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Journal of Veterinary and Animal Research

RESEARCH ARTICLE

ISSN: 2639-7315

Effects of the Incorporation of Cocoa Shell Meal Associated or not with Dried Brewers' Grains in the Feed as a Substitute for Wheat Bran on the Growth Performance of Piglets (*Sus scrofa domesticus*)

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Citation: Emile Miégoué, David Fokom Wauffo , France-Gina Djoumessi Tobou , Geraud C. Tasse Taboue, Jeasmine Laura Mabou Nguemo et al. (2024) Effects of the Incorporation of Cocoa Shell Meal Associated or not with Dried Brewers' Grains in the Feed as a Substitute for Wheat Bran on the Growth Performance of Piglets (Sus scrofa domesticus), J Vet Ani Res 6:101

Abstract

The increase in feed costs in pig production in recent years has led breeders to increasingly turn to unconventional resources. In order to better exploit cocoa shell powder associated or not with dried brewery spent grain, studies were carried out at the pig farm of the multipurpose station of the Agricultural Research Institute for Development (IRAD) in Bangangté between January and July 2023. For this trial, 24 piglets of the Naima hybrid breed, aged 2.5 months and average weight of 14.54 kg was randomly distributed in the fattening pens. Each batch contained 3 males and 3 females. The experimental rations consisted of a basic ration without cocoa shells or brewers' grains (CD_0) and three other rations containing respectively 50% cocoa shells (CC_{50}), 50% dried spent grain (DB_{50}) and a combination of 25% cocoa shells + 25% dried spent grain (CD_{50}) as a substitute for wheat bran. From this it appear that, the highest significantly ($p>0.05$) total weight gains were obtained with ration DB_{50} (30.95 kg) on the one hand and rations CD_{50} and CD_0 (28.27 and 28.17 Kg) on the other hand. Moreover, the recorded consumption index showed that, the animals of batches CD_0, DB_{50} and CD_{50} obtained consumption index (respectively 2.59, 2.46 and 2.62) significantly ($P\leq0.05$) lower than that of CC_{50} (3.44). The economic analysis of these 4 rations therefore reveals that DB_{50} records the lowest production cost (852.74 FCFA/kg of live weight) because its lower consumption index thus allows it to better value the feed and to provide the best yield unlike the other batches, particularly CC_{50} which has a higher food production cost per kg of live weight (1050.63 FCFA/kg of live weight). The DB_{50} ration had

the most interesting parameters to improve the growth performances in pigs. In addition, cocoa shell powder and dried spent grain can be associated in the ration at the rates of 25% each in substitution of wheat bran without reducing the growth parameters.

Keywords: cocoa shell, dried spent grain, piglets, growth performance

Introduction

One of the strategies undertaken by the government to fill the deficit and meet the national demand for meat products is the promotion of the breeding of short-cycle and fast-growing species such as pork (MINEPIA, 2021). Indeed, pork has very efficient feed conversion factors which gives it a relatively short fattening time and very rapid growth. The sow has a reproductive cycle of 21 days and a gestation period allowing it to have an average of two litters per year [1]. Thus, to improve the pork production sector in Cameroon, several parameters must be optimized, controlled and diversified, for example feed which is the main limiting factor in the development of this sector in Cameroon. In fact, feed costs are increasingly high on the market due to the scarcity of certain essential inputs that go into the manufacture of pig feed such as wheat bran. This feed ingredient whose price has increased considerably on the African market in general and Cameroon in particular in recent years, especially since the outbreak of the war between Russia and Ukraine, which are the leading producers of wheat. To compensate for this deficit, breeders are increasingly turning to unconventional feed ingredients from agro-industrial by-products and agricultural by-products such as dried brewery grains and cocoa shell powder. This is with a view to reducing pig production costs without affecting its zootechnical performance. Thus, brewing industries produce large quantities of spent grain annually, which represent a potential food source for pig breeding [2, 3]. Studies have shown that incorporating this ingredient into pig feed can improve the growth performance of these animals [2]. As for cocoa shells, they are obtained after extraction of the bean and can be used in pig feed. Thus, studies have shown that cocoa shell powder incorporated at 10 and 20% in feed rations improves growth performance in pigs [4]. On the other hand, very few studies on the use of cocoa shell powder associated or not with dried brewers' spent grain in pig feed have been conducted to date. It is in this perspective that this work is born, the main objective of which is to contribute to the improvement of pig feeding through the use of non-conventional food ingredients.

