Open Journal of Animal Sciences, 2022, 12, 428-440
https://www.scirp.org/journal/ojas
ISSN Online: 2161-7627
ISSN Print: 2161-7597

Growth Performance of Butcher's Pigs Fed on Diets Made from the Ruminal Contents of Bovine Animals

Ngouana Tadjong Ruben[1*], Mube Kuietche Hervé[2], Tsafack Antoine[2], Kana Jean Raphaël[2]

[1]Laboratory of Aquaculture and Demography of Fisheries Resources, Department of Aquaculture, Institute of Fisheries and Aquatic Science of Yabassi, University of Douala, Douala, Cameroon
[2]Laboratory of Animal Nutrition, Department of Animal Science, Faculty of Agronomy and Agricultural Sciences, University of Dschang, Dschang, Cameroon
Email: *ngouanarubens@yahoo.fr

How to cite this paper: Ruben, N.T., Hervé, M.K., Antoine, T. and Raphaël, K.J. (2022) Growth Performance of Butcher's Pigs Fed on Diets Made from the Ruminal Contents of Bovine Animals. *Open Journal of Animal Sciences*, **12**, 428-440.
https://doi.org/10.4236/ojas.2022.123032

Received: September 18, 2021
Accepted: July 2, 2022
Published: July 5, 2022

Abstract

Both quantitatively and qualitatively, underfeeding materialized by under-consumption of meat remains one of the things most felt in Africa. To make up for this deficit, emphasis is placed on the production of short-cycle animals such as poultry, rabbits and pork. Among these animals, pig plays a very important socio-economic role in the life of local populations. Its meat is required in various ceremonies such as the dowry and funerals. For this purpose, twenty four males cross piglets with Large White × Landrace × Duroc × Pietrain phenotypic traits, aged between 58 and 62 days and having an average weight of 9.978 ± 1.11 kg were used to evaluate the influence of graded levels of bovine rumen content on the growth performances of grower finisher pigs. The piglets were submitted to 4 treatments, housed in pairs and fed *ad libitum* with a diet containing 0, 5%, 10% and 20% bovine rumen content. The trial which lasted for 18 weeks was carried out at the Teaching and Research Farm of the University of Dschang. The results showed that drying process destroyed most microbes found in the rumen content. These results also showed that the incorporation of bovine rumen content in diets had no significant ($p > 0.05$) effect on feed conversion ratio efficiency. However, feed intake, body weight and body weight gain were significantly higher in pigs fed with a diet (R_5) containing 5% of bovine rumen content. Feed cost per kg of live body weight was significantly ($p < 0.05$) higher for the animals fed R_{20} diet compared to the animals receiving the control diet which was lower than that of the other two diets (R_0) and (R_5) but comparable with animals fed diet R_{10}. The analysis of the carcass showed that increasing incorporation level of bovine rumen content in the diet reduces abdominal fat and back fat thickness.

For offal, the lowest weight was recorded in animals fed the control diet (R_0) and the highest weight with animals fed a diet containing 5% bovine rumen content. Carcass length of animals fed the control diet (R_0) was significantly greater compared with the carcass of animals fed diet R_{10} and comparable to that of the other two treatments. The pH of the pork was comparable ($p > 0.05$) in all the treatments. In conclusion, a diet containing 5% bovine rumen content induced the best growth performances compared to all the other groups, while diet R_{20} produced lean pork with the higher production cost.

Keywords

Carcass Characteristics, Dried Bovine Rumen Contents, Growth Performances, Pigs

1. Introduction

Both quantitatively and qualitatively, underfeeding materialized by underconsumption of meat remains one of the things most felt in Africa [1]. To make up for this deficit, emphasis is placed on the production of short-cycle animals such as poultry, rabbits and pork. Among these animals, pig plays a very important socio-economic role in the life of local populations. Its meat is required in various ceremonies such as the dowry and funerals. According to [2], the contribution of pig farming to meet up with the population's needs for meat was 38,000 tonnes out of the 32,400 produced in 2010, a percentage of 11.73%. In addition, the porcine sector uses diverse rural and urban workforces such as breeders, pork merchants, feed manufacturers and sellers, pork butchers, roasters, veterinarians and zootechnicians. In addition, the fact that pigs are omnivorous makes them undemanding animals and able to value a very varied range of agricultural and agro-industrial products.

