IOSR Journal Of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 18, Issue 5 Ser. 1 (May. 2025), Pp 49-58
www.Iosrjournals.Org

Substitution Of Soybean Meal With Palm Kernel And Brewer's Grains Does Not Reduce Growth Performance In Weaned Pics

UMBA Marie-Jeanne, UMBA Joachim, NDOKI Jean-Christian, SYAUSWA Daniel, KIATOKO Honoré, MBOMA Jean

Loyola University Of The Congo, Faculty Of Agricultural And Veterinary Sciences, Kimwenza-Mission, P.O. Box 3724 Kinshasa, Democratic Republic Of The Congo
National Teaching University, Faculty Of Veterinary Sciences, Route De Matadi/Avenue De La Libération, Quartier Binza/UPN, P.O. Box 8815, Kinshasa, Democratic Republic Of The Congo
University Of Kinshasa, Faculty Of Agricultural Sciences And Environment, Commune De Lemba, Kinshasa, Democratic Republic Of The Congo

Summary
Due to growing demographics, urban development, and rising food prices, meat consumption is expected to increase by 70% by 2050. Thus, expanding livestock production will require a corresponding increase in feed production, including pork. However, the major problem with pig speculation is feed, which covers 50% to 70% of production costs. Protein sources, including soybean meal, are scarce and expensive in the markets of the Democratic Republic of Congo (DR Congo) in general, and particularly in the city of Kinshasa. This situation is hampering livestock farmers and affecting food security.
In order to contribute to the solution of this problem, the general objective of this study is to improve pig feeding by the use of palm kernel cake and brewer's grains as protein ingredients in the diet of second-age piglets. This involves replacing soybean meal feed with a feed made from palm kernel cake and brewer's grains, and verifying its effects on zootechnical parameters, in particular weight gain and feed conversion in order to determine the optimal incorporation rate and evaluate economic performance. We hypothesized that a complete substitution of soybean meal with palm kernel cake and brewer's grains could give the same zootechnical and economic performance. To that end, 30 piglets (> 10 weeks) divided into two blocks were fed five (5) diets for 35 days. The weights of the piglets were taken once a week and their feed consumption was assessed daily. The results obtained were subjected to an analysis of variance (ANOVA) using STATITIX software (version 10) to determine significant differences between the rations.
The results obtained show that a total substitution of soybean meal with palm kernel meal and brewers' grains results in similar performances in second-age piglets and allows to reduce the production cost. In view of these results, it is possible to conclude that alternative sources of vegetable proteins such as palm kernel meal and brewers' grains can be fully incorporated into the ration of second-age piglets at a low cost. It remains, however, to see if the substitution could have affected meat quality.
Keywords: *Piglets, soybean meal, brewer's grains, palm kernel, growth rate*

Date of Submission: 09-05-2025 Date of Acceptance: 19-05-2025

I. Introduction

Growing demographics in the world, in Africa, in the Democratic Republic of Congo (DR Congo) and in particular in the city of Kinshasa and urbanization, which puts agricultural land under heavy demand (FAO, 2024), leads to a decrease in income and increases in food prices. This reality generates acute food insecurity for 26.6 million people in the DR CONGO and emergency food insecurity for 3.1 million people in the DR Congo (IPC 2024). According to the FAO (2024), the consumption of meat products will increase by 70% by 2050. The development of animal production will require an equivalent increase in the production of animal feed, including pork. The major problem with pig farming is feed, which covers 50% to 70% of production costs. Protein sources, including soybean meal, are scarce and expensive on markets in the Democratic Republic of Congo (DR Congo) in general, and particularly in the city-province of Kinshasa. This situation is hampering farmers and affecting food security.

The current global concern, according to the United Nations Sustainable Development Goals (SDGs) (UN, 2015), is to eradicate hunger by 2030 "zero hunger" (Goal 2). As humans depend on agriculture and livestock for food and food security, these two sectors are critical to feeding humanity. For the Food and Agriculture Organization of the United Nations (FAO, 1996), there is food security only when all human beings, at all times, have physical and economic access to sufficient, safe and nutritious food, allowing them to meet their dietary needs and food preferences for a healthy and active life. On this, the population explosion, urbanization which nibbles away at agricultural land and the growing demand for meat create strong demands for food products in the world which could be at the origin of a significant deficit in proteins of plant and animal origin (FAO, 2019). The development of animal production will require an equivalent increase in the production of animal feed. The consumption of animal products, within the limits of current recommendations (50% of protein intake), improves the quality of our diet by ensuring better coverage of all nutritional needs (Remond, 2019).

