Response of growing rabbits to graded levels of fermented and unfermented pineapple peel

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Abstract

Forty growing rabbits were allocated equally to five groups in a 2 x 3 factorial layout and caged individually for a 56-day trial period in hutches. They were used to compare the effects of two processing methods (unfermented and fermented) and three dietary replacement levels of Pineapple peel meal (PPM) at 0%, 12.5% and 25% of maize on weight for weight basis. Parameters evaluated during the trial period included: growth rate, feed intake, feed conversion ratio and feed cost. Results show that average daily weight gain (ADG) reduced ($P < 0.05$) as dietary inclusion level of PPM increased, although rabbits fed PPM at 12.5% dietary inclusion level compared favourably ($P > 0.05$) with those fed the control diet (0%). However, ADG of rabbits fed fermented PPM was statistically higher ($P < 0.05$) than that recorded for rabbits fed unfermented PPM. No significant ($P > 0.05$) difference was observed in daily feed intake of rabbits as a result of dietary inclusion level or processing type of PPM. Better ($P < 0.05$) feed efficiency was recorded in rabbits fed PPM at 12.5% dietary inclusion level than those fed at 25%. Fermentation enhanced the nutritional value of feedstuff and also improved feed efficiency. Total feed cost reduced ($P < 0.05$) by 21.39% when PPM was included in the diet at 25%. However, production result was not comparable with the control. But feeding fermented PPM at 12.5% inclusion level resulted in the best ($P < 0.05$) economy of production. Processing type or dietary inclusion level of PPM had no significant ($P > 0.05$) effect on dressing-out percentage of experimental animals. There were neither significant ($P > 0.05$) effects of processing type nor dietary inclusion level on retail cuts of the rabbits fed the different experimental diets. In all feeding rabbits with diets containing fermented PPM up to 12.5% replacement level for maize encouraged optimum performance.

Keywords: Rabbit performance. Pineapple peel meal. Fermentation. Retail cuts. Economy of production

Introduction

Poultry, pig and rabbit production represent the fastest means of correcting the shortage of animal protein intake. This is because, apart from their high rate of reproduction, these species are characterized by the best efficiency of nutrient transformation into high quality animal protein. Cheeke (1986) listed the advantages of rabbits over swine, poultry and other livestock. Rabbits have the ability to thrive on agricultural and agro-industrial by-products and they convert forages into meat more efficiently than

Ruminant animals. The flesh also has higher protein content than poultry, cattle and pigs (Youdeowei *et al.*, 1986). Rabbit is an animal with considerable potential for integration into the livestock farming system. Interest in rabbit production has been on the increase in recent years. Rabbit occupies a unique niche in that it is a mini livestock that is easy to manage, highly prolific and has a short generation interval. The cost of feeding rabbits is however very high, a condition that also prevailed for other Nigerian livestock

species (Adeyemi *et al.*, 2008). Agunbiade *et al.* (2001) explained that the most important and expensive feed items are the energy concentrates, usually grains. Ikurior and Akem (1998) observed that in many of the less developed tropical regions shortages in cereal grain supplies have persisted into the terminal years of the twentieth century. The resulting unprecedented increase in the cost of grains necessitated intensive investigations into the use of agricultural and agro-based industrial by-products. One of such by-products is pineapple peel.

Pineapple is a monocotyledonous perennial herb that probably originated from South America (Purseglove, 1988). In South America, the fruit of some wild species such as *Ananas monstrosus* and *Brondia karatas* (Pinuella) are eaten, while others (*Ananas lucidus erectifolius*) are used as fibre (Py *et al.*, 1984). Pineapple is eaten fresh. The fruit contains 80-85% water, 12-15% sugar, 0.4% protein, 0.5% ash (chiefly potassium), 0.1% fat, some fibre and several vitamins (mainly A, B and C) (Samson, 1986).

Owing to the increasing investigations of alternative feedstuffs and the scanty reports on the use of Pineapple Peel Meal (PPM) as dietary source of energy in rabbit nutrition, this study was carried out to:

Evaluate the effect of dietary level of PPM in the diet of growing rabbits.

