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Chemical Composition of Pineapple Press Residues (*Ananas comosus*) and Effect on Growth Performance of Rabbit (*Oryctolagus cuniculus*)

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Abstract

With a view to improving rabbit production performance, a trial on the chemical composition of pineapple press residue (*Ananas comosus*) and the effect of its incorporation in the ration on rabbit growth performance (*Oryctolagus cuniculus*) was carried out at the KUATE Cunicole Farm in Bandjoun, in Western Cameroon. To do this, 36 rabbits of the local breed, aged 53 days with an average weight of 1337 ± 119 g were distributed and randomly assigned to 3 experimental rations corresponding respectively to treatments or batches T0, T1 and T2. The animals in treatment T0 received a ration containing no pineapple press residue, while those in treatments T1 and T2 received a ration containing 20% and 40% pineapple press residue, respectively. These residues were dried and ground for chemical composition analysis. The feed served as well as refusals from the previous day were weighed each morning to assess feed intake. The animals were weighed every 7 days to assess weight performance. At the end of the trial which lasted 7 weeks, the animals were fasted for 24 hours, then sacrificed to evaluate carcass characteristics and the relative weights of some digestive organs. The results of this study showed that pineapple press residues had a high crude fiber content (19.2%) and energy (2500 Kcal/kg DM). Their incorporation had no significant effect on feed intake and feed conversion ratio. The average live weight, weight gain and average daily weight gain of the animals receiving the ration with 20% inclusion of pineapple press residue were comparable to those of the control group and significantly higher than those of animals fed with 40% inclusion of pineapple residue. The highest carcass yields were obtained with rabbits fed 20% pineapple

press residue in their ration. The cost of feed for the production of a kilogram live weight of rabbit tends to decrease with the ration incorporated with 20% pineapple press residue. Pineapple press residues constitute a by-product that can be recycled and their incorporation at 20% can increase rabbit growth performance and reduce production costs.

Keywords

Chemical Composition, Growth, Pineapple Press Residue, Production Cost, Rabbit

1. Introduction

In Cameroon, the influx of refugees fleeing violence and repeated attacks by non-state armed groups from Nigeria and the Central African Republic and the socio-political crisis in the North-West and South-West Regions of Cameroon have caused displacements and internal refugees, causing an increase, already existing, in food insecurity in most Cameroonian regions [1]. To contribute to the fight against this growing food insecurity and against poverty in general, MINEPIA recommends, among other things, the development of small-scale breeding of short-cycle species including rabbits [2].

Indeed, the rabbit is best suited for the valorization of harvest residues. In addition to having a short cycle and high prolificacy (40 to 45 rabbits/female/year), rabbits are one kind of animal of high nutritional and agronomic interest. It is an herbivore with a digestive particularity (caecotrophy) that allows it to exploit all kinds of plants that do not enter directly into the human diet. It takes advantage of plants and agro-industrial co-products rich in fibers [3].

Furthermore, feed accounts for more than half of animal production costs [4]. In Africa and particularly in Cameroon, strong competition between people and animals for cereals limits productivity and increases production costs on animal farms [5]. To address this problem, unexploited or poorly recovered industrial waste should be considered. According to Chapoutot [6], for decades the agri-food sectors have generated co-products of the first or second transformation which represent a significant source. Considered as waste in the production process, ¾ of these products are raw materials used in animal feed, including pineapple press residue.