However, it must be recognized that even if pig farming has a large number of advantages compared to other animal farming, it is not, after all, free from health, managerial, financial and food constraints [3]. Among these, the high cost of feed is one of the major constraints that oppose the development of pig farming in Cameroon. In feeding, energy ingredients occupy the largest proportion and are therefore costly.

Previous work aimed at overcoming this constraint has shown that non-conventional by-products such as straw, kitchen waste, agro-industrial by-products and rumen content of cattle can be used in animal feed in general and in pigs in particular [4]. Indeed, rumen content is available in large quantities in all our slaughterhouses and previous work has shown that it is deprived of salmonella and is not contaminated with other germs such as Staphylococci and Coliforms when it is dry [4]. In preruminants, this rumen content distributed in the fresh state stimulates the complex activity of the microbial flora [5]. [6] Roissart reported that the incorporation of 10% of the inactive bacterial production of rumen content in the diet of laying hens gives favorable results. Likewise, [4] Adeniji reported that the incorporation of 16% of fresh or dry rumen content in pig feed, improves the average daily gain from 303.57 to 714.07 grams per day between 10.05 and 92.13 kg of live weight. Recently, the work of [7] noted that supplementing chicken feed with 4% of manufactured decanted and dried rumen fluid improves growth performance and carcass quality.

The general objective of the present study was to promote the utilization of the ruminal contents of bovine animals in monogastric feeding in order to increase protein availability and reduce pigs' production costs.

2. Material and Methods

This study was carried out at the Teaching and Research Farm (TRF) of the Faculty of Agronomy and Agricultural Sciences (FAAS), University of Dschang (UDs), Cameroon. Dschang is located between 5˚25' North latitude and 10˚20' East longitude, at an average altitude of 1420 m in the agro-ecological zone of the highlands of Western Cameroon. The climate is equatorial and it is characterized by a short dry season (mid-November to mid-March) and a long rainy season (mid-March to mid-November). The average annual rainfall was 2000 mm, the average temperature was around 20˚C and the relative humidity was generally higher than 60%.

2.1. Rumen Content: Collection, Microbiological and Proximate Analyses

The rumen content was collected at the municipal slaughterhouse in Dschang after the cattle was slaughtered. The cattle were mainly coming from the North-West region of Cameroon and the Noun division in the Western region. This rumen content was directly transferred in bags, then transported and dried for 5 to 7 days under the shade on tarps depending on the weather.

As soon as the rumen contents were taken, a fresh sample was taken for microbiological analysis. These analyzes focused on the identification and enumeration of microbes (Coliforms, fungi, Staphylococci) using respectively Purple Red Bile Agar (PRBA), Potato Dextrose Agar (PDA) and Mannitol Salt Agar (MSA) for the evaluation of the microbiological quality of milk and according to the microbiological standards applicable in food industries used by [4] for the evaluation of any raw material used in the manufacture of food products on an industrial scale.

After the rumen contents had dried, a sample was taken for proximate analyses. These analyzes were dry matter, crude proteins, lipids, crude cellulose, ash, non-nitrogenous extractives and the estimation of digestible energy. These analyses were carried out according to the methods described by [8] and [9].

2.2. Animal Material and Prophylaxis

24 male cross piglets with dominant features of Large White × Landrace × Duroc × Piétrain weighing averagely of 9.978 ± 1.118 kg and aged between 58 and

62 days purchased from a breeder in the Fokoué sub-division, Ménoua division were used in this trial.

Medical prophylaxis was the administration of the vaccine (RUVAX) against red mullet at the age of 3 months with a reminder 4 weeks later. Preventive treatment against scabies, external parasites and intestinal worms consisted of the administration of Ivermectin as soon as the piglets arrived with a reminder 15 days later and then every two months thereafter. An organophosphorus and lemongrass based ascaricide was also used to control external parasites as well, but also against flies, especially during periods when they appeared in large numbers. With a high pressure of microbial bacteria responsible for red diseases during the trial period, a covering antibiotic based on Penicillin and Streptomycin was used at the beginning of each month for 3 consecutive days. The use of all these products ceased four weeks before the end of the trial.