Evaluate the effect of fermentation on the feeding value of PPM for rabbits.

Evaluate the effect of PPM based diet on carcass composition, and

Undertake a cost evaluation.

Materials and methods

Preparation of experimental diets

Pineapple peels were obtained from Dee Bee Company (Makers of Popapine®

pineapple wine), Isonyin, Ogun State, Nigeria. These peels were divided into two equal parts. The first half was sun-dried on a concrete floor for four days with constant turning until a constant weight was obtained. It was then milled for incorporation into the experimental diets. The second half was packed into a plastic drum, tightly sealed and allowed to ferment for 7 days. By the 7th day, the fermented material was sun-dried as described for the unfermented portion and milled. Five samples each of the fermented and unfermented pineapple peels were taken from different portions in the milled bag of pineapple peels and subjected to proximate analysis. Other ingredients were obtained from a feed depot in Ayetoro. The composition of experimental diets is presented in Table 1.

Experimental animals and management

A total of 40, six week old weaner rabbits weighing between 500 and 600g, and of mixed breeds (New Zealand x Chinchilla) and sexes were used for the 56-day feeding trial. They were randomly divided into 5 experimental groups of 8 rabbits per treatment after balancing for weight. The experimental layout was a 2 x 3 factorial combination of processing methods of test material (fermented and unfermented) and dietary PPM inclusion levels (0%, 12.5% and 25%). The experimental site is situated in the south-western part of Nigeria which is a derived savannah zone with a mean annual precipitation of 1100 mm, mean annual temperature of 34.4 °C and a relative humidity of 76%. It is in the region 72 m above sea level of latitude 7°5'-7°8' N and longitude 3°11.2'E.

The animals were individually housed in washed and disinfected hutches raised 90cm above the floor, measuring 40 x 25 x 42cm and provided with wire screen floor which permit faeces and urine to drop.

Each animal was provided with water trough and feeder. All rabbits were injected with Ivomec® (1ml/50kg) and allowed to adapt for 10 days before experimental feeding. The experimental diets were offered *ad-libitum in pellet form while cool water was offered free choice*. Records of feed intake and body weight changes were kept while feed conversion (measured as feed: gain ratio) was calculated.

Cost Analysis

The prevailing market prices of the feed ingredients were used to estimate the unit cost of the various diets. Feed cost and cost per weight gain were calculated. At the time of the experiment €1 was equivalent to ₦185.

Table 1: Percentage Composition of Experimental Diets (g/100g)

Ingredient	Diets				
	1	2	3	4	5
Maize	50.00	37.50	25.00	37.50	25.00
UPPM	-	12.50	25.00	-	-
FPPM	-	-	-	12.50	25.00
Brewers Dried Grain	20.00	20.00	20.00	20.00	20.00
Groundnut Cake	22.00	22.00	22.00	22.00	22.00
Fish Meal	2.50	2.50	2.50	2.50	2.50
Salt	1.00	1.00	1.00	1.00	1.00
Oyster Shell	1.50	1.50	1.50	1.50	1.50
Bone Meal	2.50	2.50	2.50	2.50	2.50
Premix	0.50	0.50	0.50	0.50	0.50
Total	100	100	100	100	100

Diet 1 – 0% Pineapple Peel Meal (PPM)
Diet 2 – 12.5% Unfermented Pineapple Peel Meal (UPPM)
Diet 3 – 25.0% Unfermented Pineapple Peel Meal (UPPM)
Diet 4 – 12.5% Fermented Pineapple Peel Meal (FPPM)
Diet 5 – 25.0% Fermented Pineapple Peel Meal (FPPM)

Carcass Analysis

At the end of the feeding trial, four rabbits whose weight were close to the mean treatment weight were picked from each treatment, tagged, fasted overnight from solid feed but allowed access to water and slaughtered by cutting the jugular vein. The carcass was cut into prime parts including Fore leg, Thoracic cage and Hind legs, weighed and expressed as a proportion of final live-weight. In

addition, organs including the pancreas, heart, liver, kidney, spleen, caecum and lungs were excised out and weighed. Liver weight was taken without gall bladder while weight of both kidneys were measured without perirenal fat (Blasco and Ouhayoun, 1993).