The cultivation and production of pineapple is increasingly expanding throughout the world, particularly in Cameroon [7]. This development results in an increase in the quantities of pineapple placed on the market, which leads to a diversification of its use, such as the transformation into pineapple tin or natural juice from fruit pressing [8]. Furthermore, the pineapple processing industry produces enormous quantities of waste, including pineapple leaves, skin and press waste [9] [10], thus contributing to aggravating environmental problems. Indeed, in food

processing industries, the quantity of waste produced varies between 25% and 65% of the total weight of the pineapple fruit [11]. Several studies have reported that the crown usually constitutes 13% of pineapple waste compared to 30% to 42% for peels, the core 7% to 10%, and the pulp 50% [12] [13]. In order to preserve the environment from this waste, they are recycled into valuable finished products [10]. According to Marignol [14], this waste can be recovered in several forms, notably as energy substitutes (manufacture of ecological coal, biochar, etc.), as a means of soil amendment and in animal feed. Thus, waste, particularly pineapple press residue, could contain significant quantities of nutrients that rabbits could use to improve their growth performance while lowering their production costs. The general objective of this work is therefore to contribute to improving the productivity of rabbit farms through the valorization of available local food resources. More specifically it is:

- Determine the chemical composition of pineapple press residues;
- Evaluate the effect of incorporating pineapple press residues in the ration on the growth performance of rabbits;
- Evaluate the effect of incorporating pineapple press residues in the ration on the cost of feed for the production of a kg of live weight of the rabbit.

2. Materials and Methods

2.1. Site and Location

The present study was carried out at the KUATE farm located in Bandjoun in the Western region of Cameroon characterized by an equatorial climate of the Guinean and Cameroonian mountain type with two seasons: a dry season lasting 4 months (mid-November to mid-March) and a rainy season lasting 8 months (mid-March to mid-November).

2.2. Animal Equipment and Housing

To carry out this work, 36 weaned rabbits (24 males and 12 females) of local breed aged on average 53 days and having an average weight of 1337 ± 119 g were used. The animals were housed in a building containing bamboo and wire hutches, arranged in a battery like structure and divided into boxes each containing a semi-automatic feeder and a pipette connected to a trough containing drinking water. The rabbits were identified with a marker by alphabetical letters and numbers written inside the left ear.

2.3. Plant Material

The plant material consisted of pineapple press residue as the main source of fiber. These residues were collected fresh, dried (**Figure 1**), and then crushed before being incorporated into feed.

2.4. Formulation of Feed Rations

From the dry residue of crushed pineapple presses and other ingredients purchased

commercially, three rations were formulated and then granulated. The basic ration or control ration did not contain pineapple press residues (0%). The other two rations were formulated with increasing levels of inclusion of pineapple press residues (20% and 40%). Table 1 presents the bromatological composition of the rations used.

(a) Fresh residues (b) Dry residues

Figure 1. Pineapple press residue after juice extraction.

Table 1. Centesimal and bromatological composition of the different rations used.

Ingredients (Kg)	T0	T1	T2
Maize	24	10	0
Wheat bran	55	50	40
Pineapple residue	0	20	40
Soybean meal	6	6	3
Red oil	2	2	2
Fish meal 60 Belgo	1	2	5
Pork concentrate 10% Belgo Cam	10	10	10
Belgo Fos 23 (Calcium + Phosphorus)	2	0	0
Total	**100**	**100**	**100**
Bromatological composition analyzed			
Metabolizable energy (Kcal/kg DM)	2243.55	2192.31	2215.22
Crude protein (%DM)	17.66	17.40	16.30
Crude fiber (%DM)	6.88	9.57	11.782

DM: dry matter; T0: control ration without dry pineapple press residue; T1: ration containing 20% of dry pineapple press residue; T2 ration containing 40% dry pineapple press residue. Belgo Fos 23: Calcium + Phosphorus, Pork concentrate 10% Belgo Cam: proteins + fats + minerals.

The formulated rations were:

- T0: Basal ration + 0% dry pineapple press residue (control);
- T1: Basal ration + 20% dry pineapple press residue;
- T2: Basal ration + 40% dry pineapple press residue.