Material and Methods

Study Site

This study was conducted between January and June 2023 at the application farm of the IRAD Bangangté multipurpose station. This research institute is located in the Ndé division of the West region of Cameroon (Figure 1). This division is located between 10° 21‟ and 10° 51‟ East longitude and 4° 52‟ and 5° 16‟ North latitude with a population of more than 200,000 inhabitants [5] . It covers an area of approximately 1524 km^2 and has a tropical climate of the Aw type (savannah climate with dry winter) according to the Koppen classification, with an average annual temperature of 20.4°C and precipitation of approximately 1950 mm per year [6] . The Bangangté council concentrates more than half of the population of the division and extends over an area of approximately 800 km^2. The Tonga and Bazou councils have an area of 342 km2 and 243 km^2 respectively. The village of Bassamba, formerly the district of Bangangté, has been the smallest council in the Ndé division since 1995 with an area of 123 km^2 [6]. The Ndé division has a total of four councils (Bangangté, Bazou, Tonga and Bassamba) [5] .

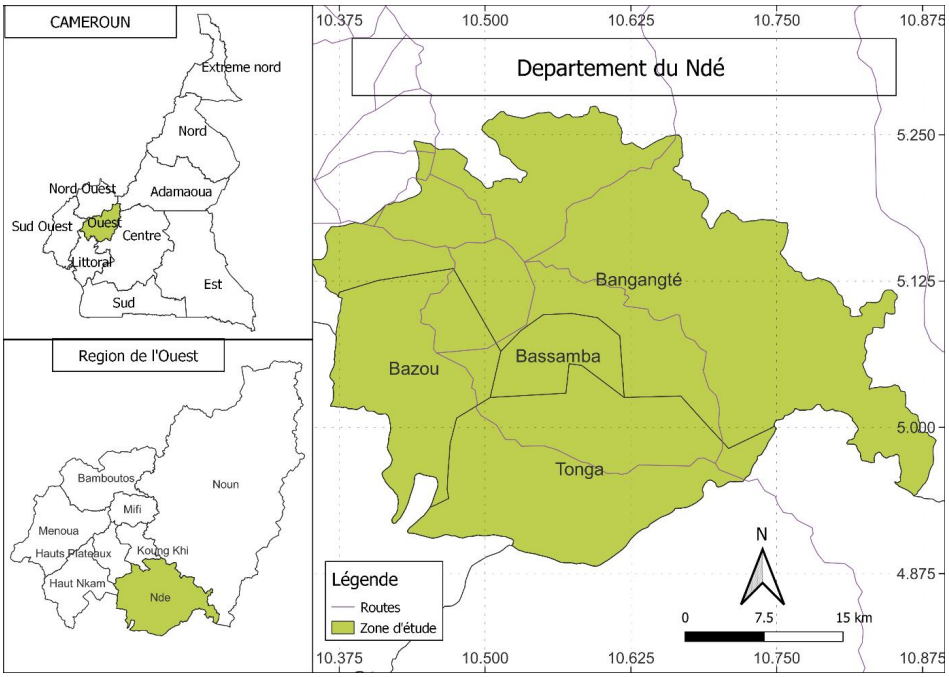

Figure 1: Geographic location of the study area

Source: Fokom et *al.* (2023)

Animal Equipment and Housing

During the entire study period, 24 Naima piglets were used to evaluate post-weaning growth performance (12 males and 12 females). These animals were 2.5 months old on average with an average weight of 14.54 ± 0.86 kg. For this test, the animals were distributed in 4 pens of 6.25 m^2 (2.5 m x 2.5 m). Each box was equipped with a feeder and an automated watering system.

Figure 2: Partial view of the livestock building

Plant Material

The plant material consisted of cocoa shell meal and brewers' spent grains. Cocoa shells were collected fresh from a peasant plantation in the Tonga subdivision in December. The shells were cut into small pieces and dried at room temperature (25 ^{0}C) for 10 days to 14 days. At the end of this drying, the shells were ground using a mixer grinder to obtain cocoa shell meal (Figure 3a). Brewers' spent grains were obtained from a brewing company in the town of Bafoussam in the Mifi division. This spent

grains were dried away from the hot sun at room temperature for 10 days to obtain dried brewers' spent grains (Figure 3b). Samples of 100 g of cocoa shell meal and dried spent grains were taken and stored in an envelope in order to determine their chemical compositions in the laboratory.