Analytical and Statistical procedure

The proximate composition of the test ingredients and experimental diets were determined by the method of A.O.A.C. (1990).

All data collected were subjected to statistical analysis appropriate for 2 x 3 factorial layout using Minitab Analytical Computer Package (Minitab Inc., 1999). Significant differences between treatment means were determined using the Duncan's Multiple Range Test (Steel and Torrie, 1990).

Results and Discussion The proximate composition of fermented and unfermented pineapple peel meals presented in Table 2 indicated a crude protein (CP) content of 7.28 and 5.11% respectively. Fermentation had been reported to enhance the nutritional value of feedstuff, especially the protein content (Eka, 1979). The CP values are less than the value of 8.8% reported for maize (NRC, 1994). Lamidi *et al.* (2008) reported a value of 9.13% as crude protein content of pineapple crush waste. Value obtained, however, are higher than 4.13% crude protein content of pineapple waste (PW) reported by Fapohunda *et al.* (2008). One likely reason for this apart from varietal differences may be the inadequate description of test materials. The dry matter, crude protein and nitrogen free extract contents of the FPPM were slightly higher than those of the UPPM, while the crude fibre, ether extract, ash and gross energy contents of

the UPPM were slightly higher than those of the FPPM. This trend is comparable to that reported by Adeyemi *et al* (2007) and Adejinmi *et al.* (2007) for unfermented and fermented whole cassava root meal and cocoa pod husk respectively. Result

Table 2 : Proximate Chemical Composition (g/100g DM) of fermented and unfermented pineapple peel meal

Component	FPPM	UPPM
Dry matter	86.72	85.90
Crude protein	7.28	5.11
Crude fibre	23.36	27.95
Ether extract	1.55	1.79
Ash	9.84	11.80
Nitrogen free extract	56.97	53.35
Gross energy (MJ/Kg)	7.78	8.45

obtained indicated that PPM is a good source of dietary fibre but relatively low in crude protein, it is also uniquely low in fat and could serve as energy diluents when compounding a low fat diet for rabbits.

The proximate composition of the experimental diet is presented in Table 3. The crude fibre, ether extract and gross energy contents were slightly higher in diets containing UPPM, while the crude protein, dry matter, ash and nitrogen free extract contents were slightly higher in the diets containing FPPM. Eka (1979) opined that during fermentation of foodstuffs, there may be an enrichment of the products as fermented products tend to exhibit a relative increase in protein, lipid and ash content even though the products may have decreased carbohydrate content.

Table 3: Proximate Composition g/100g gross energy content of experimental diets

Diets	DM	CP	EE	CF	ASH	NFE	GE(MJ/Kg)
1 (0% PPM)	90.91	19.80	6.98	6.04	9.64	57.54	11.92
2 (12.5% UPPM)	91.48	19.66	5.76	9.68	10.33	54.57	11.22
3 (25% UPPM)	89.72	19.52	5.58	10.08	10.08	54.70	10.53
4 (12.5% FPPM)	91.86	19.84	19.84	8.72	10.76	55.27	11.17
5 (25% FPPM)	91.57	19.89	19.89	8.78	10.50	55.48	10.42

UPPM - Unfermented pineapple peel meal

FPPM - Fermented pineapple peel meal

Result showed that diet 3(25% UPPM) had the lowest crude protein (19.52%) while diet 6(25% FPPM) had the highest (19.89%). However, the crude protein values observed are within the range 18 - 22% reported by Omole (1982) for optimal production of rabbits in the tropical environment. The inclusion of FPPM increased the crude protein contents of the experimental diets. The relatively higher crude fibre of the UPPM

reflected in the higher fibre in the experimental diets (diets 2(12.5% UPPM) and 3(25% UPPM) that contained it. Diet 3 also recorded the highest crude fibre value of 10.08%. The decreased gross energy observed due to fermentation may be attributed to the fact that a large proportion of the fermentable carbohydrates of the pineapple peels could have been removed during fermentation, which may have resulted in

the fermented PPM based diets having reduced energy values. The control (0% PPM) recorded the highest gross energy (11.92 MJ/Kg).