2.5. Studied Parameters and Data Collected

2.5.1. Evaluation of the Chemical Composition of Pineapple Press Residues

Once the fresh pineapple press residues were collected, three samples of 500 g were taken to the Animal Production and Nutrition Research Unit of the University of Dschang where they were dried at 50°C to constant weight in a ventilated oven of Gallenkamp brand and preserved for various analyses. The determination of the dry matter, organic matter, ash, crude protein and fat content were done following the AOAC method [15]. Crude fiber was determined by the Scharrer method meanwhile Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) and Acid Detergent Lignin (ADL) contents were determined according to the method of Van Soest [16]. The phosphorus content was determined by UV-visible spectrophotometry according to protocol ISO/TC 34/ SC6 N371 (1991) and that of other minerals by flame atomic absorption spectrophotometry after dry incineration, according to official analysis methods AOAC [17] and Jorhem [18].

2.5.2. Evaluation of the Effect of Pineapple Press Residues on the Growth Performance and Carcass Characteristics of Young Rabbits

The weaned rabbits (24 males and 12 females) were randomly distributed into three batches or treatments (T0, T1 and T2), each treatment had 3 repetitions of 4 animals each (12 animals per treatment). The rabbits in each treatment received the formulated feed for 49 days. The animals were fed *ad libitum* and the quantities served as well as refusals were weighed every day, which made it possible to evaluate feed intake. At the start of the trial, the rabbits were weighed, and then, every 7 days, their weights were recorded in a database. This made it possible to evaluate weight gain. Weighing was done using an electronic scale with a maximum capacity of 10 kg and accuracy of 1 g.

On the last day of the test (49th day), 3 rabbits were randomly selected from each treatment, fasted for 24 hours then sacrificed for the evaluation of carcass characteristics. The emphasis was placed on the liver, the caecum, the kidneys, the classic carcass yield and the commercial carcass yield.

2.5.3. Evaluation of the Effect of Pineapple Press Residues on the Production Cost of Young Rabbits

It consisted of determining the price per kg of each experimental ration based on the local prices of raw materials, and for each treatment, feed cost of production per kilogram of live weight of rabbit based on the price per kg of feed and feed convention ratio.

2.6. Studied Parameters

- Chemical composition of pineapple press residue.

- Weekly feed intake (FI) calculated according to the formula:

$$\textbf{FI (Kg)} = \text{Quantity of feed distributed} - \text{quantity refused}$$

- The total weight gain (WG) of A rabbit was calculated during the entire experiment according to the formula:

$$\textbf{WG (g)} = \frac{\text{Total weight of young rabbits weighed}}{\text{number of subjects weighed}}$$

- The average daily weight gain (ADWG) calculated using the formula:

$$\textbf{ADWG (g)} = \frac{\text{Weight obtained after one week}}{7}$$

where 7: Number of days per week.

- The weekly change in live weight assessed by weighing the rabbits weekly throughout the duration of the trial.
- The feed conversion ratio (FCR) was calculated using the formula:

$$\textbf{FCR} = \frac{\text{amount of feed consumed per week (g)}}{\text{weight gain per week (g)}}$$

- Carcass yield (CY) calculated according to the formula:

$$\textbf{CY (\%)} = \frac{\text{carcass weight (g)}}{\text{live weight of the animal before sacrifice (g)}} \times 100$$

- The relative weight of some organs (RWO) such as liver, cecum and kidneys determined according to the formula:

$$\textbf{RWO (\%)} = \frac{\text{weight of the organ (g)}}{\text{live weight of the animal before sacrifice (g)}} \times 100$$

- The feed cost of production (FCP) per kilogram of live weight of rabbit was calculated according to the formula:

$$\textbf{FCP of Kg of rabbit}\left(\textbf{FCFA}\right) = \text{Price of Kg of feed}\ \left(\text{FCFA}\right) \times \text{FCR}$$

2.7. Statistical Analysis

Data on all studied parameters were submitted to one-way analysis of variance (ANOVA) (food intake) and the Duncan test was used at the 5% significance level, to compare the means when it existed. Significant differences.

3. Results

3.1. Chemical Composition of Dried Pineapple Press Residues

The chemical composition of pineapple press residues is summarized in Table 2. It reveals that pineapple press residues are rich in cellulose, and have a significant energy value, but have a low crude protein content.