(a) (b)

Figure 3: Brewers' spent grain (a) and cocoa shells (b)

Conducting the Trial

Evaluation of the Chemical Composition of Cocoa Shell Meal and Dried Spent Grains

Analysis of the chemical composition of cocoa shell powder and dried spent grains was carried out in order to determine their dry matter, ash, organic matter, crude cellulose, crude protein, fat and crude energy contents. These analyses were carried out at the Animal Nutrition and Feeding Laboratory of the Faculty of Agronomy and Agricultural Sciences of the University of Dschang using the method described by the AOAC (2000).

Preparing rations

The different rations were formulated, mixed before being served to the piglets. The ingredients were purchased from a feed mill in the city of Bangangté. For this trial, four rations were made by gradually substituting wheat bran with cocoa shell powder and dried spent grain at different rates (Table 1). These rations consisted of a control ration (CD_0) without cocoa shell powder or dried spent grain , a ration (CC_{50}) containing 50% cocoa shell meal, a ration (DB_{50}) containing 50% dried spent grain and a ration (CD_{50}) containing 25% cocoa shell powder and 25% dried spent grain. Water was provided *ad libitum* throughout the trial period.

Table 1: Centesimal and chemical composition of the different rations

Ingredients	CD_0	CC_{50}	DB_{50}	CD_{50}
But	59	59	59	59
Wheat bran	17	8.5	8.5	8.5
Cottonseed cake	8	8	8	8
Soybean meal	8	8	8	8
Palm kernel cake	1	1	1	1
Fish meal	4	4	4	4
Shellfish	1	1	1	1
Premix 2%	2	2	2	2
Cocoa shell flour	0	8.5	0	4.25
Dried spent grain	0	0	8.5	4.25
Total	**100**	**100**	**100**	**100**
Gross energy (kcal/kg)	2736.76	2948.03	3010.08	2979.06
Crude protein (%MS)	17.86	16.92	18.41	17.66
Crude cellulose (% DM)	6.52	8.77	7.53	7.15
Fat content (%MS)	3.23	3.33	2.91	3.13

Evaluation of Growth Performance

Evaluation of Food Consumption

Feeds were weighed daily and fed twice daily (in the morning between 8.00 and 9.00 and in the evening between 15.00 and 16.00). Mean feed consumption (kg/d) was determined based on the age of the animals and the duration of feed consumption (Table 2).

Table 2: Feed consumption of piglets during fattening

Weeks	Quantity/subject/days (kg)	Quantity/batch/day (kg)	Quantity/batch/week (kg)
1	0.75	4.5	31.5
2	0.75	4.5	31.5
3	1	6	42
4	1	6	42
5	1.5	9	63
6	1.5	9	63
7	1.75	10.5	73.5
8	1.75	10.5	73.5

Evaluation of Weight Performance in Piglets

The growing piglets were randomly distributed into pens. After a two-week period of adaptation to the new feed, the animals

were weighed. At the end of this period, the growing piglets were weighed fasting for eight weeks. The weight of the animals was recorded using a precision electronic scale 0.5 kg brand TCS-300 kg, voltage 220V. This made it possible to evaluate the weight evolution of the pigs, total gains (TG), average daily gains (ADG) and consumption indices (CI).

Statistical Analysis

Growth performance data were subjected to one-way (feed ration) analysis of variance following the general linear model (GLM). When significant differences existed between treatments, separation of means was done by Duncan's test at the 5% significance level (Steel and Torrie, 1980). The analysis software used was SPSS 21.0.

Results

Chemical Composition of Cocoa Shell Meal and Dried Spent Grains

The analysis shows that cocoa shell meal is composed of 87.25% dry matter, its gross energy value of 3957.45 kcal/kg, protein of 3.79% and crude fiber of 21.68% , it could therefore be well used in animal production despite its low protein content (Table 3). The analysis of dried spent grain shows that it is an excellent ingredient to be valued in animal feed in view of its high protein content in crude protein (21.55%), energy (4698.13 kcal/kg) and its high crude fiber content (12.63).

