

Effects of wheat bran substitution with spent grain powder on growth performance of pigs (*Susscrofa domestica*)

Miéguoue E^{1*}, Fokom WD¹, Nya CK¹, Sitchoma D¹, Djoumessi TGF¹, Tasse TG², Mbitkebeyo PR², Etchu KA³ and Tendonkeng F¹

¹Department of Animal Production, Faculty of Agronomy and Agricultural Sciences, University of Dschang, Cameroon

²Multipurpose Research Station, Institute of Agricultural Research for Development, Bangangté, Cameroon

³Institute of Agricultural Research for Development, Head Office, Yaoundé, Cameroon

Corresponding author: migoumile@yahoo.fr

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ABSTRACT

Aim: The study was conducted to improve pig feeding through the use of non-conventional ingredient sources on the substitution of wheat bran by spent grain meal for growth performance of Naima piglets.

Method and materials: Total 25 piglets of the Naima hybrid breed, aged 75 days with an average weight of 10.36±4.98 kg were randomly assigned to five experimental groups corresponding to treatments T₀, T₁, T₂, T₃ and T₄ made up of rations containing 0, 25, 50, 75 and 100% spent grain meal, respectively, as a substitute for wheat bran in the rations. Feed intake and refusals were measured every morning. Animals were weighed every 7 days for weight performance assessment during 8 weeks.

Results: The results of this study showed an increase in feed consumption over time for all rations. In addition, the significantly highest mean feed consumption was obtained with animals in group T₂ (80.88 ±0.59 kg). The average live weight of pigs recorded with batch T₂(26.92±1.80 kg) was comparable to that obtained with batch T₁ (25.22±1.56 kg) but significantly higher than the values produced by batches T₀ (22.17±2.95 kg), T₃ (22.81±1.33 kg) and T₄ (22.84±3.04 kg). On the other hand, total gains, average daily gains and feed conversion were not significantly influenced by the rate of incorporation of brewers' spent grain in the rations.

Conclusion: It was concluded that brewers' spent grains are an agro-industrial by-product that can be used as an ingredient in the feed of fattening pigs.

Keywords: Dried spent grain, growth performance, pig, unconventional feeds and wheat bran.

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Introduction

The world population is increasing at an exponential rate, leading to a high demand for food products that is expected to increase by 70 to 100% by 2050 (World Bank, 2020). This situation is already causing an increase in the price of food resources and will increase pressure on the animal production sector in the future (FAO, 2013). To meet the additional needs for food and feed, a 70% increase in global production will be required by 2050 (FAO, 2019). Thus, the challenge for the various stakeholders is to meet the needs for animal proteins according to the increase in the population.

One of the strategies undertaken by the government to fill this gap and increase the animal proteins consumption level is the promotion of short-cycle and fast-growing species breeding such as pigs. Pigs are precocious animals with a relatively short gestation period (114 days on average), a large litter size (7-18 piglets for improved breeds), with satisfactory productivity and rapid growth (Cees De Haan, 2001). Their breeding makes it possible to capitalize, diversify and secure the income of vulnerable populations in Cameroon. Despite these advantages, pig farming is faced with the problem of inflation in the cost of feed following the incessant increase in the price of ingredients such as wheat bran (Zhang *et al.*, 2020). To overcome this problem, unexploited or poorly valued industrial waste such as beer manufacturing residues (spent grain) can be considered. Spent grain is a by-product of the brewing industry obtained after filtration and extraction of the fermented wort. It is rich in

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protein, energy, fiber and minerals, which makes it a potentially interesting ingredient for pig feed. A meta-analysis published in 2018 concluded that the inclusion of spent grain in pig feed rations does not affect growth performance, meat quality or animal health, and may even have beneficial effects on intestinal health and the immune response of pigs (Jha *et al.*, 2018). Thus, spent grain could be used to improve the zoo technical performance of pigs while lowering their production cost. It is therefore a good candidate for the substitution of wheat bran, the cost of which on the market continues to rise. The present was planned with the main objective to contribute the improvement of pig feed through the use of agro-industrial by-products.

Materials and Methods

The study was conducted at the application farm of the IRAD Bangangté multipurpose station. This research institute is located in the Ndédivision of the West region of Cameroon. 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 (Nya, 2020). It covers an area of approximately 1524 km² 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 (MINEPAT, 2016). The Bangangté council concentrates more than half of the population of the division and extends over an area of approximately 800 km². The Tonga and Bazou councils have an area of 342 km² and 243 km² respectively. The village of Bassamba, formerly the district of Bangangté, has been the smallest council in the Ndédivision since 1995 with an area of 123 km² (MINEPAT, 2016).