The results of main effects of PPM level and processing type on rabbits performance characteristics are presented in Table 4 while the interaction are shown in Table 5. The average initial live weights respective of level of PPM (560.00g) and processing type (558.79g + 10.65) were similar ($P>0.05$). General performance of rabbits reduced with increasing concentration of PPM in the diet. However, rabbits fed PPM at 12.5%

inclusion level in the diet compared favourably ($P>0.05$) with those fed the control diet in terms of average final live weight gain, average total weight gain, average weekly weight gain, average daily weight gain, feed conversion ratio and protein efficiency ratio. Rabbits fed PPM at 25% inclusion level in the diet recorded the lowest ($P<0.05$) average final live weight and average total weight gain (1210.76g and 650.76g respectively) as well as feed conversion and protein efficiency ratios (8.23 and 0.62 respectively).

Table 4: Main effects of level of PPM and processing type on rabbits performance characteristics

Parameter	Level of PPM (%)				Processing Type			Interaction
	0	12.5	25	SEM	F	N F	SEM	
Av. Initial live weight (g)	560.00	560.00	560.00	-	558.37	559.21	10.65	NS
Av. final live weight (g)	1241.48 ^a	1232.60 ^s	1210.76 ^b	19.50*	1238.62 ^a	1217.48 ^b	14.74*	*
Av. total weight gain (g)	681.48 ^a	672.60 ^a	650.76 ^b	9.81*	680.25 ^a	658.27 ^b	8.17*	*
Av. weekly weight gain (g)	85.19 ^a	84.08 ^a	81.35 ^b	1.17*	85.03 ^a	82.28 ^b	1.23*	*
Av. daily weight gain (g)	12.17 ^a	12.01 ^a	11.62 ^b	0.23*	12.15 ^a	11.75 ^b	0.19*	*
Av. feed: gain	5320.60	5332.30	5346.70	61.23 ^N	5468.14 ^a	5397.33 ^b	55.67*	NS
Av. feed: gain (g)	665.08	666.54	668.34	7.96 ^{NS}	683.52 ^a	674.67 ^b	8.80 ^{NS}	NS
Av. feed: gain (g)	95.01	95.22	95.48	1.26 ^{NS}	97.65	96.38	1.41 ^{NS}	NS
Av. feed: gain (g)	7.80 ^b	7.92 ^b	8.23 ^a	0.15*	8.04 ^b	8.20 ^a	0.11*	*

Figures in a row respective of level of PPM and processing type bearing different superscripts are significantly different (* $P<0.05$)

Table 5: Interaction effects of PPM level x processing type on performance characteristics

Parameter	Level of PPM (%)						SEM
	0	12.5		25			
		F	N F	F	N F		
Av. final live weight (g)	1241.48 ^a	1235.43 ^a	1200.75 ^c	1217.38 ^b	1182.67 ^d	15.21*	
Av. total weight gain (g)	681.48 ^a	676.97 ^a	652.81 ^c	667.03 ^b	643.04 ^d	8.63*	
Av. weekly weight gain (g)	85.19 ^a	84.62 ^{ab}	81.60 ^c	83.38 ^b	80.38 ^c	1.37*	
Av. daily weight gain (g)	12.17 ^a	12.09 ^a	11.66 ^c	11.91 ^b	11.48 ^d	0.16*	
Feed: Gain	7.80 ^d	7.90 ^{cd}	8.19 ^b	8.01 ^c	8.33 ^a	0.12*	

Figures in a row bearing different superscripts are significantly different (* $P<0.05$).