Table 2. Chemical composition of dried pineapple press residues.

Chemical composition	Contents
Dry matter (%)	92.44 ± 0.14
Organic matter (% DM)	97.53 ± 0.01
Ash (% DM)	2.47 ± 0.01
Fe (mg/100g)	5.21
Ca (mg/100g)	1094
Mg (mg/100g)	151.88
P (mg/100g)	131.46
K (mg/100g)	661.34
Metabolizable energy (Kcal/kg DM)	2500 ± 1.43
Crude protein (% DM)	4.58 ± 0.005
Fat (% DM)	6.61 ± 0.01
Crude fiber (% DM)	19.29 ± 0.025
NDF (% DM)	59.99 ± 0.085
ADF (% DM)	26.32 ± 0.035
ADL (%DM)	23.85 ± 0.03
Pure cellulose (% DM)	2.47 ± 0.005
Hemicellulose (% DM)	33.67 ± 0.05

DM: dry matter; NDF: neutral detergent fiber; ADF: acid detergent fiber; ADL: acid detergent lignin.

3.2. Effects of Different Levels of Incorporation of Pineapple Press Residues in the Ration on Rabbit Growth Performance

The growth parameters studied (Table 3) were significantly influenced by the presence of pineapple press residues in the rations. The highest values of feed intake were obtained respectively from rations containing 40% (968.07 ± 18.04 g) and 20% (995.14 ± 28.55 g) of pineapple press residues meanwhile the lowest ($p < 0.05$) feed intake was with the animals fed the control ration (928.46 ± 57.13 g). The significantly ($p < 0.05$) lower total weight gain (178.65 ± 18.50 g) and average daily weight gain (25.52 ± 2.64 g) were obtained from rabbits fed 40% pineapple press residues and the highest, respectively, with rations at 20% and 0% pineapple press residues. The lowest feed conversion ratio was respectively obtained from the 0% (4.39 ± 0.32) and 20% (4.63 ± 0.73) rations meanwhile the highest ($p < 0.05$) from the 40% pineapple press residue (5.42 ± 0.56).

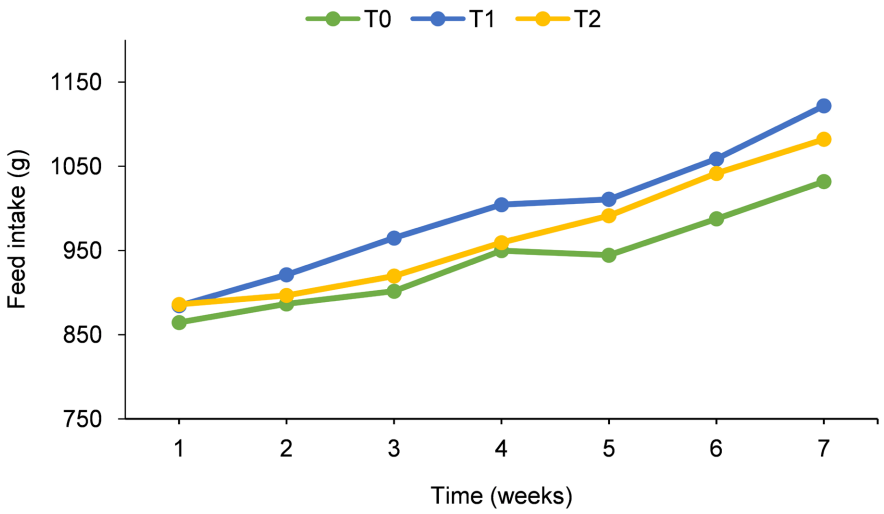
Table 3. Effect of pineapple press residue levels in the ration on rabbit growth parameters.