As for sanitary prophylaxis, it consisted of cleaning the lodges, the feeders, the drinkers and the renewal of the disinfectant solution in the footbath every morning. The pigsty was disinfected once every two weeks after weighing the animals with a disinfectant solution containing either 2.6% Chlorine diluted to 25 ml per liter of water or Cresyl diluted to 20 ml per liter of water. Access to the pigsty was limited to visitors.

2.3. Experimental Rations

During this study, four rations R_0, R_5, R_{10} and R_{20} whose characteristics are presented in **Table 1** were evaluated. R_0 ration was the control ration and did not contain the rumen content. R_5, R_{10}, R_{20} rations respectively had 5%, 10% and 20% rumen content.

2.4. Experimental Design and Water Handling

The experimental design was completely randomised design, consisting of 4 treatments of 6 male piglets housed in pairs, that is 2 piglets for an experimental unit and 3 repetitions per treatment. These piglets were numbered from 1 to 24 and 6 piglets were randomly assigned to each of the 4 treatments T_0, T_5, T_{10} and T20 so as to constitute groups having the same average weight at the start and respectively as follows: 10, 9.92, 9.98 and 10 kg.

Feed and water were served *ad libitum* once a day between 7 a.m. and 8 a.m. during the first month of the trial. From the second month, feed and water were served twice a day between 7 a.m. and 8 a.m. and then between 5 p.m. and late afternoon. This feed was served in its dry state.

2.5. Data Collection

Data were collected during a period of 18 weeks corresponding to the growth-finishing phase [10]. Data collected were feed intake, weight gain, feed conversion ratio, feed cost per kg of bodyweight and at the end of the trial period, the pigs were sacrificed and plucked then data on carcass characteristics were collected.

Table 1. Characteristics of the different experimental rations.

Ingredients (kg)	Rations			
	R_0	R_5	R_{10}	R_{20}
Maize	55	55	55	55
Wheat bran	20	10	5	0
Rumen content	0	5	10	20
Palm oil	1.1	1.7	2.7	3.5
Soybean meal	3	2	3	8
Peanut meal	2	2.4	2.4	1.7
Palm kernel meal	5	10	6.5	0.1
Fish meal	1	2	3	1.6
MNVC 10% pig	10	10	10	10
Bicalcium phosphate	0.4	0.7	0.8	0.1
Bone meal	1.5	1	1	0
Oiester shell	1	0.2	0.5	0
Belgotox	0.1	0.1	0.1	0.1
Natron	0.5	0.5	0.5	0.5
Total	100.6	100.6	100.6	100.6
Calculated chemical composition				
Digestible energy (kcal/kg)	3055	3060	3064	3051
Crude protein (%)	16.02	16.05	16.05	16.00
Energy/Protein	190.73	190.65	190.88	190.64
Calcium (%)	1.65	1.72	1.54	0.85
Phosphorus (%)	0.90	0.78	0.84	0.47
Calcium/Phosphorus	1.83	1.81	1.84	1.79
Lysine (%)	0.707	0.704	0.713	0.670
Methionine (%)	0.382	0.386	0.384	0.350
Lysine/Methionine	1.84	1.82	1.86	1.91
Crude cellulose (%)	4.19	5.33	5.68	6.92
Sodium (%)	0.033	0.038	0.051	0.058

MNVC = Mineral Nitrogen and Vitamin Complex.

2.6. Growth Performance

The quantity of feed intake during the trial period was obtained by subtracting the refusals from the quantities served day by day. The animals were weighed every two weeks using a mechanical balance. Weight gain for each period was obtained by doing the difference between two consecutive weighings and the cumulative weight gain by doing the difference between the live weight at the end and the live weight at the start of the trial. Feed conversion ratio was calculated by dividing the dry matter intake on the weight gain. The cost price of the different rations was calculated using the price of the ingredients on the market. That of the kg of rumen content was estimated at 25 FCFA taking into account the costs relating to collection, transport and drying. The cost per kg of live weight was calculated by multiplying the average feed conversion ratio by the cost price of the corresponding kg of feed.