This may have been brought about by the high fibre content (27.95%) of the test ingredient which could be indigestible at high inclusion level in the diet. It has been shown that rabbits are less efficient at digesting fibre than sheep or cattle (Joyce *et al.*, 1971). Dry matter, crude protein and other nutrient digestibilities have been reported to decrease with increasing fibre level in the diets (Adegbola and Osiyi, 1985; Onifade and Tewe, 1993; Alokun, 2000). Presence of anti nutritional factors in the test material may also be implicated. Jaeger *et al.* (1998) had reported that pineapple contains tannins and pectins which have effect on growth. Consistent growth response was observed for rabbits fed diets containing fermented PPM in terms of average final live weight, average weight gain, total feed intake and feed conversion ratio. This suggested that fermentation of PPM before dietary inclusion enhances (P<0.05) these performance

indices. This positive response may be attributed to the effects of fermentation on the test material namely: enzymatic predigestion, acquisition of flavour, friability and reduction of anti nutritional factors such as tannins and pectins. Eka (1979) reported that fermentation enhances the nutritional value of feed stuffs especially the protein content. The increase in the crude protein content is thought to be associated with the proliferation of microbial bodies Adeyemi *et al.* (2007). Adejinmi *et al.* (2007) reported that fermentation of cocoa pod husk before dietary inclusion had a positive effect on average final live weight, average total weight gain, average daily weight gain and feed conversion ratio. Dietary inclusion level of PPM had no significant (P>0.05) influence on total feed intake, weekly feed intake and daily feed intake.

However, dietary inclusion level of PPM resulted in numerically (P>0.05) higher values than those recorded for the control in term of these parameters. Growing rabbits- have been reported to compensate for the low nutrient concentration of feed mixtures by a corresponding increase in feed intake (Schlölaut, 1985). The range of feed intake values obtained in this study is within the range of 80 -115g reported by Davidson and Spreadbury (1975). Increase in feed intake will normally result in increased body weight gain (McDonald *et al.*, 1988). The increased feed intake without corresponding increase in weight gain may be ascribed to lower energy concentration per kilogramme of feed with the rabbits increasing intake to meet their energy requirement (Hill and Dansky, 1954). Lang (1981) reported that rabbits feed intake is primarily to satisfy their energy requirement. Lebas *et al.* (1986) stated that a growing rabbit is able to adjust its voluntary feed intake according to the energy concentration of the diet in order to maintain constant daily intakes of 920 - 1000KJDE/kgW^{0.75} per day. Cheeke and Amberg (1972) observed increased voluntary feed intake with increased dietary crude fibre in growing rabbits. Also, the result agree with the earlier work of Esonu *et al.* (2003) which showed that inclusion of fibrous material in a feeding trial had an energy dilution effect on feed and consequently increased feed intake.

Pineapple peel meal is relatively fibrous and, this could be responsible for the depression in the weight gain as fibre impaired digestion and absorption of nutrients (Fernandez and Jorgensen, 1986). The average daily weight gain of 1 1.86g (1 1.48 - 1 2.17g) obtained in this study is lower than 34 to 41 g per day

reported by Parigi-Bini and Chiericato (1975) and Deblas and Gravey (1975) for temperate climates, but the value

obtained is general higher

Table 6: Main effect of level of PPM and processing on cost analysis

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Parameter	Level of PPM				Processing Type			Interaction L x P
	0	12.5	25	SEM	F	N F	SEM	
Cost/kg	40.07 ^a	35.69 ^b	31.32 ^c	2.36*	37.51 ^a	33.72 ^b	1.22*	*
Feed (N)	5.32	5.33	5.34	-	5.47 ^a	5.40 ^b	-	-
Feed (kg)	213.17 ^a	190.23 ^b	167.56 ^c	16.87*	200.16 ^a	182.09 ^b	11.23*	*
Weight	0.68 ^a	0.67 ^a	0.65 ^b	-	0.68 ^a	0.66 ^a	-	-
Weight	313.49 ^a	283.93 ^b	257.78 ^c	19.26*	294.35	275.89	17.13*	*

