber (9%) in lactation rations containing 12% cocoa meal waste. Indeed, a diet enriched with fiber (8-13%) will increase the volume of insoluble fiber consumed and stimulate intestinal motility. It will accelerate the transit time of the feed bolus through the intestine and prevent constipation because these fibers pass into the stomach and small intestine undigested (Jensen

et al., 2003)[7]. Soluble fibers serve as food for bacteria in the large intestine and promote a healthy gut microbiota. These phenomena will lead to an increase in feed intake (Wilfart et al., 2006)[8]. These results differ from those of Quiniou (2006b)[9], who noted that during the first 28 days of lactation, feed intake was not influenced by the profile of formulas using the following raw materials: peas at 11%, rapeseed meal at 10%, and beet pulp at 18.9%. However, the results obtained are consistent with those of Guillemet et al. (2006)[10], Matte et al. (1994)[11], Vestergaard and Danielsen (1998)[12], and Courboulay and Gaudré (2002)[13], who observed that a particular type of feed improved sow nutrition by leading them to consume more meals daily (an increase of 25% to 39%). Indeed, according to these authors, providing an incorporated feed of oilseeds and protein-rich seeds, enriched with vegetable fiber (12.4% compared to 3.2%), during gestation promotes feed intake throughout lactation, increasing it by 4.4% to 10%. This was the case in this experiment with diets containing 20% cocoa meal during lactation.

The rearing conditions being identical for all rations (breed, parity, number of piglets per sow, temperature, etc.), the significant influence of cocoa meal rejection on the growth of piglets would be linked to the level of consumption of lactating sows which increased in this study for rations containing 12% cocoa meal. Indeed, an increase in the consumption of lactating sows leads to higher milk production and leads to greater piglet weights (Courboulay and Gaudré, 2002[13]; Farmer et al., 2008[3]). These results disagree with the results of Quiniou (2006a)[14]. For Quiniou (2006a)[14], the raw material profile of the formulas does not influence lactation performance. On the other hand, these results are consistent with those of Guillemet et al. (2006)[10] who note that the average daily gains (ADG) of piglets are different in the 1st week of lactation. For these authors, in fact, an increase in average daily gain (ADG) of 13.5% of piglets was observed in sows having received a diet of oilseeds and a high proportion of fiber during pregnancy. This favored the consumption of these sows at the start of lactation and, consequently, increased milk production which led to increased consumption and weight of the piglets. This was the case for certain diets used in this study where fiber levels are higher (9%). These results are also identical to those obtained by Farmer et al. (2008)[3] for an experiment with flax. For these authors, the addition of flaxseed meal equivalent to 10% of flaxseed in the ration of sows at the end of gestation and in lactation makes it possible to increase the weight of piglets by 4.74% at 28 days of age.

The increase in piglet productivity would be linked to the nutritional enrichment of food rations after the introduction of cocoa cake waste. These meals rich in iron, magnesium and zinc could increase the proportions of these nutrients in the food. Zinc could be found in milk and strengthen the immune system of piglets by making them more resistant to microbial infections.

These observations are not in agreement with those of Quiniou (2006a)[14] and Guillemet et al. (2006)[10]. These authors note that the use of diets based on oil-protein seeds known to be palatable (peas at 11%, rapeseed meal at 10% and beet pulp at 18.9%) and with a high proportion of fiber (12.4%) has no impact on the number of piglets weaned.

5 CONCLUSION

At the end of this experiment, the food intake at the end of lactation of the sows was 1 kg higher for the diets containing 12% cocoa cake compared to the control diet without the introduction of cocoa cake. Likewise, the use of 12% cocoa cake residue in food rations during the lactation period significantly increased the number of weaned piglets by 1.6 ($P<0.05$). At weaning, the food intake and the average daily gain (ADG) of animals fed the diet containing 12% cocoa cake are respectively 1 kg and 40 g/d higher than those fed the control diet without cocoa cake.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declare no conflicts of interest regarding this manuscript.

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