The accumulation of all these phenomena could intensify food insecurity, a crisis that is significantly affecting developing countries, including the DR Congo. Indeed, the IPC partners on the food security and nutrition overview state that approximately 26.4 million people living in DR Congo are experiencing high levels of acute food insecurity (IPC Phase 3 or higher). The latest analyses carried out by the IPC partners indicate that, among these 26.4 million people, 22.6 million are classified in Crisis (IPC Phase 3) and 3.8 million are in Emergency food insecurity (IPC Phase 4) between July and December 2022. The rate of food insecurity remains similar to the previous analysis with more than 26% of the population affected (IPC, 2022). Despite the advocated state of emergency, the DR Congo remains in the grip of a complex crisis: the price of meat is high and the population's income is falling sharply, and many people cannot afford proper nutrition (FAO, 2024). Hence the urgent need to intensify the animal sector in order to meet the increased needs of a growing population. However, the crux of the problem remains animal feed, which can represent 50 to 70% of production costs depending on the species and breeding methods (FAO, 2024).

Soybean meal is the main source of protein used for livestock feed. It accounts for two-thirds of the total global production of protein for animal feed, which includes oilseed meals and fish meal (Heuze et *al.*, 2023). Soybean meal is a highly palatable feed, characterized by its high crude protein content (43 and 53%) and low crude fiber content (less than 3% for dehulled soybean meal) which presents a nutritional advantage. It has a very good amino acid balance and contains high amounts of lysine, tryptophan, threonine and isoleucine which are lacking in cereal grains. The concentrations of cystine and methionine are not optimal for monogastric animals. The nutritional value of soybean meal is unsurpassed, surpassing all other plant protein sources. It therefore constitutes the reference food for determining the value of other protein sources.

However, not only is most of the soybean meal used in the DR Congo imported and expensive for small producers, but the abundance of biodiversity in the country provides Agri-Food Science with many local plant resources that can be used in animal feed. Unconventional food resources are foods of plant, animal or industrial origin, little or not used for animal feed, which do not compete with human food and which are little known to most livestock farmers. These are substitute or replacement foods for conventional feed. In developing countries, interest in these resources in recent decades has particularly increased with the cereal crisis and the increase in the price of soybeans on the world market. For the DR Congo in general and the city province of Kinshasa in particular, conventional sources of protein such as soybean and peanut meal are indeed rare and therefore expensive (Kilemba *et al* , 2018). This situation particularly hinders the development of the pig sector, resulting in the formulation of protein-deficient feed rations. Given the irregular supply of certain agro-industrial by-products, breeders use fodder, papaya, household waste and this causes a dietary imbalance leading to growth retardation and reduced productivity, so the yield is poor at the end of the cycle (Mebanga *et al*., 2021).

Palm kernel cake, obtained from the production of palm kernel oil, is available in the DR Congo and contains 15-16% crude protein with a degradability of 40 to 50% (Kilemba *and al* ., 2018). Although there is a problem with the consistency of the quality and availability of their proteins, palm kernel cake is proposed by nutritionists as a total or partial substitute for conventional proteins. Palm kernel cake, in addition to being used as a protein source, is also considered a mixed-use feed, i.e., protein and energy. It can be incorporated in small proportions for animal feed, but it is preferable to incorporate a combination of cakes rather than a single cake. The digestibility of the organic matter of palm kernel cake is variable with values between 68 and 77%. Generally, rich cakes that contain a high oil content are considered more digestible than those whose oil is extracted by solvents, which contain less oil (Kilemba *et al.,* 2018). It has been shown that, given that palm kernel cake is not sufficiently palatable for pigs, especially young animals, it is preferable to introduce it gradually into their diet (Gohl, 1982). Furthermore, brewer's grains have fairly high protein contents (20-33% DM), which makes it an interesting source of protein, even if the heat treatments undergone during the brewing process tend to reduce the protein value. Brewer's grains are also relatively rich in fiber (17-26% DM), which is what limits its use in monogastrics, particularly in post-weaning piglets, hence its incorporation into the ration is done gradually (Heuzé *et al.,* 2023).

Taking into account the elements developed above, the present work aims to promote palm kernel cakes and brewer's grains in the diet of second-age piglets in order to determine the rate of substitution of soybean cake by palm kernel cake and brewer's grains in the ration of these piglets. This work is based on the hypothesis that the partial or total substitution of soybean meal by palm kernel meal and brewer's grains would allow good growth of second-age piglets to be maintained and the cost price of a kg of pork in terms of feed to be reduced. The general objective of this study is to contribute to the improvement of livestock feed in DR Congo by using palm kernel cakes and brewer's spent grains in the feed of older piglets.

II. Materials And Methods

To carry out our experiment, we used different materials, namely biological and non-biological materials.

Living biological material

For our experiment we used 30 second-age piglets weighing on average 13kg which served as biological material fed with our rations for 5 weeks or 35 days placed in 10 pens in 2 blocks including one male and two females. (Photos appendix 2)

Non-living biological materials

In this work we used the following food ingredients:

Brewer's grains, palm kernel meal, soybean meal, wheat bran, crushed corn, palm oil, vitamin and mineral concentrates, limestone powder.

Methods

In our study, the methods used include the inductive method, which consisted of reviewing the literature on pig feeding in general and the most used ingredients in particular; and the experimental method, which was beneficial to us in formulating the different rations.

Formulation of rations

Among the ingredients used, we have brewer's spent grain, which was purchased fresh, dried for eight days in the open air, and stored for two months without changing its color. The ingredients used in our rations were first analyzed in the chemistry laboratory at the Faculty of Agricultural and Environmental Sciences at the University of Kinshasa.