Table 3: Chemical composition of cocoa shell meal and dried spent grain

Chemical characteristics	Cocoa shell	Dried spent grain
Dry matter (%)	87.25	90.81
Organic Matter (%MS)	89.22	96.32
Crude Protein (%MS)	3.79	21.55
Fat content (%MS)	0.91	5.61
Crude cellulose (% DM)	21.68	12.63
Ash (%MS)	10.78	3.68
Gross energy (Kcal/Kg MS)	3957.45	4698.14

Effect of the Level of Incorporation of Cocoa Shell Meal or Dried Spent Grains on the Evolution of the Average Daily Gain of Pigs During Fattening

Table 4 shows that between the first and second weeks there was no significant difference ($P \geq 0.05$) between the different batches. At week 3, the ADG of the animals fed with the CC_{50} rations and CD_{50} were comparable ($p > 0.05$) with the ADG of animals fed with the DB_{50} rations, but significantly ($p < 0.05$) lower than the weights of animals fed the control ration. At weeks 4 and 6, no significant difference ($P \geq 0.05$) was observed between the different batches. The ADG obtained from the DB_{50} ration at the fifth week was significantly ($p < 0.05$) higher than the ADG obtained from the CD_0, CC_{50}, and CD_{50} rations which were comparable ($P > 0.05$) with each other. At the seventh week, the ADG of pigs fed with the CD_0, DB_{50}, and CD_{50} rations were comparable ($P > 0.05$) and significantly ($p < 0.05$) higher than the value obtained with the CC_{50} ration. The same observation was made at the eighth week of fattening the pigs.

Table 4: Evolution of the average daily gain of piglets during fattening

Average daily gain (Kg)	Treatments				
	CD_0	CC_{50}	DB_{50}	CD_{50}	P
Week 1	0.28± 0.02 [a]	0.25± 0.05 [a]	0.29± 0.14 [a]	0.30± 0.06 [a]	0.10
Week 2	0.42±0.09 [a]	0.46±0.09 [a]	0.53±0.08 [a]	0.48± 0.20 [a]	0.07
Week 3	0.62±0.07 [a]	0.48±0.05 [b]	0.55±0.12 [ab]	0.49±0.08 [b]	0.00
Week 4	0.51±0.11 [a]	0.45± 0.07 [a]	0.52± 0.11 [a]	0.51±0.05 [a]	0.07
Week 5	0.47± 0.11 [b]	0.48± 0.10 [b]	0.68± 0.10 [a]	0.50±0.08 [b]	0.00
Week 6	0.52±0.13 [a]	0.53± 0.01 [a]	0.55± 0.08 [a]	0.57±0.10 [a]	0.11
Week 7	0.54±0.08 [a]	0.37±0.13 [b]	0.61±0.04 [a]	0.57±0.08 [a]	0.00
Week 8	0.67±0.12 [a]	0.38±0.18 [b]	0.68±0.08 [a]	0.61±0.11 [a]	0.00

[a and b]: means with the same letter on the same line are not significantly different at the 5% threshold, p: probability **, CD_0, CC_{50}, DB_{50}, and CD_{50} : rations** whose wheat bran substitution rates for cocoa shell meal and/or dried **spent** grains are respectively 0, 50%, 50 % and 25+ 25% .

Effect of the Level of Incorporation of Cocoa Shell Powder or Dried Spent Grains on the Weight Performance of Pigs during Fattening

Piglet weights at the beginning of the study showed no significant difference (P>0.05) between them (Table 5). After 9 weeks of fattening, the weights of animals fed the control (CD_0) and CD_{50} diets were comparable (p>0.05), but significantly (p<0.05) higher than the weights of animals fed the CC_{50} diet. In addition, the significantly (p<0.05) lowest weight performances were obtained with the CC_{50} diet and the highest with the DB_{50} diet. However, the weight performances obtained with the CD_0 and CD_{50} diets remained comparable (p > 0.05) at the end of the trial.