Growth performance	Treatments			p
	T0	T1	T2	
Feed intake (g)	928.46 ± 57.13b	995.14 ± 28.55a	968.07± 18.04a	0.002
Final live weight (g)	2859.42 ±98.35a	2900.77 ± 124.74a	2682.28 ± 109.66b	0.003
Average total weight gain (g)	211.30 ± 22.87a	214.80 ± 30.30a	178.65 ± 18.50b	0.005
Average daily weight gain (g)	30.18 ± 3.26a	30.68 ± 4.33a	25.52 ± 2.64b	0.005
Feed conversion ratio	4.39 ± 0.32b	4.63 ± 0.73b	5.42 ± 0.56a	0.001

a, b: means bearing identical letters are not significantly different ($p > 0.05$) for the same characteristics. T0: control ration without pineapple press residue; T1: ration incorporated with 20% pineapple press residue; T2 ration incorporated with 40% pineapple press residue; p: probability.

3.3. Weekly Evolution of Feed Intake

The animals' feed intake (Figure 2) showed an increasing level throughout the trial, regardless of the ration. However, feed intake of ration containing 20% pineapple press residue (T1) was regularly higher than that of the other rations.



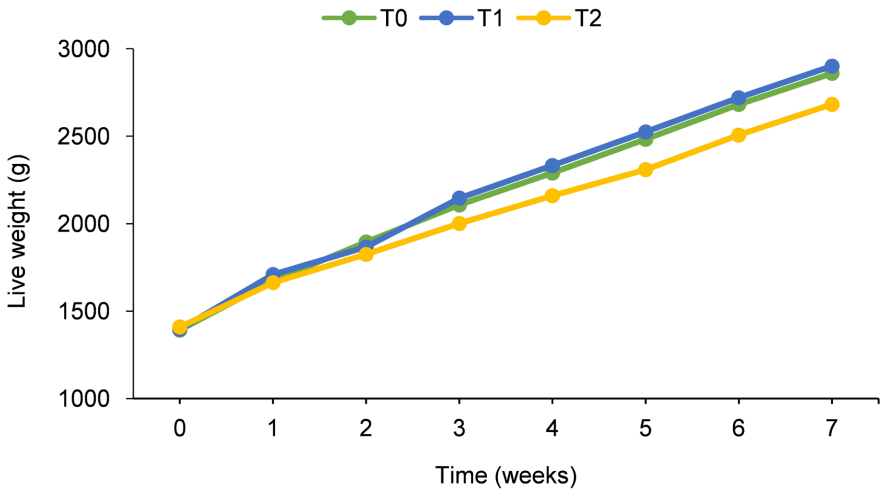
T0: control ration without pineapple press residue; T1: ration incorporated with 20% pineapple press residue; T2: ration incorporated with 40% pineapple press residue

Figure 2. Effect of the levels of pineapple press residue in the ration on the evolution of feed intake of rabbits.

3.4. Evolution of Live Weights of Rabbits

Figure 3 shows that throughout the trial, the curves showing the changes in the live weight of the animals according to the different rations presented the same trend and pattern. However, the curve materializing the weights of animals from batch T1 (20% pineapple press residue) tends to be above and that of animals from batch T2 (40% pineapple press residue) below the other curves. Indeed, from the

first week after birth, the weights of animals who received 20% pineapple press residue in their ration (T1) were highest, followed by those of animals having received 0% (T0) and 40% (T2) respectively.