Table 1: Composition of the T0 ration.

Ingredients	Quantity (kg)	PB (%)	ED (Kcal/kg)	That (%)	P (%)	Price (FC)
Cracked corn	14.5	1.08	343.94	0.0087	0.83	11,107
Wheat bran	50	6.64	1162.5	0.305	1.92	23,300
Palm kernel cake	0	0	0	0	0	0
Soybean meal	20.5	11.08	645.96	0.37	1.28	74,620
Brewer's grain	4.5	1,036	99.45	0.011	0.13	900
Palm oil	7		656.6			11,200
Concentrate	1	0.196	14.11	0.055	0.01	3,360
Limestone powder	2.5			1.21		
Total	**100.00**	**20.03**	**2922.56**	**1.96**	**4.16**	**124,487**
Needs	**100**	**20**	**3000**	**0.75**	**0.75**	

Description of the T1 ration.

This ration, the complete formulation of which is presented below (Tab. 2), consists of 15.5% soybean meal as protein, 14% palm kernel meal and 10% brewer's spent grain. The calculations are obtained using the ingredient analysis data (Tab. 6).

Table 2: Composition of the T1 ration.

Ingredients	Quantity (kg)	PB (%)	ED (Kcal/kg)	That (%)	P(%)	Price (FC)
Cracked corn	10.5	0.78	249.06	0.0063	0.99	8,043

Wheat bran	40	5.31	930	0.24	1.53	18,640
Palm kernel cake	14	2.72	463.82	0.06	0.24	5,600
Soybean meal	15.5	8,381	488.40	0.28	0.96	56,420
Brewer's grain	10	2.30	221	0.024	0.29	2000
Palm oil	6		562.8			9600
Concentrate	2	0.39	28.22	0.11	0.02	6720
Limestone	2			0.77		
Total	**100.0**	**19.89**	**2943.31**	**1.50**	**4.03**	**107,023**
Needs	**100**	**20**	**3000**	**0.75**	**0.75**	

Formulation of the T2 ration.

This ration, the complete formulation of which is presented in the table below (Tab. 3), consists of 13.5 % of soybean meal as protein, 21% of palm kernel meal, and 14% of brewers' spent grain. Calculations are obtained using ingredient analysis data (Tab 6).

Table 3: Composition of the T2 ration.

Ingredients	Quantity (kg)	PB (%)	ED (Kcal/kg)	That (%)	P(%)	Price (FC)
Cracked corn	10	0.74	237.2	0.006	0.94	7,660
Wheat bran	33	4.38	767.25	0.20	1.26	15,378
Palm kernel cake	21	4.08	695.73	0.09	0.36	8,400
Soybean meal	13.5	7.29	425.38	0.26	0.84	49,140
Brewer's spent grain	14	3.22	309.4	0.03	0.40	2,800
Palm oil	5		469			8,000
Concentrate	1	0.19	14.11	0.05	0.0081	3,360
Limestone	2.5			0.96		
Total	**100**	**19.92**	**2918.08**	**1.61**	**3.81**	**94,738**
Needs	**100**	**20**	**3000**	**0.75**	**0.75**	

Formulation of the T3 ration.

This ration, the complete formulation of which is presented in the table below (Tab. 4), consists of 12.5% soybean meal as protein, 28% palm kernel meal and 11% brewer's spent grain. The calculations are obtained using the ingredient analysis data (Tab. 6).

Table 4: Composition of the T3 ration

Ingredients	Quantity (kg)	PB (%)	ED (Kcal/kg)	That (%)	P (%)	Price (FC)
Cracked corn	6	0.44	142.32	0.003	0.56	4,596
Wheat bran	35	4.64	813.75	0.21	1.34	16,310
Palm kernel cake	28	5.44	927.64	0.13	0.47	11,200
Soybean meal	12.5	6.76	393.87	0.23	0.78	45,500
Brewer's spent grain	11	2.53	243.1	0.03	0.32	2,200
Palm oil	4		375.2			6400
Concentrate	1	0.19	14.11	0.05	0.008	3,360

Limestone	2.5			0.96		
Total	**100**	**20.02**	**2910**	**1.62**	**3.48**	**89,566**
Needs	**100**	**20**	**3000**	**0.75**	**0.75**	

Formulation of the T4 ration.

This ration, the complete formulation of which is presented in the table below (Tab 5), consists of 0% soybean meal as protein, 32.5% palm kernel meal and 25.5% brewer's spent grain. The calculations are obtained using the ingredient analysis data (Tab 6).