At the end of the trial, three pigs per treatment (one large, one medium and one small) were selected, sacrificed and depilated after 12 hours of fasting. The cutting was carried out according to the scheme of the Parisian cutting described by [10]. After cutting, the weighings were carried out on the left half-carcass and multiplied by two thereafter. The yields of the components of the sacrificed pig and those of the carcass were calculated. For the thickness of the dorsal lard, the measurements were made at the level of the kidney and the last rib as described by [11]. The length of the carcass, on the other hand, was measured from the 1st cervical vertebra (Atlas) to the pubic bone [12]. A CONSORT C831 electronic electrode pH meter was used to measure the pH of the meat. For the weight, we used two scales: a CAMRY brand electronic balance having a maximum scale of 5 kg and sensitivity 1 g for low quantity ingredients and the other was a CACHAPUZ brand mechanical balance having a maximum scale of 200 kg and a sensitivity of 100 g for pigs and ingredients having high weights. A tape was used to measure the length and thickness of the lard.

2.7. Statistical Analysis

The data obtained on the studied parameters were submitted to one way analysis of variance (ANOVA) and Duncan's multiple range test was used to compare the treatments means. The Statistical software used for the analysis was SPSS 20.0 (Statistical Package for Social Sciences).

3. Results and Discussion

Overall, it appeared from **Table 2** that drying destroys the majority of the microbes present in the rumen content and the level of resistant microbes was considerably reduced.

From **Table 3**, it is showN that the rumen content was very rich in cellulose (27.26%), poor in crude proteins and digestible energy.

Table 2. Microbial analysis of fresh and dried rumen content (CFU/kg).

Rumen content	Entero bacteria	*E. coli*	*Strepto cocus*	*Staphy lococus*	*Salmo nella*	*Shigella spp*	*Listéria spp*	*Aerobic mesophili*	*Lacto bacilli*
Fresh	800	300	100	800	50	300	20	500	300
Dried	00	00	00	150	00	00	00	200	200

CFU = Colony Forming Units.

Table 3. Proximate analyses of the rumen content

DM% (% DM)	Crude protéine (% DM)	Lipids	Crude cellulose (% DM)	Ash (% DM)	NNE (% DM)	DE (kcal/kg DM)
92.03	7.00	0. 40	27.26	12.13	45. 24	1115.67

The digestible energy was calculated from the following prediction equation: DE = 53.7 TNM + 75.8 lipids + 41.1 Starch + 7.6 NDF + 39.0 Residue (ETR = 83), taken from book entitled Tables of the composition and nutritional values of raw materials intended for livestock by Noblet *et al.* in 2002.

Table 4. Effect of the incorporation level of rumen content in the ration on growth performance and the cost of production of a kg of pork.

Rations	Feed intake (kg)	Live weight	Weight gain (kg)	Feed conversion ratio	Cost of production (Fcfa)
R_0	239.15 ± 2.88^b	92.00 ± 6.73^{bc}	82.00 ± 5.17^b	2.92 ± 0.17^a	716.78 ± 40.93^a
R_5	253.45 ± 7.74^c	94.00 ± 5.83^c	84.08 ± 4.76^b	3.02 ± 0.07^a	720.01 ± 16.39^b
R_{10}	224.68 ± 3.30^a	82.75 ± 12.83^{ab}	72.76 ± 12.43^a	3.10 ± 0.21^a	756.81 ± 51.70^{ab}
R_{20}	226.16 ± 5.52^a	79.25 ± 5.83^a	69.25 ± 4.99^a	3.27 ± 0.09^a	797.24 ± 21.50^b

a, b, c: means with identical letters in the same column are not significantly ($p > 0.05$) different.

Above 5% of incorporation, the rumen content significantly ($p < 0.05$) decreased the production performance of pigs compared to the R_0 and R_5 rations. Feed cost of producing a kilogram of pork also increased significantly with the increasing level of rumen content in feed.

Above 5% in feed, the rumen content was induced a significant ($p < 0.05$) drop in feed intake (**Table 2**). Furthermore, the highest feed intake ($p < 0.05$) was recorded with R_5 ration compared to all the other rations. On the other hand, R_{10} and R_{20} treatments were comparable ($p > 0.05$) and lower compared to R_0 and R_5 treatments.

Analysis of variance revealed that body weight and weight gain of the pigs were significantly ($p < 0.05$) affected by the incorporation level of rumen content in the ration. Thus, R_5 ration induced the highest live weight and weight gain ($p < 0.05$) compared to R_{10} and R_{20} rations but comparable to R_0 ration. In addition, these parameters were higher with the incorporation of 5% rumen content in feed but decreased significantly ($p < 0.05$) with the increasing level of this by-product in feed.