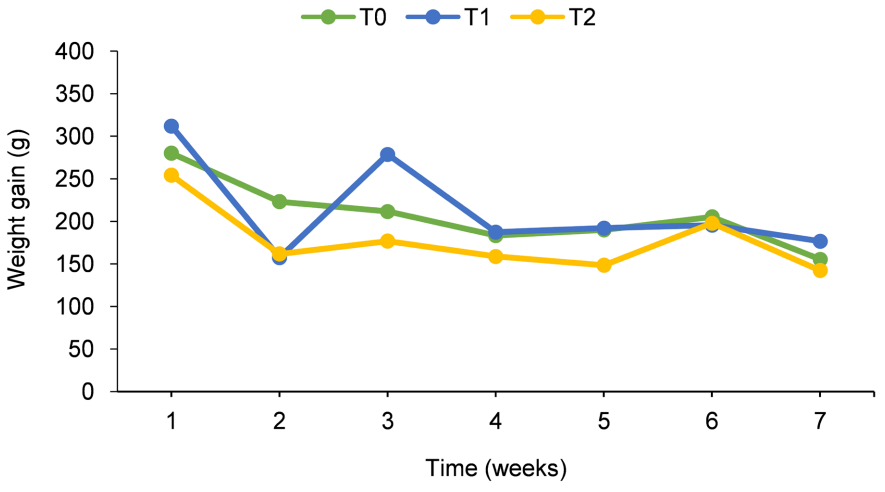


T0: control ration without pineapple press residue; T1: ration incorporated with 20% pineapple press residue; T2: ration incorporated with 40% pineapple press residue

Figure 3. Evolution of live weights of rabbits according to the level of inclusion of pineapple press residues in the ration.

3.5. Evolution of Weight Gain in Rabbits

The weekly evolution of weight gain shown in **Figure 4** revealed that they fell with age, whatever the ratio. However, the best weight gain was regularly obtained from animals having received 20% pineapple residue in their ration (batch T1) and the lowest from those having received 40% (batch T2).

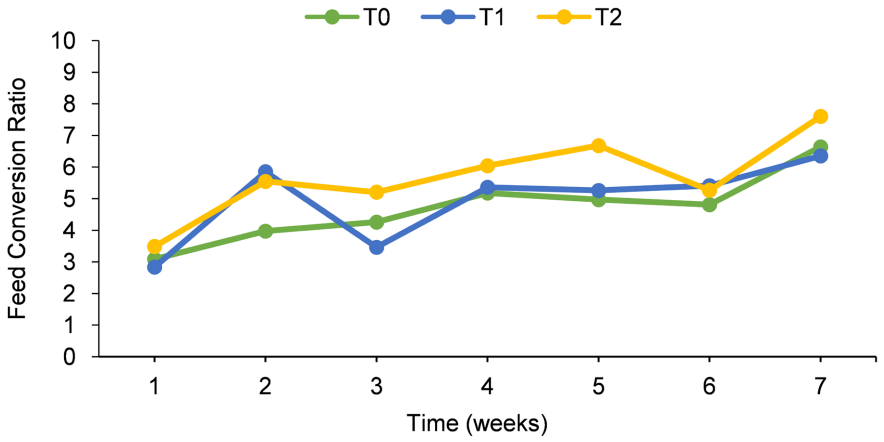


T0: control ration without pineapple press residue; T1: ration incorporated with 20% pineapple press residue; T2 ration incorporated with 40% pineapple press residue

Figure 4. Weekly evolution of weight gain of rabbits according to the level of inclusion of pineapple press residues in the ration.

3.6. Evolution of Feed Conversion Ratio of Rabbit

Figure 5 shows that the feed conversion ratio of all rabbits evolved in a jagged pattern. However, those of the animals which did not receive pineapple press residues in their ration (T0) had a downward trend throughout the trial, followed by animals in treatments T2 and T1 respectively.



T0: control ration without pineapple press residue; T1: ration incorporated with 20% pineapple press residue; T2 ration incorporated with 40% pineapple press residue

Figure 5. Evolution of feed conversion ratio of rabbits according to the level of incorporation of pineapple press residues in the ration.

3.7. Carcass Yields and Relative Weights of Organs

Carcass yields and relative weight of organs were significantly ($p < 0.05$) influenced by the presence of pineapple press residues in the animals' rations (Table 4). Indeed, the analysis of variance showed that the yields of commercial (53.07% ± 0.13%) and classic (76.15% ± 0.17%) carcasses of animals fed with the ration containing 20% pineapple press residues were significantly ($p < 0.05$) higher than those of the other animals. Furthermore, the yield of the classic carcass (73.17% ± 0.05%) of animals fed with the ration containing 40% pineapple press residue was significantly ($p < 0.05$) higher than that of animals from the control group (72.69% ± 0.21%).