Table 5: Composition of the T4 ration

Ingredients	Quantity (Kg)	PB (%)	ED (Kcal/kg)	That (%)	P(%)	Price (Fc)
Cracked corn	11.5	0.85445	272.78	0.0069	1,081	8809
Wheat bran	20.5	2,7224	476,625	0.12505	0.78515	9553
Palm kernel cake	32.5	6,318	1076.73	0.1495	0.55575	13000
Soybean meal	0	0	0	0	0	0
Brewer's spent grain	25.5	5,8701	563.55	0.0612	0.7344	5100
Palm oil	5		469			8000
Concentrate	2.5	0.49	35,275	0.1375	0.02025	8400
Limestone	2.5			0.9625		
Total	100	16,255	2893.96	1,44265	3,17655	52862
Needs	100	20	3000	0.75	0.75	

Experimental method

To produce our rations, we used preliminary analyses of all the ingredients incorporated into the rations, and these analyses were only possible thanks to the Chemistry laboratory of the Faculty of Agronomic and Environmental Sciences of the University of Kinshasa. In the next chapter, we will present the results and discussion of our work.

Statistical analysis of the results

The results obtained were analyzed using the factorial Split-Plot design to evaluate both the ratio factor and the age factor. To do this, we used the statistix software (version 10) .

III. Results And Discussion

In this chapter, we present the results of ingredient analyses and the results obtained after statistical analyses of the collected data.

The results of ingredient analyses

The results of bromatological analyses of the ingredients of the rations used are presented in the table below (Tab 6.).

Table 6: Bromatological composition of the ingredients of the rations used

Ingredients	**Dry matter**	**Ash**	**Lipids**	**Proteins**	**Fibe r %**	**Carboh ydrate**	**Phosph orus**	**Calciu m**	**Potassi um**	**Ed/kcal/ KG**
	%	%	(MG)	(PB)	Cellu lose	%	%	%	%	
But crushed	11.95	3.4	0.41	7.43	6.3	70.53	5.7	0.06	9.4	2372
Wheat bran	11.3	6	3.08	13.28	49.3	17.03	3.83	0.61	13,81	2535

Palm kernel cake	8.06	4	9.19	19.44	33.0	26.29	1.71	0.46	8.8	3313
Soybean meal	11.44	8.95	0	54.07	6.28	19.26	6.23	1.26	3.31	3151
Brewer's spent grain	9.26	7.05	1.16	23.02	1.43	29.07	2.88	0.24	0.89	2210
Palm oil	0	0	0	0	0	0	0	0	0	9330
Concentrate		25	2.8	19.6	9.99					

This table reveals the nutritional values of the ingredients incorporated in the rations of second-age piglets. Certainly, these analysis results made it possible to know the real chemical composition of each concentrate to meet the specific nutritional needs of the animal. To do this, the sample of palm kernel cake analyzed presented a higher value in crude protein with a rate of (19.44%) compared to the analyses of Kilemba *et al.*, 2018, which states that palm kernel cake has a crude protein content ranging from 15-16%. These results confirm the variability of the chemical composition of the same raw material depending on its origin and the technology applied for its extraction. The analysis of ingredients is fundamental in the management of operating systems. On this, the results obtained on the studied parameters are presented in the tables: (13, 14, 15, 16 and 17).

Evolution of live weight of piglets

The variation in live weight of piglets during the experiment is presented in the table below (Tab 7). Weights were collected weekly.

Table 7: Evolution of live weight according to ration and duration of experiment

Ration	Length of experience in weeks and (Pig age in days)						Average weight (KG)
	0 (90)	1 (97)	2 (104)	3 (111)	4 (118)	5 (125)	
T0 (R1)	13	16.15	20.16	23.35	25.35	30.4 ^{a}	21.45 ^{a}
T1 (R2)	13	15.25	17.25	20.6	22.8	27.25 ^{a}	19.35 ^{a}
T2 (R3)	13	16.5	18.55	18.85	24.1	27.6 ^{a}	20.1 ^{a}
T3 (R4)	13	16.55	19.65	23.65	25.5	30 ^{a}	21.3 ^{a}
T4 (R5)	13	17.35	19.9	22.85	26.5	29.65 ^{a}	21.54 ^{a}
Medium duration	13 ^{f}	16.36 ^{e}	19.1 ^{d}	22.29 ^{c}	24.85 ^{b}	28.98 ^{a}	

The averages with different indices are different. The average weights of piglets according to the types of rations varied from 19.35 to 21.54 kg, while the final weights varied between 27.25 and 30.4 kg. Analysis of variance showed no significant difference between the five types of rations. Regarding the duration of the experiment, the average weights of piglets varied between 13 kg at the beginning of the experiment and 30.4 kg at the fifth week of the experiment.

Analysis of variance showed significant differences between the weights of piglets of different ages. The LSD test asserts that there was an increase in piglet weights from the beginning of the experiment until the fifth week. According to Bourdon *et al.*, 1989, growing piglets aged 70 to 130 days can reach a live weight of 25 to 60 kg. In our experimental study, we started from 13 kg at 90 days and at the age of 125 days we obtained the average live weight of piglets varying from 27.25 to 30.4 depending on the type of ration. These results show that our formulated rations were efficient.

Feed consumption

The fluctuation of food consumption of different rations during the experiment is demonstrated in the table below (Tab 8).