The regression of weight gain according to the incorporation level of rumen content was practically linear with a very high regression coefficient ($R^2 = 0.791$). This curve followed the regression line reflecting a strong correlation of this parameter with the incorporation level of rumen content in the ration (**Figure 1**).

Although feed conversion ratio (FCR) was not significantly ($p > 0.05$) affected by the incorporation level of the rumen content in the rations, the control treatment R_0 induced the lowest FCR (2.92) while R_{20} containing the highest incorporation level induced the highest feed conversion ratio (3.27) of all groups.

The regression curve of FCR with respect to the incorporation level of rumen content in feed is linear and is confused with the regression line with a very high regression coefficient ($R^2 = 0.999$) reflecting a strong correlation of this parameter with the level of this by-product in feed (Figure 2).

In general, feed cost of producing a kg of bodyweight increased with the incorporation level of rumen content (Table 4). This increase was significant ($p < 0.05$) with R_{20} ration compared to R_0, R_5, and R_{10} rations which were comparable ($p > 0.05$). In addition, R_0 ration had the lowest production cost compared to R20 ration which recorded the highest cost.

It is seen from Table 5 that, with the exception of the weight of by-products, the incorporation of rumen content in feed significantly ($p < 0.05$) affected the weight of offal and carcass yield. Indeed, the highest carcass yield was recorded with animals fed R_0 ration (79.59%) while the lowest was obtained with animals fed R_{20} ration (75.97%). On the other hand, the highest offal weights (white and red) were obtained with animals fed R_5 ration compared to those fed R_0 and R_{10} rations.

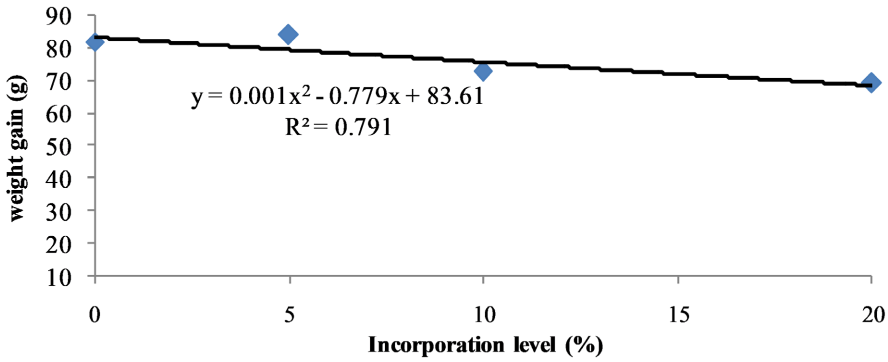

Figure 1. Regression of weight gain according to the incorporation level of rumen content in feed.

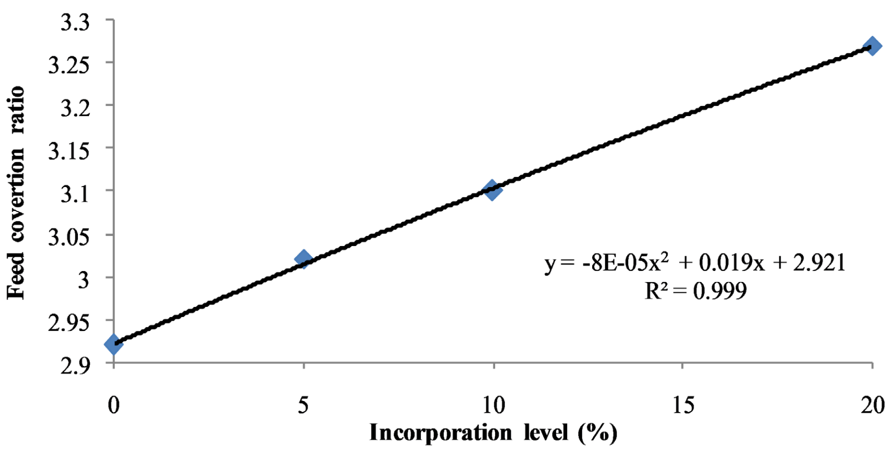

Figure 2. Regression of FCR with respect to the incorporation level of rumen content in feed.