Table 5: Weight performance of piglets during fattening

Settings	Treatments				
	CD_0	CC_{50}	DB_{50}	CD_{50}	P
Initial weight	14.63± 0.51 [a]	14.31 ± 0.72 [a]	14.63 ± 0.63 [a]	14.58 ± 0.64 [a]	0.79
Final weight	42.80± 0.79 [b]	37.61±0.57 [c]	45.58± 0.40 [a]	42.85±0.71 [b]	0.00
TG (kg)	28.17± 0.65 [b]	23.3±0.55 [c]	30.95± 0.94 [a]	28.27±0.51 [b]	0.00
ADG (kg/d)	0.50 ± 0.01 [b]	0.43± 0.01 [c]	0.55± 0.02 [a]	0.50±0.01 [b]	0.00

[a, b and c]: means with the same letter on the same line are not significantly different at the 5% threshold, p: probability, **CD_0, CC_{50}, DB_{50}, and CD_{50}:** rations whose wheat bran substitution rates for cocoa shell powder and/or dried spent grains are respectively 0, 50%, 50% and 25+25, **TG:** Total Gain, **ADG:** Average Daily Gain.

Effect of the Level of Incorporation of Cocoa Shell Meal or Dried Spent Grains on the Consumption Index of Pigs during Fattening

The quantities of feed rationed and distributed proportionally in each batch, the parameter that varied the weekly consumption index remained only the average weekly gain. It emerges from this study that between the first and second week, the consumption index was not significantly affected ($p \geq 0.05$) in the different batches (Table 6). Similarly, the consumption indices of batches CD_0, CC_{50}, DB_{50}, and CD_{50} at the 3rd, 4th and 6th week were comparable ($p \geq 0.05$) between them. On the other hand, the consumption indices of the different batches were significantly different ($P \leq 0.05$) at the 5th, 7th and 8th week of the trial. Indeed, batch CC_{50} presented the highest consumption index for these periods unlike the DB_{50} ration which recorded the lowest consumption index. Figure 16 illustrates the variation of the consumption index during the experimental study, at the last week, the difference is very significant between the different batches. Batch which receive 50% of cocoa shell records the highest CI compared to the other batches. Batches 1 and 4 present comparable CI and batch 3 stands out for having the lowest consumption index.

Table 6: Consumption indices of different rations during fattening

CI	Rations				
	CD_0	CC_{50}	DB_{50}	CD_{50}	p
Week 1	2.71±0.49 [a]	3.16±12.15 [a]	3.56±0.58 [a]	2.67±0.52 [a]	0.28
Week 2	1.95±0.57 [a]	1.73±0.29 [a]	1.49±0.39 [a]	2.12±0.24 [a]	0.87
Week 3	1.69±0.42 [a]	2.12±0.01 [a]	1.9±0.2 [a]	2.17±0.26 [a]	0.36
Week 4	2.13±16.87 [a]	2.36±0.90 [a]	2.02±0.37 [a]	2.05±2.90 [a]	0.59
Week 5	3.16±0.50 [a]	3.42±0.39 [a]	2.27±0.05 [b]	3.11±0.43 [a]	0.041
Week 6	3.0±0.11 [a]	2.82±0.44 [a]	2.84±0.09 [a]	2.74±0.06 [a]	0.61
Week 7	3.32±0.10 [b]	4.72±0.31 [a]	2.93 ±0.4 [b]	3.16±0.42 [b]	0.01
Week 8	2.76±0.15 [b]	4.01±1.17 [a]	2.67±1.24 [b]	2.92±0.64 [b]	0.00

[a and b]: means with the same letter on the same line are not significantly different at the 5% threshold, **CI:** Consumption Index, **p:** probability, **CD_0, CC_{50}, DB_{50}, and CD_{50}:** rations whose wheat bran substitution rates for cocoa shell powder and/or dried spent grains are respectively 0, 50%, 50% and 25+25.

Effect of the Level of Incorporation of Cocoa Shell Powder or Dried Spent Grains on the Average Feed Consumption Index of Pigs

At the end of this study, the mean consumption indices of pigs fed the control, DB_{50} and CD_{50} rations were comparable ($p<0.05$), but significantly lower than the CC_{50} rations (Figure 4).