Table 8: Variation in feed consumption according to ration types and piglet age (kg/piglet/week)

Ration	Length of experience in weeks and (Pig age in days)					Total	Average treatment
	1 (97)	2 (104)	3 (111)	4 (118)	5 (125)		
T0 (R1)	6.07	6.63	7.37	9,10	9.12	38.29 has	7.65 a
T1 (R2)	5.99	6.23	5.65	7.06	8.14	33.03 has	6.61 a
T2 (R3)	6.34	5.75	6.18	7.31	8.13	33.71 has	6.74 a
T3 (R4)	6.42	6.22	6.07	7.56	8.69	34.99 has	7.0 a
T4 (R5)	6.44	6.45	6.79	7.56	8.67	35.91 has	7.18 a
Medium duration	6.25 c	6.26 c	6.41 c	7.71 b	8.55 a	-	

The average feed consumption per week was in the order of 7.00 to 7.65 kg or 1 to 1.026 kg per day for the five rations studied. The ANOVA showed no significant difference between the rations. This average quantity of feed consumed per day per piglet is in disagreement with Quiniou *and* Renaudeau (2000) who report that piglets aged 90 to 180 days have a feed consumption varying from 1.5 to 2.5 kg per day.

Weight gain

The variation in piglet weight gain during the experiment is presented in the table below (Tab 15). The duration of the experiment is in weeks and the age of the piglets is in days.

Table 9: Weight gain

Ration	Duration of experience in weeks and (Age of piglets in days)					Total	Average treatment
	1 (97)	2 (104)	3 (111)	4 (118)	5 (125)		
T0 (R1)	3.15	4.00	3.50	1.6	5.10	17.35	3.47 a
T1 (R2)	2.50	2.00	3.35	2.20	4.45	14.2	2.84 a
.T2 (R3)	3.50	2.05	2.20	3.25	3.50	14.6	2.92 a
T3 (R4)	3.55	3.10	3.45	2.40	4.50	17	3.40 a
T4 (R5)	4.35	2.55	2.95	3.65	3.15	16.65	3.33 a

The total weight gain of our piglets during the five weeks of experiment for the different rations varied between 14.2 and 17.35 kg or 2.84 to 3.47 kg per week (Tab. 9). For the five rations, the weights were similar. The ANOVA showed no significant difference (Appendix 1). The weight gains of the piglets are close to the results of Vignole *et al.*, 2002, who report that the average weight gain of piglets ranges from 3.5 to 5.6 kg per week.

Consumption index

The variation of consumption indices during the experiment is demonstrated in the table below (Tab 10) according to statistical analyses.

Table 10: Consumption index.

Ration	Length of experience in weeks (Pig age in days)					Average treatment
	1 (97)	2 (104)	3 (111)	4 (118)	5 (125)	
T0 (R1)	2.85	1.65	2.35	6.00	1.80	2.93 a
T1 (R2)	3.70	6.35	1.16	3.25	3.05	3.54 a
T2 (R3)	1.80	2.85	2.65	2.55	2.85	2.54 a
T3 (R4)	1.80	2.75	2.10	4.00	2.00	2.53 a
T4 (R5)	1.60	2.75	2.40	2.10	2.85	2.34 a

Average	2.35	3.27	2.13	3.59	2.51	

Table 10 shows the average consumption indices of the experiment

These indices varied between 2.34 and 3.54 for the five rations. ANOVA showed no significant difference between the rations. The average consumption indices are similar to the results obtained by AUBRY *et al.,* 2004, who state that a good consumption index for 3- to 4-month-old pigs is in the order of 2.5 to 3.5.

Economic evaluation

The economic evaluation of all rations during the experiment and the total cost of feed consumed per animal per ration is demonstrated in (Tab 11) in order to know the cost price of one kg of pork in terms of feed.

Table 11: Cost price of one kg of feed

Ration	Total weight gain (kg)	Food consumed (kg)	Price of one kg of feed (FC)	Total feed cost	Cost price of one kg of pork in terms of feed (FC)
T0 (R1)	17.4	38.31	1244.87	47690.9	2740
T1 (R2)	14.25	33.04	1070.23	35360.4	2481
T2 (R3)	14.6	33.72	947.38	31945.6	2188
T3 (R4)	17.0	35.02	895.66	31366	1845
T4 (R5)	16.65	35.93	543.83	19539.8	1173

Table 11 shows the total weight gain obtained, the quantity of feed consumed during the entire experiment and the total cost of feed consumed per animal per ration; these values led us to calculate the cost price of a kg of pork in terms of feed. These results show that it is necessary to spend 2740 FC, 2481 FC, 2188 FC, 1845 FC and 1173 FC to produce 1 kg of pork, respectively with feed T0 (20.5% soybean meal, 0% palm kernel meal and 4.5% brewer's grains), T1 (15.5% soybean meal 14% palm kernel meal 10% brewer's grains), T2 (13.5% soybean meal, 21% palm kernel meal, and 14% brewer's grains), T3 (12.5% soybean meal, 28% palm kernel meal and 11% brewer's grains), and T4 (0% soybean meal, 32.5% palm kernel meal and 25.5% brewer's grains). The T4 ration based on palm kernel cake and brewer's grains without soybean meal appears more economical than rations based on soybean meal. Indeed, it has been noted that the production cost of a kg of pork decreases as the soybean meal content decreases. This situation is due to the fact that soybean meal is an imported by-product that is expensive and rare on the market in the DR Congo in general and particularly in the city-province of Kinshasa.