Animal equipment and housing

During the entire study period, 30 hybrid Naima piglets were used to evaluate post-weaning growth performance (15 males and 15 females). These animals were 75 days old with an average weight of 10.36±4.98kg. For this test, the animals were divided into 5 pens of 6.25 m² (2.5 m x 2.5 m). Each box was equipped with a feeder and an automated watering system.

Origin of the spent grain

Before the beginning of the experiment, fresh spent grain residues were obtained from the breweries of Cameroon in Bafoussam. The spent

grain was dried away from the hot sun at room temperature for 10 days to obtain dried brewery spent grain (Fig 1).



Fig 1. Dried brewery spent grain

Conducting the trial

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, five rations (T₀; T₁; T₂; T₃ and T₄) were manufactured by gradually substituting wheat bran with dried spent grain. A control ration (T₀) was formulated without dried spent grain and four other rations (T₁; T₂; T₃ and T₄) in which wheat bran was substituted at rates of 25, 50, 75, and 100% by dried spent grain (Table 1).

Evaluation of growth performance

Evaluation of food consumption: Feed was previously weighed and fed to the piglets and the following day the refusals were collected and weighed as well. Thus, 1 kg of formulated feed was fed per piglet per day during the first four weeks and 1.5 kg of feed was fed per piglet per day during the other four weeks. Water was fed *ad libitum* throughout the trial period. Daily feed consumption was assessed by taking the difference between the quantities fed and the leftovers collected in each experimental unit.

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 in the fasting state for nine weeks. The weight of the animals was recorded using a precision electronic scale 0.5 kg brand TCS-300 kg, voltage 220V. This allowed to evaluate the weight evolution of the pigs, the total gains (TG), the average daily gains (ADG) and the consumption index (CI).

| Ingredients | Experimental rations | | | | |
|--------------------------------|----------------------|--------------------|--------------------|--------------------|--------------------|
| | T ₀ (%) | T ₁ (%) | T ₂ (%) | T ₃ (%) | T ₄ (%) |
| Wheat bran | 20 | 15 | 10 | 5 | 0 |
| Draff | 0 | 5 | 10 | 15 | 20 |
| But | 45 | 45 | 45 | 45 | 45 |
| Soybean meal | 10 | 10 | 10 | 10 | 10 |
| Palm kernel cakes | 10 | 10 | 10 | 10 | 10 |
| Cottonseed cakes | 4 | 4 | 4 | 4 | 4 |
| Pork concentrate 10% | 10 | 10 | 10 | 10 | 10 |
| Bone meal | 1 | 1 | 1 | 1 | 1 |
| Total | 100 | 100 | 100 | 100 | 100 |
| Chemical composition | | | | | |
| Metabolizable energy (Kcal/Kg) | 2353.75 | 2280.25 | 2206.75 | 2133.25 | 2059.75 |
| Crude protein (%MS) | 15.22 | 14.47 | 13.72 | 12.97 | 12.22 |
| Ca abs (%MS) | 0.39 | 0.38 | 0.37 | 0.36 | 0.36 |
| P abs (%MS) | 0.58 | 0.52 | 0.46 | 0.40 | 0.34 |
| Lysine (%MS) | 0.69 | 0.66 | 0.63 | 0.60 | 0.57 |
| Methionine (%MS) | 0.23 | 0.22 | 0.21 | 0.2 | 0.18 |

Economic evaluation of production

The cost of a kilogram of feed was estimated from the prices of practical ingredients in the local market at the time of the study. The cost of feed consumption was calculated by multiplying the quantity of feed consumed by the price of the corresponding kg of feed. The production cost of a kg of live weight of pigs was calculated by multiplying the cost of a kilogram of feed by the feed consumption index.

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 and Discussion

Effects of the level of substitution of wheat bran in the ration on the evolution of pig feed consumption

The weekly evolution of food consumption (Fig 2) showed that it increased over time for all rations. Between the 1st and 3rd week, the quantities of food ingested in the five rations were comparable ($p > 0.05$). Between the 4th and 6th week, the food consumption of the ration containing 75% and that containing 100% spent grain powder was comparable ($p > 0.05$) but significantly lower ($p < 0.05$) than that of the control ration, those containing 25% and 50% spent grain powder. Whatever the level of incorporation of spent grain powder in the rations, the quantities of food ingested were not significantly influenced ($p > 0.05$) between the 7th and 8th week.

Effects of the level of substitution of wheat bran in the ration on the evolution of live weight of pigs

It was showed that evolution of live weight evolution of pigs during trial (Fig 3). However, live weights of pigs fed with diets T₀, T₃ and T₄ were comparable ($p > 0.05$) but significantly lower ($p < 0.05$) than live weights of pigs fed with diets T₁ & T₂ throughout the trial. In addition, evolution of live weight of pigs fed with rations T₁ and T₂ were comparable ($p > 0.05$) regardless of week considered.