Table 4 shows that the relative weight of the liver significantly ($p < 0.05$) increased with the level of pineapple press residues in the ration. The highest value (2.81% ± 0.03%) was obtained from animals that received 40% pineapple press residues (T2) and the lowest (2.38% ± 0.04%) from those in the control (T0). The relative weights of the kidneys of the animals fed press residues were comparable ($p > 0.05$) between them (0.55% ± 0.04% and 0.53% ± 0.03% respectively for batches T2 and T1) but significantly ($p < 0.05$) higher than that of the animals in control (0.45% ± 0.02%) group. As for the caecum, the significantly highest relative weight ($p < 0.05$) was obtained from animals in the control group (6.07% ± 0.18%) followed respectively by those of the animals from the T2 (4.40% ± 0.08%) and T1 (3.50% ± 0.19%) groups.

Table 4. Effect of levels of pineapple juice residues in the ration on carcass characteristics and on the relative weight of some digestive organs of rabbits.

Carcass characteristics (% body weight)	Rations			p
	T0	T1	T2	
Yields				
Commercial carcass	51.87 ± 0.28b	53.07 ± 0.13a	51.51 ±0.09b	0.00
Classic carcass	72.69 ± 0.21c	76.15 ± 0.17a	73.17 ± 0.05b	0.00
Relative organ weights				
Liver	2.38 ± 0.04c	2.66 ± 0.04b	2.81 ± 0.03a	0.00
Kidney	0.45 ± 0.02b	0.53 ± 0.03a	0.55 ± 0.04a	0.02
Caecum	6.07 ± 0.18a	3.50 ± 0.19c	4.40 ± 0.08b	0.00

a, b and c: means bearing identical letters are not significantly different ($p > 0.05$) for the same characteristics. T0: control ration without pineapple press residue; T1: ration incorporated with 20% pineapple press residue; T2: ration incorporated with 40% pineapple press residue; p: probability.

3.8. Effect of Levels of Pineapple Press Residue in the Ration on Feed Cost of Production of a Kg Body Weight of Rabbit

The incorporation of pineapple press residues reduced the cost of rations (Table 5). Indeed, the price per kg of the T1 ration (318.00 FCFA) was the least expensive, followed by that of the T2 ration (334.50 FCFA), the cost per kg of the T0 ration (341.50 FCFA) being the most expensive. In addition, the ration incorporated with 20% pineapple press residue (T1) presented the lowest feed cost of production of a Kg body weight of rabbit and that incorporated with 40% pineapple press residue (T2) had the highest cost.

Table 5. Effect of level of pineapple press residue in the ration on feed cost of rabbit production.

Features	**Treatments**		
	T0	T1	T2
Final live weight (g)	2859.42 ±98.35	2900.77 ± 124.74	2682.28 ± 109.66
Cost of Kg of granulated feed (FCFA)	341.50	318.00	334.50
Feed conversion ratio	4.39	4.63	5.42
FPC of Kg of rabbit (FCFA)	1499.19	1472.34	1813.00
FPC of a rabbit	4286.81	4270.92	4862.97

T0: control ration without pineapple press residue; T1: ration incorporated with 20% pineapple press residue; T2 ration incorporated with 40% pineapple press residue; FPC: feed production cost; FCFA: franc of the African financial community.

4. Discussion

The chemical composition of pineapple press residues indicated a crude protein content of 4.58% DM, lower than that obtained by Zagré [9] (8.11% DM) from spoilage and peelings of fresh pineapples, to that of Adeyemi [19] (5.11% DM) obtained from pineapple peel flour, to that of Aboh *et al.* [20] (7.06%; 6.81%; 6.12% DM obtained respectively from crushed pineapple heart, crown and peel). Crude fiber content of pineapple press residues in the present study (19.29% DM) was higher than the 15.2% DM obtained by Zagré *et al.* [9] from spoilage and peelings of fresh pineapples but lower than those obtained by Aboh *et al.* [20] flours from the crown (27.24% DM), heart (26.95% DM) and peels (19.99% DM) of pineapple. Furthermore, the energy value of pineapple press residues (2500 Kcal/kg DM) was higher than that of pineapple peel flour (2020 Kcal/kg DM) reported by Adeyemi *et al.* [19].