SEM (N=5) were computed in Nair (N). At the time of the experiment €1 was equivalent to ₦185. Figures in a row respective of PPM level and processing type bearing different superscripts are significantly different (*P<0.05)

than 5g per day reported by Adegbola and Akinwande (1981) and Ngodigha *et al.* (1999) respectively for tropical environment and only slightly lower than 15 - 20g per day obtained by Aduku and Olukosi (1990) also for tropical climate. The FCR of 8.05 (7.80 - 8.33) is similar to the value of 7.4 (4.8 - 10.4) reported by Aduku and Olukosi (1990) for rabbits in the humid tropics. Feed intake of rabbits fed diets with fermented PPM was statistically higher (P<0.05) than that recorded for rabbits fed unfermented PPM. This was probably due to the flavour that the fermented PPM added to the diet (Adejinmi *et al.*, 2007). Schlolaut (1985) observed that the quantity of feed intake in rabbits is dependent to a large extent on the palatability of the feed, the consistency and, in roughage, the fibre content. The feed intake pattern observed for the FPPM based diets agreed with the observation of Adejinmi *et al.* (2007) that feed intake increased when fermented cocoa pod husk (FCPH) was included in the diets of growing rabbits compared with non-fermented cocoa pod husk.

No positive (P>0.05) influence was observed as a result of dietary inclusion level or processing type of PPM on daily protein intake. Results showed positive interaction effect between dietary

inclusion level and processing type of PPM on average final live weight, average total weight gain, average weekly weight gain, average daily weight gain and feed conversion ratio. Increasing the level of dietary inclusion of PPM from 0 to 12.5% reduced final live weight of rabbits (P>0.05). However, average final live weight of rabbits significantly (P<0.05) reduced as inclusion level of PPM (fermented and unfermented) increased. This agreed with the report of Lamidi *et al.* (2008) who observed decreasing final body weight gain when the inclusion level of pineapple crush waste (PCW) was increased in broilers diet. Fapohunda *et al.* (2008) also reported decreasing live weight gain when the inclusion level of pineapple waste (PW) was increased in the diet of growing rabbits.

In all, performance of rabbits was better (P<0.05) when fermented PPM and maize based diets were offered to the animals than when unfermented PPM and maize based diets were fed. However, optimum performance was observed when fermented PPM was fed at 12.5% dietary inclusion level.

The result of main effect of level of PPM and processing type on cost analysis is presented in Table 6. Cost analysis data

for which significant interaction effect of level of PPM x processing type occurred are shown in Table 7. Results showed that dietary inclusion level of PPM and processing type had significant ($P<0.05$) difference on cost per kilogramme feed, total feed cost and cost per weight gain. Increasing the PPM level from 0 to 12.5% resulted in a 10.93% reduction in feed cost while at 25% PPM inclusion level, a cost reduction of 21.84% was obtained. This is similar to the findings of Adejinmi *et al.* (2007) who reported reduced cost per kilogramme feed with increasing level of cocoa pod husk in the diet of growing rabbit. Lamidi *et al.* (2008) also reported reduced cost of feed per kilogramme diet with increasing inclusion level of pineapple crush waste (PCW) in broilers diet. Total feed cost reduced by 10.76% when PPM inclusion level was increased from 0 to 12.5% while a cost reduction of 21.39% was obtained at 25% PPMN inclusion level. This result agreed with findings of Fapohunda *et al.* (2008) who reported that total feed cost reduced with increasing inclusion level of pineapple waste (PW) in the diet of growing rabbit. Cost of producing one kilogramme of rabbit meat reduced by 9.43% from 0 to 12.5% PPM level. While

at 25% PPM inclusion level, cost reduction of 17.77% was obtained. This is in agreement with the report of Fapohunda *et al.* (2008) that cost per weight gain reduced as the level of pineapple waste (PW) increased in the diet. Fermentation of PPM before dietary inclusion led to a 11.24% hike ($P<0.05$) in feed cost, increased ($P<0.05$) cost per weight gain by 6.69% and raised the total feed cost by 9.92%. ($P<0.05$). Adejinmi *et al.* (2007) reported that fermentation of cocoa pod husk before inclusion in the diet of growing rabbits did not ($P>0.05$) increase cost of feed. Level of PPM and processing type had positive interaction effect on cost per kilogramme feed, total feed cost and cost per weight gain.