Carcass weight and that of the three main groups of lumps gradually decreased following the incorporation level of rumen content in the rations. In general, carcass weight and fat deposition were significantly ($p < 0.05$) affected by the increasing incorporation level of rumen content in rations. The highest carcass and fat weights were obtained with the control ration R_0 while the lowest weights were recorded with R_{20} ration containing the highest rumen content. On the other hand, all the rations were comparable ($p > 0.05$) for the weights of lumps of the 1st and 2nd choice. However, the heaviest lumps were obtained with animals fed R_0 ration while the lightest lumps were recorded with animals fed R_{20} ration. The different lumps that make up the carcass and the corresponding weights are grouped in **Table 6** below.

From **Table 7**, it was seen that the highest values of body length and the thickness of the dorsal lard were observed in pigs fed R_0 ration and the lowest values in the treatment receiving R_{10} ration. These differences can be justified by the size of the slaughtered animals and the low level of crude cellulose in R_0 ration. The largest intestine surface, on the other hand, was recorded in the treatment receiving R_{20} ration while the smallest in the treatment receiving R_{10} ration. The fibber content in the ration could have influenced this parameter as well as the size of the animals since the 2nd large surface was observed in animals submitted to R_0 ration.

Table 5. Effect of the incorporation level of rumen content in feed on yields, offal and by-products.

Rations	Yields (%)	White Offal (kg)	Red Offal (kg)	By-products
R_0	79.59 ± 1.04^{a}	6.15 ± 0.42^{b}	4.00 ± 0.26^{c}	4.72 ± 0.28^{a}
R_5	76.99 ± 1.37^{bc}	7.98 ± 0.51^{a}	4.99 ± 0.28^{a}	4.73 ± 0.20^{a}
R_{10}	78.79 ± 1.14^{ab}	6.29 ± 0.62^{b}	4.21 ± 0.55^{bc}	4.10 ± 0.53^{a}
R_{20}	75.97 ± 1.11^{c}	7.37 ± 0.60^{a}	4.83 ± 0.31^{ab}	4.78 ± 0.31^{a}
P	0.02	0.04	0.03	0.08

a, b, c: means with identical letters in the same column are not significantly ($p > 0.05$) different.

Table 6. Effect of the incorporation level of rumen content on carcass weight and different groups of lumps (kg).

Rations	Carcass weight	1st choice lump	2nd choice lump	Fat
R_0	72.42 ± 0.42^{a}	40.43 ± 3.62^{a}	20.84 ± 1.86^{a}	5.00 ± 0.44^{a}
R_5	70.83 ± 0.83^{b}	37.50 ± 3.01^{a}	19.99 ± 1.61^{a}	4.88 ± 0.39^{ab}
R_{10}	67.76 ± 0.76^{c}	37.14 ± 7.64^{a}	19.41 ± 3.99^{a}	3.89 ± 0.80^{bc}
R_{20}	60.77 ± 0.77^{d}	34.39 ± 3.87^{a}	16.41 ± 1.84^{a}	3.13 ± 0.35^{c}
P	0.02	0.06	0.07	0.03

a, b, c, d: means with the same letter in the same column are not significantly ($p > 0.05$) different.

Table 7. Effect of the incorporation level of rumen content in feed on the length of the body, the intestine surface, the dorsal lard thickness and the pH of the meat.

Rations	Body length	Intestine surface	Dorsal lard thickness(mm)	pH of the meat
R_0	1.21 ± 0.21^a	1.94 ± 0.04^b	21.5 ± 0.22^a	6.28 ± 0.28^a
R_5	1.10 ± 0.1^{ab}	1.74 ± 0.04^c	18.0 ± 0.26^{ab}	6.30 ± 0.30^a
R_{10}	0.95 ± 0.05^b	1.89 ± 0.09^b	15.2 ± 0.43^{bc}	6.28 ± 0.28^a
R_{20}	0.98 ± 0.08^{ab}	2.23 ± 0.04^a	9.8 ± 0.28^c	6.31 ± 0.31^a
P	0.02	0.04	0.03	0.09

a, b, c: means with the same letter in the same column are not significantly ($p > 0.05$) different.

With all four rations, the thickness of the dorsal lard recorded at the end of this trial remain well within the limit of less than 30 mm accepted in Europe and recommended by [11]. Since the pigs were fed *ad libitum*, the small thickness of the observed lard could be justified by the high content of low-energy fibbers in our rations.