IV. Conclusion And Suggestions

Due to urban development and rising food prices, meat consumption is expected to increase by 70% by 2050. Thus, the development of livestock production will require an equivalent increase in the production of animal feed, including pork. However, the major problem with pig speculation is feed, which covers 40% to 70% of production costs. Protein sources, including soybean meal, are rare and expensive on the market in the Democratic Republic of Congo (DR Congo), particularly in the city-province of Kinshasa. This situation is a handicap for livestock farmers and affects food security.

In order to contribute to the solution of this problem, the general objective of this study was to improve pig feeding by the use of palm kernel cake and brewers' grains as protein ingredients in the diet of older piglets. The aim is to verify its effects on zootechnical parameters, in particular weight gain and feed conversion ratio in order to determine the optimal incorporation rate and to evaluate economic performance. We hypothesized that a total substitution of soybean meal with palm kernel cake and brewers' grains would give the same zootechnical and economic performance.

A study on the substitution of soybean meal with palm kernel meal and brewer's grains was conducted in piglets aged 90 to 125 days in the FSAV farm in order to define the best rate of substitution of soybean meal with palm kernel meal and brewer's grains in terms of pigs and the production cost in terms of comparative feed. As a result, our hypothesis was confirmed.

To do this, 5 types of iso-caloric and iso-protein rations were compared, namely: T0 (20.5% soybean meal, 0% palm kernel meal and 4.5% brewer's grains), T1 (15% soybean meal, 14% palm kernel meal and 10% brewer's grains), T2 (13.5% soybean meal, 21% palm kernel meal and 14% brewer's grains), T3 (12.5% soybean meal, 28% palm kernel meal and 11% brewer's grains) and T4 (0% soybean meal, 32.5% palm kernel meal and 25.5% brewer's grains). The results showed no significant difference between the five rations with regard to live weight and feed consumption. On the other hand, from an economic point of view, rations based on soybean meal have a higher cost price for the production of one kg of pork. The ration based on palm kernel meal and brewer's spent grain appears more economical.

In conclusion, our experience has shown that it is better to use palm kernel meal and brewers' spent grain instead of soybean meal in pig rations to maximize profit and minimize cost.

Based on the results obtained, we propose the use of palm kernel cake and brewer's spent grain instead of soybean meal in pig feed. To do this, farmers should ensure the quality of the palm kernel cake, as the artisanal production of the latter does not very often certify the quality of the by-product in terms of protein and crude fiber. We therefore recommend that a bromatological analysis be carried out beforehand to verify the nutrient content. We ask those who undertake the same studies to verify the slaughter weight and back fat thickness at the end of the experiment.