The incorporation of pineapple press residues into the ration significantly affected the feed intake of rabbits. These results confirm those of Aboh *et al.* [20], in their essay on the dietary supplementation of sheep with by-products from pineapple processing. This increase could be due to the fact that pineapple press residues essentially contain pulp (sweet part) of the pineapple. Their sweet taste would have improved the palatability of the ration.

The weight gain and final weight obtained from rabbits fed the ration containing 40% pineapple press residue were significantly lower than those obtained with the other rations. This downward trend was obtained by Aboh *et al.* [21] who incorporated 20%, 30% and 40% of dried pineapple skin in rabbit's ration and observed that beyond a 20% incorporation level, the digestibility of feed and consequently, the weight gain and final weight of the rabbits decreased as the level of incorporation of pineapple skins increased in the ration. These results could be explained by the excessive incorporation of fiber in the rabbit ration. This is because excess fiber can fill the stomach and intestine, reducing the space available for essential nutrients necessary for growth such as protein and fatty acids, thus potentially having a negative effect on the growth performance of rabbits. In addition, fiber is difficult to digest. An excess in the ration can disrupt the digestion process and lead to a reduction in nutrient absorption [22] [23].

The feed conversion ratio was not significantly affected by the incorporation of 20% pineapple press residue. However, 40% pineapple juice residues in the ration significantly increased the feed conversion ratio of rabbits. This result could be explained by the existing positive correlation between feed intake and feed conversion ratio [3]. Indeed, animals fed with 40% pineapple press residue had a significant feed intake, but did not succeed in converting it into significant weight gain. Therefore, the feed conversion ratio was higher in these animals.

The yield of commercial and classic carcasses improved with the incorporation of pineapple press residue in the ration. This increase could be explained by the presence of bromelain, a proteolytic enzyme contained in the heart of the pineapple which, according to Wiszniewski [24], is able to hydrolyze proteins into

smaller and more digestible protein peptides. Indeed, proteases are already secreted throughout the digestive gut, the inclusion of pineapple press residues in the ration at a defined rate, increases the quantity of digestive enzymes and therefore improves the digestion of feed, particularly protein valorization. Proteins having a structural role in the body have therefore contributed to improving the carcass of rabbits. These results are consistent with those of Zagré *et al.* [9] who found that the diet based on pineapple waste allows for better quality carcasses and a better carcass yield in fattening pigs. The results of the present study are contrary to those of Aboh *et al.* [21] who found no significant variation in the carcass yield of rabbits fed rations containing dried pineapple skins.

The weight of the kidneys and liver significantly increased with the inclusion of pineapple juice residues in the ration. This increase could reflect the presence of a factor which could limit the use of pineapple press residues, or in the long term, be harmful to animals. Indeed, according to Rouas [25], kidney and liver weights are respectively indices of nephrotoxicity and hepathotoxicity.

The economic evaluation of the feed cost of production of a kilogram of live-weight rabbit in the present study showed that the incorporation of 20% pineapple press residues in the rabbit ration could reduce the cost of production of rabbits. This drop could be explained by the availability of pineapple press residues, which make it a more financially accessible ingredient.

5. Conclusion

Pineapple press residues have strong exploitation potential through their cellulose (19.29% DM), energy (2500 Kcal/kg DM) and mineral contents. Their incorporation at 20% in the ration allowed an improvement in growth performance (live weight, average daily weight gain, weight gain) and carcass yield and had a reducing economic impact on the production cost per kilogram live weight of rabbits. We can therefore use pineapple press residue to incorporate it in feed intended for rabbits.

Conflicts of Interest

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

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