Effect of substitution level of wheat bran in the ration on growth parameters of pigs

The study showed that significantly ($p < 0.05$) highest mean feed consumption was obtained in animals fed the ration containing 50% brewers' grains as a substitute for wheat bran (Table 2). Mean live weight of pigs recorded with batch T₂ was comparable ($p > 0.05$) to that obtained with batch T₁ but significantly ($p < 0.05$) higher than values produced by batches T₀, T₃ and T₄. On other hand, total gains, average daily gains and feed conversion were not significantly influenced ($p > 0.05$) by rate of incorporation of brewers' spent grains in rations.

Effect of the substitution level of wheat bran by spent grain meal in the ration on the production cost of kg of pig depending on the feed

It was observed that production cost of a kg of feed decreases with increasing rate of incorporation of dried spent grain meal into rations (Table 3). In fact, T₄ ration has lowest feed producing cost. The same observation was made with calculation of production costs of live weight according to consumption index which showed that subjects receiving T₄ ration allowed to have lowest and most economical price per kilogram of live weight.

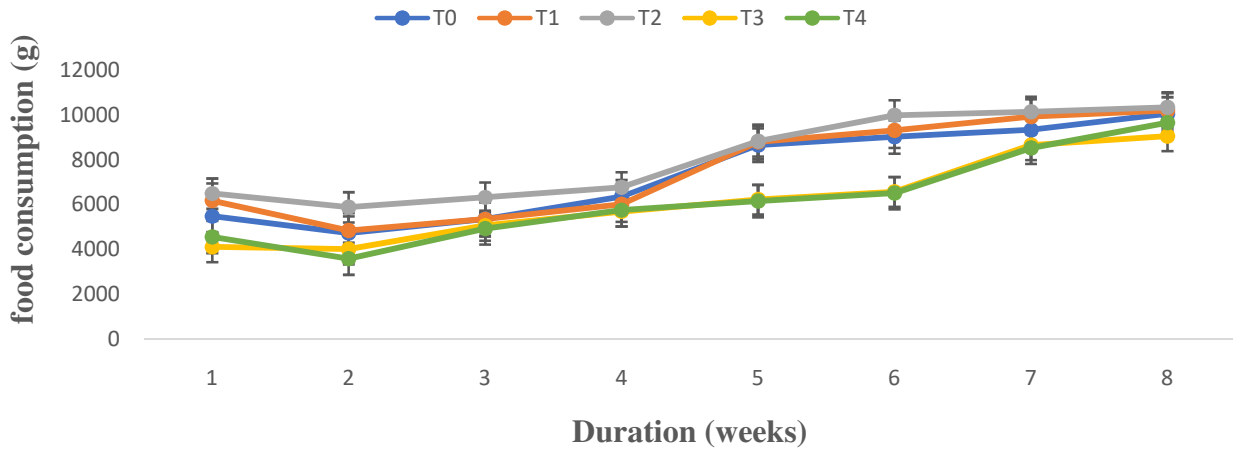


Fig 2. Evolution of pig feed consumption: **T₀**: control ration without spent grain powder residues; **T₁**: ration substituted with 25% spent grain powder; **T₂**: ration substituted with 50% spent grain powder; **T₃**: ration substituted with 75% spent grain powder; **T₄**: ration substituted with 100% spent grain powder

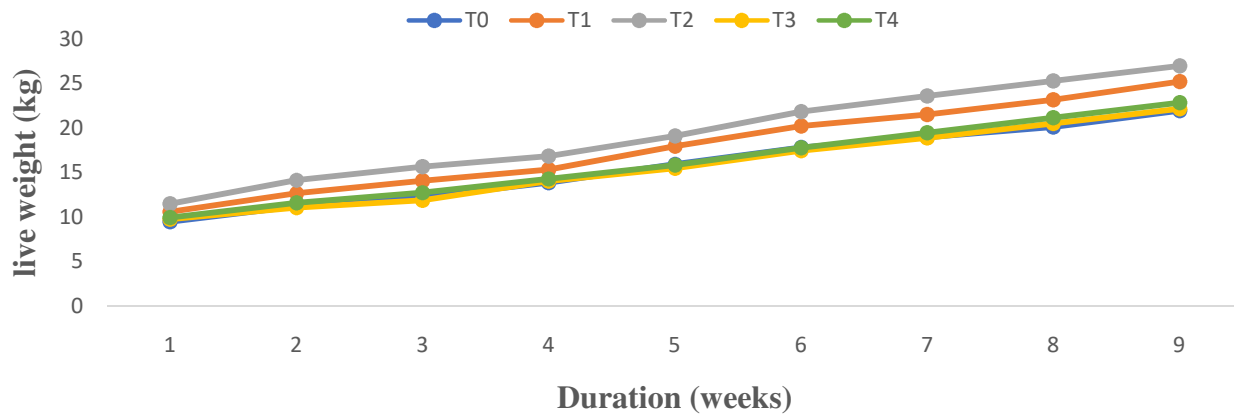


Fig 3. Evolution of live weight of pigs: **T₀**: control ration without spent grain powder residues; **T₁**: ration substituted with 25% spent grain powder; **T₂**: ration substituted with 50% spent grain powder; **T₃**: ration substituted with 75% spent grain powder; **T₄**: ration substituted with 100% spent grain powder