Bibliography

[1] Coudurier, Nathalie Bareille
[2] Bastianelli. D., L. Derail And S. Klotz. 2002, Pig Farming. In: Agronomist's Handbook, Cirad, Gret, Isbn 2-86844-129-7 Pp.1487-1527.
[3] Boessinger M. Et Al., 2015. Ufa Review 4/05. Winterthur, Switzerland Pp54. Brewer's Grains, An Interesting Protein Food.
[4] Bau, Hmc Giannangeli, F. Nicolas, Jp Mejean Optimization Of Heating And Nutritional And Functional Values Of Soy Proteins. The French National Institute Of Health And Medical Research, Unit 308 Villaume. Pp. 66
[5] Boessinger M. And H. Hug, Labor Veritas; U. Wyss, Alp Liebefeld Posieux, 2015. Brewer's Grains, An Interesting Protein Food Ufa Review 4/05, Pp.54
[6] Bomsel Marie-Claude, 2024. Domestic Pig Encyclopédia Universelis. France Pp2
[7] Bourdon Et Al ., 1989. Feeding Monogastric Animals: Pigs, Rabbits, Poultry. Inra. 147 Rue De L'université. 75341 Paris Cedex. Pp. 62
[8] Branckaert.R., Vallerand.F., 2008. Use Of Dried Brewers' Grains In Animal Feed In Equatorial And Tropical Regions. Iii - The Pig Journal Of Livestock And Veterinary Medicine In Tropical Countries 25(1) Pp.106
[9] Cappelaere Léa, William Lambert, Josselin Le Cour Grandmaison, Aude Simongiovanni And Marie Pierre, 2024. Protein Nutrition And Climate Change: Current Status And Perspectives. Pp. 46
[10] Dick M., G. Westenbrinket J. Meinderts, 2003. Pig Farming In Tropical Areas, Agromisa Wageningen Foundation, 4; P86
[11] Drogoul Carole, Raymond Gadoud, Marie Madeleine Joseph, Roland Jussiau, Marie Jacqueline Lisberney, Brigitte Mangeol, Louis Montmeas And Andre Tarris, 2004. Nutrition And Feeding Of Farm Animals – Volume 2 Pp8
[12] Drogoul Carole, Raymond Gadoud, Marie Madeleine Joseph, Roland Jussiau, Marie Jacqueline Lisberney, Brigitte Mangeol, Louis Montmeas And Andre Tarris, 2004. Nutrition And Feeding Of Farm Animals – Volume 1 Pp191
[13] Fao, (2024). Food Security And Nutrition In The World . P 23.
[14] Fao, 1996. Food Security, Its Links With Nutrition And Health; Food Crisis And Security: Towards A New World Food Order. Pp. 45
[15] Fao, 2019. First Fao/Who/Au International Conference On Food Safety, Addis Ababa. Public Health Burden Of Unsafe Food: The Need For Global Commitment. Pp. 39-48
[16] Fao, 2024. Constantly Changing Balances . Pp. 38
[17] Gipalanga, Yve, 2015. General Climatology Course L1 Higher Institute Of Agronomy And Veterinary Medicine, Unpublished. Pp69
[18] Gohl, 1981. Ensiled Grain, Palm Kernel Cake And Cocoa Shells.
[19] Gohl, 1982. Livestock Feeds In The Tropics. Division Of Animal Production And Health. Pp. 29
[20] Gonzalo Et Al., 2022; Millet Et Al., 2022. Pig Protein Nutrition And Climate Change: Current Situation And Outlook. Pp. 111
[21] Gonzalo, Marie-Pierre Létourneau Montminy, Agnès Narcy, Jean F. Bernier, Candido Pomar 2014. Optimization Of Phosphorus And Calcium Intake To Maximize Their Use In Growing Pigs In A Sustainable Context. Department Of Animal Sciences, Université Laval, Québec, Canada, 1a6 Inra De Tours. Pp 46, 113-118.
[22] Guillou. D, Landeau . E, 2000. Granulometry And Pig Nutrition, Inera Animal Production, Pp. 137-145. Saint Gregory Codex. France.
[23] Heuze Valérie And Gilles Tran (Afz), 2023. Brewer's Grains, Wet Brewer's Grains, Dehydrated Brewer's Grains, Ensiled Brewer's Grains (French Association Of Zootechnicians). Brewer's Grains. Pp2 Heuze , Valérie Gilles Tran And Benoit Rouille, 2017. (Afz: French Association Of Zootechnics) - (Livestock Institute) Palm Kernel Cake. Pp1.
[24] Houzelstein Aubin, Genevieve Valérie Courboulay, Maxime Delsart, Elodie Merlot, Séverine Parois, Céline Tallet, 2023. Experts From The Cnr Bea, Characteristics And Physiological And Behavioral Needs Of The Pig Sus Scrofa Domesticus Hal Id: Hal-04305796 Pp11
[25] Ifip, 2022. Raw Materials And Animal Feed Market, In Review. Pp. 19.
[26] Inera, 1989. Feeding Of Monogastric Animals: Pigs, Rabbits, Poultry. Paris Pp67
[27] Ipc, 2022. Food Security Outlook. Pp59
[28] Coulon, Jp. P. Lecomte, M. Boval, Jm Perez Vol. 24 No. 1 2011 Special: Inra Animal Production Livestock Farming In Hot Regions.
[29] Kiatoko Mangeye Honoré, 2024. Special Zootechnics Course. Loyola University Of Congo/Faculty Of Agronomic And Veterinary Sciences. Master Zootechnics 1 And 2 Pp. 64. Unpublished.
[30] Kilemba Mukangala Benjamin, Kt James, Tm Innocent, 2018. Trial Of Substitution Of Soybean Meal By Palm Kernel Meal In The Ration Of Broiler Chickens In Lubumbashi: Effects On Growth Performance And Economic Parameters International Journal Of Innovation And Applied Studies Issn 2028-9324 Vol. 25. Pp 89
[31] Klooster Johan Van 'T, 2011. Pig Farming In Tropical Areas From Domestic Farming To Small-Scale Intensive Farming Systems Netherlands Isbn Agromisa, Isbn Cta, Agrodok Series No. 1
[32] L'hoste Philippe, Dolle Vincent, Rousseau J., Soltenr D, 1990. Feeding Domestic Animals. Volume 2, The Practice Of Rationing Cattle, Sheep, Pigs. Agricultural Sciences And Techniques, 224p. Isbn. Paris. 2- 907710- 13-3
[33] Laitat M.1, De Jaeger F.2, Vandenheede M.3, Nicks B.3 2004. Factors Influencing Feed Consumption And Zootechnical Performance Of Weaned Pigs: Perception And Characteristics Of Feed. P16 - 24
[34] Laurent A., 2012. Ifip: Animal Nutritional Needs According To Physiological Stage. France Paris. Pp. 1
[35] Laurent Alibert, 2023. (Ifip) Animal Nutritional Needs According To Physiological Stage. France Paris. Pp. 1
[36] Lautrou Marion, Candido Pomar, Philippe Schmidely, Marie-Pierre Létourneau-Montminy, 2021. Effects Of Phosphorus And Calcium Depletion-Repletion On Performance And Bone Mineralization Of Growing Pigs.