4. Discussion

Drying destroys most of the microbes present in the rumen contents and the level of resistant microbes was considerably reduced. The number of colonies observed is higher than that obtained by [4]. This difference can be justified by the drying conditions and the storage method. However, it remains below the standards used by [4] and could not be able to cause disease in animals consuming this feed.

The level of digestible energy and the level of crude protein observed in this study are lower than those reported by [4]. These differences can be justified by the prediction equation used for energy and/or by the age and the floristic composition of the rangeland for the two being understood that for the drying facilities in the sun, collection was done from December to February when the grass was quite lignified on the rangelands.

Above 5% in feed, the rumen content induced a significant ($p < 0.05$) drop in feed intake. The average feed intake obtained in this trial (1.85 to 2.04 kg/pig/d) was lower compared to that recorded by [4] with 16% of dried rumen content in the ration of Large white pigs. This low feed intake could be justified by the animal material used. Indeed, cross (hybrid) pigs were used while the latter worked with the large white pigs. However, though feed intake was low, it remains much higher than that obtained by [10] with Large white pigs.

Live weight and weight gain of pigs decrease significantly beyond 5% of rumen content incorporation, but remained comparable to the control ration. Live weight and the weight gain recorded in this work are very close to those of [4] and [10] who reported that 25% and 50% of potato peels in pig's feed gave DWGs of 818 and 829 g for the two rations respectively. The housing system and the density used could be responsible for these differences. Indeed, our animals were housed on the floor at a density of 2 pigs for 4.14 ± 0.55 m^2 while theirs were housed in cages with a density of 0.6 m^2/pig. The incorporation of 10% and 20% rumen content in the ration made it possible to obtain live weight and weight gain close to those recorded by [4] who used dry rumen content at a single level of 16% and obtained DWG varying from 303.57 to 714.07 g. On the other hand, with 5% incorporation, the results obtained were higher compared to those obtained by this author. This could be explained by the weak predispositions that monogastrics have to properly value feed rich in fiber.

Feed conversion ratio (FCR) was not significantly ($p > 0.05$) affected by the incorporation level of rumen content in the rations. This observed feed conversion ratio is better compared to that recommended by [10] and which varied between 2 and 3.89 when the pigs' weights varied between 10 kg and 100 kg. Similarly, the work of [4] made it possible to record a high feed conversion ratio (3.25 and 3.95) compared to that recorded during this trial. The fact that a better FCR was obtained even with the R20 ration containing 20% rumen content could be justified by the high energy to protein ratio (187.5) against 170 for the latter author. On the other hand, these results corroborate perfectly those of [4] and that of [10] with FCR varying from 3.03 to 3.19 and from 2.95 to 3.39 respectively.

Feed cost of producing a kg of live weight increased with the incorporation level of rumen content. The increase in the cost of production with the increasing incorporation level of rumen content observed in this study is in agreement with the work of [13] who, using a mixture of rumen content and enzymes in pullet's feed observed an increase in the cost of production following the mixing level. In contrast, the work of [4] with a mixture of rumen content and maggots in early weaned piglets and by [4] with a mixture of rumen content and blood meal in the feed of finished broiler chickens showed a gradual decrease in feed cost per kg of body weight with the increasing level of mixture. This reduction in feed cost per kg of live weight can be justified by the supplementation of rumen content with maggots and blood meal available and accessible at low prices in slaughterhouses.

In general, carcass yields recorded with all four treatments are slightly lower than those obtained by [10] (77% to 80%) but corroborate those obtained by [4] which are 77.6%. However, the yields obtained in this trial were significantly better compared to those obtained by [10] which ranged from 67.8% to 72.6%. These low yields can be justified by the low weight (45.3 to 55.2 kg) of animals when they were sacrificed. The weights of white and red offal obtained are higher than those obtained by [10] but very close to those obtained by [11] and which varied from 15 to 16 kg with the weight of the blood (4 to 5 kg). The weight of registered by-products is very low compared to that of [12] and evaluated at 7.8 kg.

The carcass weights recorded at the end of this trial are lower than those of [4] and [10] However, these weights remain much higher than those obtained by

[10]. The weight of the first choice lumps obtained with R_0 ration fits perfectly with that of [10]. This can be justified by the high proportion of muscle tissue in the carcass. With regard to fat, the weights obtained in this study are very low compared to the 11.1 kg obtained by [10] but, significantly higher than those obtained by [10]. The low proportion of fat observed in the carcasses of this trial could be justified by the low energy content of the rations and the high level of low-energy fibers in the rations in accordance with the results obtained [10]. In addition, the low level of fat recorded by the latter is linked to the high level of crude cellulose in the rations and especially linked to the age (4.5 months) which shows that they were still in the growth phase.