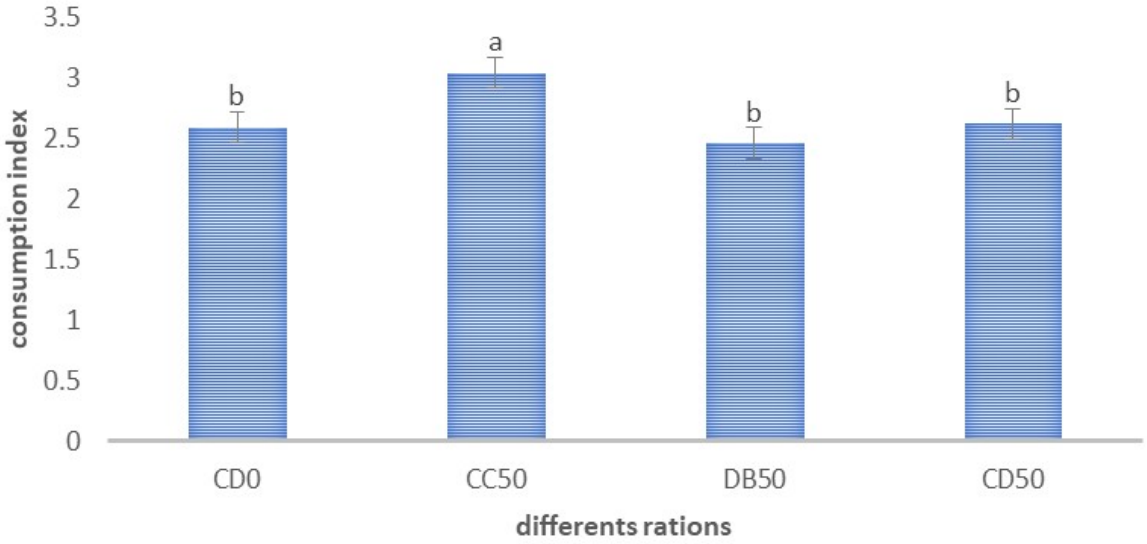

Figure 4: Average feed consumption index of pigs

[a and b]: means with the same letter on the same line are not significantly different at the 5% threshold, **CI:** Consumption Index, **CD_0, CC_{50}, DB_{50}, and CD_{50}:** rations whose substitution rates of wheat bran by cocoa shell powder and/or dried spent grain are respectively 0, 50%, 50% and 25+25.

Effect of the level of incorporation of cocoa shell powder or dried spent grains on the cost of production of the different rations for the production of one kg of live weight

It emerges from this study that the lowest production cost of a kg of feed was obtained with the CC_{50} ration (Table7). However, the calculation of the feed production costs of live weight according to the consumption index shows that the subjects receiving the BD_{50} ration allowed to have the lowest and most economical price per kilogram of live weight.

Table 7: Analysis of the cost of food production by live weight

Settings	Rations			
	CD_0	CC_{50}	DB_{50}	CD_{50}
Price for 100Kg food (FCFA)	35552.5	35020.5	35531.09	35275.31
Price for 1kg food (FCFA)	355.53	350.21	355.31	352.75
Cost (FCFA) food/kg PV	924.37	1050.63	852.74	917.15

PV: Live Weight, **CD_0, CC_{50}, DB_{50}, and CD_{50}:** rations whose wheat bran substitution rates by cocoa shell powder and/or dried spent grain are respectively 0, 50%, 50% and 25+25.

Discussion

Analysis of the chemical composition shows that cocoa shell meal has a crude protein content of 3.79% DM and a crude cellulose content of 21.68% DM. These rates are lower than the values reported by Meffeja [4]. As for the crude protein content (21.55 % DM) and crude cellulose (12.63% DM) of dried spent grain, it is close to the results of Guermah [7] who found 20.4% crude protein and 13.05% crude cellulose. After 9 weeks of fattening, the significantly lowest weight performance was recorded with the ration containing cocoa shell meal in 50% substitution of wheat bran. This could be explained by the fact that this ra-