In all, production cost was lowest ($P<0.05$) in rabbits fed unfermented PPM at 25% dietary inclusion level, the cost of producing a kilogramme of rabbit was N62.26 (€ 0.34) cheaper than the control diet. But, production result is not comparable with the control. Ekenyen (2002) reported that reducing feed cost per kilogramme was only justifiable when production result is comparable with the standard (control). Thus, feeding fermented

Table 7: Interaction effect of level of PPM x processing type on cost analysis¹

Level of PPM (%)							
	0		12.5		25		SEM
Parameter			F	NF	F	NF	
Cost/kg feed	40.07 ^a	37.49 ^a	31.67 ^b	30.23 ^b	25.06 ^c	2.95*	
Total feed cost	213.17 ^a	205.18 ^a	190.70 ^b	183.42 ^{bc}	175.56 ^c	9.76*	
Cost/weight gain	313.49 ^a	296.28 ^a	273.54 ^b	268.26 ^{bc}	251.23 ^c	18.57*	

¹ All costs were computed in Naira (N). At the time of the experiment €1 was equivalent to N185.

Figures in a row bearing different superscripts are significantly different (* $P<0.05$).

Table 8: Main effects of level of PPM and processing type on retail cuts of rabbits (% LW)

Parameter	Level of PPM				Processing Type			Interaction L x P
	(%0)	12.5	25	SEM	F	NF	SEM	
Dressing-out %	70.34	69.06	68.81	1.57 ^{NS}	69.79	68.00	1.83 ^{NS}	NS
Retail weight	18.27	17.59	17.30	0.67 ^{NS}	18.27	18.24	0.57 ^{NS}	NS
Thoracic cage weight	8.20	7.98	7.82	0.41 ^{NS}	8.13	8.00	0.33 ^{NS}	NS
Hind legs weight	19.30	19.19	18.83	0.48 ^{NS}	19.27	19.03	0.54 ^{NS}	NS
Hind legs weight	20.17	20.10	19.95	0.71 ^{NS}	20.03	19.91	0.81 ^{NS}	NS

Figures in a row respective of PPM level and processing type bearing different superscripts are different (*P<0.05).

Table 9: Main effect of level of PPM and processing type on relative organs of rabbits (% LW)

Parameter	Level of PPM %				Processing Type			Interaction L x P
	0	12.5	25	SEM	F	NF	SEM	
Pancreas	0.05	0.06	0.07	0.02 ^{NS}	0.06	0.08	0.18 ^{NS}	NS
Heart	0.24	0.28	0.26	0.04 ^{NS}	0.26	0.28	0.03 ^{NS}	NS
Liver	2.44 ^b	2.50 ^{ab}	2.55 ^a	0.07*	2.46 ^b	2.52 ^a	0.05*	NS
Kidney	0.87	0.88	0.89	0.18 ^{NS}	0.88	0.92	0.15 ^{NS}	NS
Spleen	0.06	0.05	0.07	0.02 ^{NS}	0.08	0.07	0.02 ^{NS}	NS
Caecum	2.32 ^b	2.38 ^b	2.53 ^a	0.08*	2.37 ^b	2.55 ^a	0.09*	NS
Lungs	0.46	0.51	0.48	0.06 ^{NS}	0.49	0.50	0.04 ^{NS}	NS
Stomach	1.58	1.55	1.53	0.07 ^{NS}	1.56	1.54	0.10 ^{NS}	NS
Small intestine	1.53	1.49	1.45	0.10 ^{NS}	1.56	1.45	0.12 ^{NS}	NS

Figures in a row respective of PPM level and processing type bearing different superscripts are significantly different (*P<0.05)

PPM at 12.5% inclusion level resulted in the best economy of production as N296.28 or €1.60 (N17.21 or € 0.09 cheaper than the control diet) was expended to produce similar (P>0.05) body weight as the control.