[37] Lautrou, Marion 2022 . Modeling Of Phosphocalcic Requirements And Strategies For Improving Phosphorus Utilization In Growing Pigs. Food And Nutrition. Université Paris Saclay; Université Laval (Québec, Canada), French. Ffnnt : 2022upasb011ff. Fftel-03920784f Pp 3&5

[38] Legrand P., 2005. Omega 3: Nature, Roles, Needs And Form Of Intake, Medicine And Nutrition, P41, 109-115

[39] Leopold R, 2020. Léopold Rittle, 2020. Recommendations For The Use Of Soybeans In Pig Farming 1&2pp Switzerland, Belgium.

[40] L é t o u r n e a u M o n t m i n y , 2024. Pig Protein Nutrition And Climate Change: Current Status And Perspectives. Inrae Animal Production.

[41] Linnaeus, Carl Von, 1758. Systematic Classification Of The Three Kingdoms: Animal, Vegetable And Mineral. France P136

[42] Motte Bruce, 2019. Brewers ' Spent Grains: A Co-Product With Multiple Uses Pp7

[43] Nicolas Aubert, 2023. Feeding In Pig Farming Wizville Pp1 Paris;

[44] Noblet, J., Bontems, V., And Tran, G. (2003). Estimation Of The Energy Value Of Pig Feed. Inrae Productions Animales, 16(3),197–210.

[45] Noblet, Jean-Yves Dourma D, Jaap Van Milgen Inr, 2016. And Places And Perspectives On Pig Nutrition. 86pp. Saint-Gilles, France Agro Campus West, Umr Pegase, 35000 Rennes, France.

[46] F Meffeja, N Njifutié, Y Manjeli, J Tchoumboué And J Tchakounté, 2007. Comparative Digestibility Of Rations Containing Brewery Silage, Palm Kernel Cake Or Cocoa Shells In Growing-Finishing Pigs In Cameroon. Pp 102.

[47] Un, Agenda 2030. Sustainable Development Goals (Sdgs) Website France. Action Plan. Pp. 21

[48] Pcm, 2022. Feeding Pigs Cereal Soups. Scientific Article Vpp- 2512.

[49] Peyronnet Corinne, Jean-Paul La Campagne, Patricia Le Cadre And Frédéric Pressen2014. Protein Sources In Livestock Feed In France: The Role Of Oilseeds. Pp. 9. 75231 Paris Cedex 05, France.

[50] Preston, 1983. Pigs And Poultry In The Tropics, Agricultural And Rural Technical Centre (Cta). 26p

[51] Quiniou Nj . -Y. Dourmad Noblet, 1996. Influence Of Energy Intake And Live Weight On The Lysine Requirement Of Growing Pens, 413-420pp.

[52] Quiniou N, D Renaudeau, J Noblet, 2000. Effects Of Heat Exposure On The Characteristics Of Pig Feed Intake At Different Physiological Stages. Vol. 13 No. 4. P 233-245

[53] Quiniou Nathalie, Renaudeau David, Daumas Gérard 2021. Influence Of Rationing And Coverage Of Amino Acid Requirements On The Performance Of Growing Pigs According To Climatic Conditions. Ifip-Institut Du Porc, Bp 35104, 35651 Le Rheu Cedex, France Pegase, Inrae, Institut Agro, 35590 Saint-Gilles, France. Pp53.

[54] Remond Didier 2019. What Place For Animal Products In The Food Of Tomorrow Inra Productions Animales, 32 (2), Pp.147-157.Ff10.20870/Productions-Animales,2019.32.2.2500ff. Ffhal02377018f

[55] Rittler Leopold, Donau Soy, Vienna, 2020. Recommendations For The Use Of Soy In Pig Farming. Verein Donau Soja Pp. 3

[56] Rivest Joël, 2009. Study Of The Zootechnical And Economic Impacts Of An Increase In Slaughter Weight In Pigs. Quebec: Université Laval. Pp. 101. Library And Archives Canada

[57] Sassa Mebanga F. Emmanuel Mbatounga Mohamadou Moussa Jp. Mingoas, 2021. Effect Of Substituting Corn With Palm Oil Sludge In The Diet On The Growth Performance Of Post-Weaning Piglets In Abong-Mbang, Cameroon. Pp77

[58] Univia Lands, 2024. Oilseed Cakes. Pp38

[59] Tra Bi Tra Constant, 2009. Pork Industry In Ivory Coast: Production, Proposals For Improvement And Development Prospects Cheikh Anta Diop University Of Dakar Inter-State School Of Veterinary Sciences And Medicine (Eismv) Pp 18…25

[60] Ufa, Ag, 2024. Pigs: Phased Feeding - Targeted Use Of Resources Pp 47

[61] Vignola, M. Sc, 2002. Heavier Pigs At Weaning: Money In The Bank. Nutrition And Development, Pig Production, Shur – Gain Québec. P 38-45

[62] Young Lg, 2013. Pig Feeding: Supplement: Corn For Pigs Mongraph; Department Of Agriculture And Agri-Food Canada App