tion has a higher fiber value than other rations. According to previous studies, the fiber level in the ration would decrease its digestibility and the average retention time of the food in the digestive tract because of a laxative effect of the fibrous substances in the digestive tract [8-10]. This resulted in a decrease in weight gain. Due to the very low digestibility of its nutrients, cocoa shells seem to be more suitable for animals in the finishing or breeding phase (lactating sows) than for those in the rapid growth phase. However, the weight performances obtained with the CD_0 and CD_{50} rations remained comparable ($p>0.05$) at the end of the trial. Thus, cocoa shells meal and dried spent grain can be incorporated into the ration with wheat bran substitution rates of 25% for each without affecting the pigs' weight performances. With rations served in equal quantities, the dietary factor that can affect the feed conversion rates remains the quality of the feed and its effectiveness in weight gain. The lower feed conversion rate values obtained in the control group, group 3 and group 4 express a better use of these feeds by the pigs. These improvements in consumption index could be explained by an additional supply of vitamins and amino acids by the spent grain in the feed rations [4]. It emerges from this study that the ration containing 50% incorporation of dried spent grain is the one with the lowest and most economical price per kilogram of live weight. Which makes it more efficient and more profitable than the other rations. This is in line with the studies conducted by Meffeja [4]which shows that the use of silage spent grain from breweries can be economically profitable at 30% incorporation in the rations of post-weaning piglets and up to 50% incorporation for the physiological phases of growth and finishing.

Conclusion

The results obtained from this study show that cocoa shell meal and dried brewers' spent grains have varied and enriched nutritional values, so the exploitation would be beneficial in pig farming. The DB_{50} ration (containing 50% dried brewers' spent grains) was better valued than the other rations by growing pigs, thus reducing the production cost per kilogram of live weight. The combination of cocoa shell flour and dried brewers' spent grains had a comparable effect to the control ration on the growth performance of pigs and on the production costs per kg of live weight. The dried brewers' spent grains therefore attenuated the negative effects of cocoa shell meal compared to the CC_{50} ration where it was substituted alone.

References

1. FAO (2013) The State of Food and Agriculture, 130p

2. Amaefule KU, Onwudike OC, Ibe SN, Abasiekong SF (2006) Performance, cost benefit, carcass quality and organ characteristics of pigs fed high graded levels of brewers' dried grain diets in the humid tropics. Pakistan Journal of nutrition, 5 : 242-7.

3. Demeke N (2007) Comparative digestibility of rations containing brewery silage, palm kernel cake or cocoa shells in growing-finishing pigs in Cameroon. Livestock Research for Rural Development, 19 : 5.

4. Meffeja F, Njifutie N, Manjeli Y, Dongmo T, Tchakounté J, Fombad RB (2006) Digestibility and influence of diets containing increasing levels of cocoa shells on the performance of growing-finishing pigs. Cellulose, 17.

5. Nya EL (2020) Report on Access to Drinking Water and Sanitation in the Ndé Department (West Region -Cameroon).

6. MINEPAT (2016) Report on the Economic Development of Cameroon RADEC- West Region.

7. Guermah H, Maertens L, Berchiche M (2016) Nutritive value of brewers' grain and maize silage for fattening rabbits. World Rabbit Sci, 24: 183-9.

8. Just A, Jorgensen H, Fernandez JA (1985) Correlation of protein deposited in growing female pigs to the ileal and faecal digestible crude proteins and amino acids. Livestock Production Science, 12: 145-59.

9. Close WH (1993) Fibrous diets for pigs. In: Gill M, Owen E, Pollott GE, Lawrence TLJ (Editors) Occasional Publications, Volume 16. British Society of Animal Production, 107-17.

10. Ndindana W, Dzama K, Maswaure S, Ndiweni PN B, Chimonyo M (2002) Evaluation of fiber digestibility and performance of growing indigenous and exotic pigs fed maize-based diets with graded levels of maize cobs. Animal Feed Science and Technology, 97 : 199-208.

11. AOAC (Association of Official Analytical Chemists) (2000) Official Method of Analysis. 15th Edition, AOAC, Washington DC.

12. Fokom WD, Tasse TG, Tsana NBM, Djoumessi TGF, Ndukong NE et al. (2023). Socio-Economic and Technical Characteristics of Beef Cattle Breeding in Ndé Division, West Region of Cameroon. Open Journal of Animal Sciences, 13 : 379-97.

13. Meffeja F, Dongmo T, Fotso JM, Fotsa JC, Tchakounté J, Nkeng N (2003) Effects of the incorporation rate of brewery silage in feed rations on the performance of fattening pigs. Cahiers Agricultures 12 : 87-91.

14. MINEPIA. (2021) Strategy document for the livestock, fisheries and animal industries subsector, 154.

15. Steele RG, Torrie JH (1980) Principles and Procedures of Statistics. McGraw Hill Book C, New York, 633.