Table 2. Weight performance of piglets during fattening

| Some growth Characteristics | Rations | | | | | p |
|-----------------------------|----------------|----------------|----------------|----------------|----------------|------|
| | T ₀ | T ₁ | T ₂ | T ₃ | T ₄ | |
| FC (kg) | 73.70 ±0.44 b | 75.73 ±0.16 b | 80.88 ±0.59 c | 61.70 ±0.16 a | 62.11 ±0.54 a | 0.00 |
| Final weight (kg) | 22.17 ±2.95 b | 25.22 ±1.56ab | 26.98 ±1.80 a | 22.81 ±1.33 b | 22.84 ±3.04 b | 0.01 |
| TG (kg) | 15.60 ±3.1 a | 18.29 ±3.75 a | 19.38 ±3.14 a | 15.51 ±2.63 a | 16.19 ±2.85 a | 0.22 |
| ADG (kg/d) | 0.22 ±0.44 a | 0.26 ±0.53 a | 0.27 ±0.44 a | 0.24 ±0.37 a | 0.23 ±0.40 a | 0.22 |
| CI | 4.72 ±2.26 a | 4.14 ±1.20 a | 4.17 ±1.24 a | 3.98 ±0.75 a | 3.84 ±0.76 a | 0.33 |

a, b and c; means with the same letter on the same line are not significantly different at the 5% threshold; p: probability; T₀, T₁, T₂, T₃ and T₄: rations whose wheat bran substitution rates by spent grain meal are respectively 0; 25; 50; 75 and 100% ; FC: Food Consumption ; TG: Total Gain; ADG: Average Daily Gain; CI: Consumption Index .

Table 3. Analysis of the cost of food production by live weight

| Characteristics | T ₀ | T ₁ | T ₂ | T ₃ | T ₄ |
|---|----------------|----------------|----------------|----------------|----------------|
| Price per kilogram of food (FCFA) | 267.05 | 259.55 | 252.05 | 244.55 | 237.05 |
| Consumption index | 4.72 | 4.14 | 4.17 | 3.98 | 3.84 |
| Cost of produce kilogram of pork (FCFA) | 1261.64 | 1074.54 | 1051.05 | 973.31 | 910.27 |

T₀, T₁, T₂, T₃ and T₄: rations whose wheat bran substitution rates by spent grain powder are respectively 0; 25; 50; 75 and 100%

The substitution of spent grain meal in the rations significantly improves the feed consumption of pigs during the trial. Indeed, an increase in feed consumption was noted with the increase in the substitution level up to 50%. The result was contrary to that of Meffeja *et al.* (2003) who incorporated up to 30% of spent grain silage in pig feed and did not observe any significant difference in feed consumption. Beyond this percentage, feed consumption drops considerably. This could be explained by the reduction of the palatability of these rations which contain high levels of dried spent grain. It emerged from the study that the significantly higher live weight was obtained in animals fed with the ration containing 50% brewers' spent grain as a substitute for wheat bran. These observations confirmed those of Pond *et al.* (1974) and Meffeja *et al.* (1998) showed that increasing the rate of incorporation of wet spent grain beyond 50% in the ration reduces feed intake and, consequently, animal growth. The feed conversion ratio was not significantly affected by the substitution of wheat bran with spent grain powder in the rations. The results were similar to that of Imonikele *et al.* (2009) in which the feed conversion ratio was comparable for all rations. The production cost of one kg of feed decreased with the increasing rate of incorporation of dried spent grain meal in the rations. Indeed, the lowest production cost of one kg of live weight of pig was obtained with the ration containing 100% of dried spent grain meal by substitution of wheat bran. It was contrary to the observations made by Branckaert and Vallerand (1972) who state that the use of breweries spent grains silaged can be economically profitable at 40% incorporation in the rations of post-weaning piglets.

Conclusion

It was concluded that brewers' spent grains are an agro-industrial by-product that can be used as an ingredient in the feed of fattening pigs. Indeed, the substitution of wheat bran with 50% spent grain meal has allowed an improvement in growth performance (feed consumption, live weight, average daily gain and weight gain). As for the production cost, the addition of spent grain in the ration as a substitute for wheat bran has considerably reduced the production cost. Furthermore, the use of brewers' spent grains can be economically profitable up to 100% for the substitution of wheat bran in the rations of post-weaning piglets.

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