Result of the main effects of level of PPM and processing type on retail cuts of rabbits are presented in Table 8. The non significant (P>0.05) difference in the dressing-out percentage indicated that PPM level and processing had very little effect on dressing-out percentage. Values obtained decreased with increasing dietary level of PPM but increased with increasing dietary level of PPM. The

results were however better with fermentation. A fibre-rich feed which lowers the speed of growth has been reported to reduce slaughter yield (FAO, 1997). This assertion gave credence to the result obtained for performance indicating poorer result with increasing dietary level of PPM and better result with fermentation Fapohunda *et al.* (2008) reported insignificant (P>0.05) consistent reduction in dressing-out percent of rabbits fed different levels of pineapple waste (PW). Lamidi *et al.* (2008) observed an insignificant (P>0.05) inconsistent reduction in dressing-out percent of rabbits fed different levels of

pineapple crush waste (PCW). Dressed weight could be said to be of much importance to rabbit meat consumer because the head, shank, fur and innards form an addition to this (FAO, 1997). In this study, the dressing-out percentage varied from 68.00 - 70.34%. This result is similar to 69.49 - 73.98% obtained by Lamidi *et al.* (2008), but higher than that (52.05 - 53.36%) reported by Sobayo *et al.* (2008). Davendra (1966) stated that division of a carcass into primal parts will enable comparison be made between various defined areas of the carcass. The observed numerically higher values ($P>0.05$) in terms of processing type on Fore leg weight, Thoracic cage weight, loin, foreleg and Hind legs weight might be attributed to the positive effect of fermentation on the feeding value of test material. Increased weight of retail cuts improves profitability of rabbits (FAO, 1997). Results obtained showed that the interaction of PPM level x processing type did not ($P>0.05$) significantly influence retail cuts. Results of main effect of level of PMM and processing type on organ weights are presented in Table 9. Except for liver and caecum, there was no evidence to suggest that the inclusion of the test material (PPM) in the diet had any negative significant ($P>0.05$) influence on the organ weights. This trend agreed with earlier reported of Sobayo *et al.* (2008) that the empty gut, lung spleen, kidney and heart of rabbits fed fomented maize waste, were not ($P>0.05$) statistically influenced. Significant ($P<0.05$) increase in liver weight was observed as a result of PPM level and processing type. But, no positive interaction effect ($P>0.05$) between PPM level and processing type on liver weight was recorded. The liver percent reported increased numerically ($P<0.05$) with increasing inclusion level of PPM while

fermentation brought about a significant ($P<0.05$) reduction. It is probably that the test ingredient contained anti nutritional factor. Jaeger *et al.* (1998) had reported that pineapple contains tannins and pectins which have effect on growth. According to Aderemi (2003), presence of anti nutritional factors has been associated with the enlargement of organs like liver and pancreas because of their higher detoxification activity. Caecum percent showed a significant ($P<0.05$) impact as a result of dietary inclusion level of PPM as well as processing type. But, no positive interaction effect between these two was observed on the caecum. 25% PPM inclusion level in the diet reflected the expected impact of the digestion of test material on the organ. Consequently, an increase in the weight of this organ occurred with increased PPM inclusion in the diet. Sarojim (2001) reported that fibre (especially cellulose) is digested in the caecum of rabbits.

Conclusion

The findings of this study revealed that average daily weight gain (ADG) reduced as dietary inclusion level of PPM increased. Daily feed intake of rabbits and dressing out percentages were not affected by dietary inclusion level or processing type of PPM. Better feed efficiency was recorded in rabbits fed PPM at 12.5% dietary inclusion level than those fed at 25%. Fermentation enhanced the nutritional value of feedstuff and also improved feed efficiency. Total feed cost reduced by 21.39% when PPM was included in the diet at 25%. However, production result was not comparable with the control. But feeding fermented PPM at 12.5% inclusion level resulted in the best economy of production. It was concluded that feeding growing rabbits with diets containing fermented PPM up to 12.5% replacement level for maize

encouraged optimum performance.

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