With all four rations, the dorsal lard thickness recorded at the end of this trial remained well within the limit of less than 30 mm accepted in Europe and recommended by [11]. Since the pigs were fed *ad libitum*, the low dorsal lard thickness observed could be justified by the high content of low-energy fibers in the rations.

5. Implication

For 18 weeks of this study, the R_5 diet containing 5% ruminal content resulted in the highest food consumption, body weight and weight gain compared to other diets including the control diet. It can be used to reduce the cost of production without any negative effect on performance.

Acknowledgements

The authors acknowledged the facilities provided by the University of Dschang through the Teaching and Research Farm (TRF) of the Faculty of Agronomy and Agricultural Sciences and the Laboratory of Animal Nutrition.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Food and Agriculture Organization of the United Nation (FAO) (2011) Pigs for Prosperity. FAO, Rome. http://www.fao.org/3/i2471e/i2471e00.pdf

[2] FAO, IFAD and WFP (2013) The State of Food Insecurity in the World 2013. The Multiple Dimensions of Food Security. FAO, Rome. https://www.fao.org/3/i3434e/i3434e00.pdf

[3] M., Labonne, Magrong, P. and Oustalet, Y. (2003). Le secteur de l'élevage au Cameroun et dans les provinces du grand Nord: situtation actuelle, contraintes, enjeux et défis. 12 p. https://hal.archives-ouvertes.fr/hal-00139191/document

[4] Adeniji, A.A. (2008) The Feeding Value of Rumen Content-Maggot Meal Mixture in the Diets of Earliy Weaned Piglets. *Asian Journal of Animal and Veterinary Advances*, **3**, 115-119. https://scialert.net/abstract/?doi=ajava.2008.115.119 https://doi.org/10.3923/ajava.2008.115.119

[5] Göhl, B. (1982) Aliment du bétail sur les tropicaux. FAO, Rome, 543 p.

[6] Roissart, H. (1994) Bactérie lactiques: Aspects fondamentaux et techniques. Quatrième Edition, Tec. Doc., Paris, 547 p

[7] Sugiarto, A., Rosyidi, D. and Hasanuddin, A. (2014) Protein Digestibility, Performance and Carcass Quality of Broiler Chicken Fed Diets Supplemented with Centrifuged Rumen Contents. *Livestock Research for Rural Development*, 26, Article No. 31. http://www.lrrd.org/lrrd26/2/sugi26031.htm

[8] Association of Official Analytical Chemist (AOAC) (2000) Official Methods of Analysis. 17th Edition, AOAC, Washington D.C. https://www.sigmaaldrich.cn/CN/zh/product/aldrich/z423645

[9] Van Soest, P.J., Robertson, J.B. and Lewis (1991) Methods for Dietary Fiber, Neutral Detergent Fiber and Non-Starch Polysaccharides in Relation to Animal Nutrition. *Journal Dairy Sciences*, **74**, 3583-3597. https://doi.org/10.3168/jds.S0022-0302(91)78551-2

[10] Sreng, S., Keo, S., DeRouchey, J., Tokach, M., Chea, B., Kang, K., Hok, L. and Vipham, J. (2020) Effect of Dietary Supplement, Base Mix, and/or Soybean Meal on Growing Pig Performance. *Journal of Animal Sciences*, **10**, 535-544. https://doi.org/10.4236/ojas.2020.103034

[11] Serres, H. (1982) Précis d'élevage du porc en zone tropicale. Institut d'Elevage et de Médécine Vétérinaire des pays tropicaux, Paris, 223 p.

[12] Naveau, J., Kerisit, R. and Ranavot, J.P. (1970) La sélection rationnelle du porc. Institut Technique du porc, Paris, 45-48.

[13] Adeniji, A.A. and Jimoh, A. (2007) Effects of Replacing Maize with Enzyme—Suplemented Bovine Rumen Content in the Diets of Pullet Chicks. *International Journal of Poultry Sciences*, **6**, 814-817. https://doi.org/10.3923/ijps.2007.814.817