EFFECTS OF REPLACING MAIZE WITH CASSAVA WHEY MEAL IN THE DIETS OF RABBITS

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ABSTRACT
A sixty-day feeding experiment was conducted to study the effect of diets containing different replacement levels of cassava whey meal (CWM) on growth performance, blood profile and carcass characteristics of rabbits. The maize portion of the diets was replaced with the CWM at 0% (Control), 50% (CWM-50%), 75% (CWM-75%) and 100% (CWM-100%). Fifty-six weaner rabbits of mixed breeds and sexes with an average initial live weight of 0.7 kg were randomly allocated to the four diets based on sex and live weight in a Randomized Complete Block Design (RCBD). There were fourteen rabbits per treatment and each animal served as a replicate. Each rabbit was offered a daily allowance of 0.4 kg of the required diet and water was provided ad libitum throughout the period of the experiment. The results of the experiment showed that the feed intake was similar (p >0.05) among the different dietary treatments. Rabbits fed the CWM-100% diet recorded the highest weight gain (p <0.05) compared to those offered the CWM-50% and CWM-75% diets. The feed to gain ratio recorded for the rabbits fed the CWM-100% diet was similar to those given the Control and CWM-50% diets but substantially (p <0.05) better than the rabbits offered CWM-75% diet. The blood profile parameters and carcass characteristics were similar (p >0.05) across the various treatments. Therefore, it was concluded that cassava whey meal can be used to replace maize in the diets of rabbits.

Keywords: *cassava whey meal, energy, gari, hydrocyanic acid, maize, starch*

INTRODUCTION
For several years now, the provision of suitable nutrition has been the utmost imperative constraint to livestock production in the tropics. This is as a result of the continual rise in prices of conventional feed ingredients, specifically, energy feed sources. The primary energy feed resource in standard livestock feed has been maize because its energy comes from highly digestible starch (Ogbuewu and Mbajiorgu, 2023). However, maize is also a staple food ingredient in most tropical countries and also serves as a raw material for most brewery industries (Puligunla *et al* 2020). Therefore, its usage as animal feed results in high feed cost and consequently high prices of livestock and livestock products.

Several studies have been conducted in Ghana to find alternative sources of feedstuffs to replace some or all of maize in the diets of monogastrics and micro livestock such as rabbits (Osman *et* *al*., 2023; Amoah *et al*., 2017). According to Rhule *et al.* (2012), cassava and its by-products have long been recognised as excellent sources of energy for monogastric farm animals and as prospective alternatives to maize in their diets.

Cassava whey or cassava waste water, however, is a by-product of cassava processing that has not garnered much attention. It results from the manufacturing of 'Gari' using cassava (*Manihot esculenta*) which involves several unit operations including peeling, washing, grating, pressing and fermenting, sieving and roasting. There is a generation of liquid waste or wastewater (usually containing significant amounts of starch, protein, and hydrocyanic acid) which occurs during the dewatering stage. This waste water is released directly into the environment causing pollution to water bodies and farm lands.

However, there is a dearth of information on the use of cassava wastewater residue as energy source in the diets of rabbits. Hence, the objective of the study was to evaluate the effects of replacing maize with cassava whey meal in the diets of rabbits on the growth performance, carcass characteristics and economy of production.

MATERIALS AND METHODS

Location and duration of the experiment

The experiment was conducted at the Beef/Dairy Cattle Research Station, Boadi, Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana. The monthly average temperature of the location was 28°C and the corresponding monthly average relative humidity was 80%. The study lasted for sixty days.

Source of cassava whey (cassava wastewater residue)

The cassava whey was obtained from a gari processing factory located at Woraso-Mampong in the Ashanti region, Ghana. It was dried in a solar dryer to a moisture content of 10 - 12%. The dried whey was then milled with a hammer mill to produce the cassava whey meal (CWM). In a previous experiment, the proximate analysis of the cassava whey meal indicated that, it contained a higher energy value of 3459.70 kcal/kg and a lower crude protein value of 1.94% CP.

Experimental animals and design

Fifty-six weaner rabbits of mixed breeds (Californian and New Zealand White breeds) and sexes with an average initial live weight of 0.7 kg were used for the experiment. The rabbits were between 5 – 7 weeks of age. They were randomly allocated to four dietary treatments based on sex and live weight in a Randomized Complete Block Design (RCBD). There were fourteen animals per treatment (i.e., seven males and seven females) and each animal in a cage served as a replicate.

Dietary treatments

The four dietary treatments were made up of a control diet (maize) and three other diets containing CWM replacing 50%, 75% and 100% maize respectively. The diets were pelleted and the composition is shown in Table 1.

Management

The rabbits were housed individually in wooden cages that were two-tiered and floors welded with wire mesh. Each cage (36 x 24 x 24 inches) had an earthenware feeder and drinker explicitly designed to avoid spillage. Each rabbit was offered a daily allowance of 0.4 kg of the required diet and water was provided *ad libitum* throughout the period. Drugs (coccidiostat and broad-spectrum antibiotics) were administered to prevent intestinal coccidiosis and bacterial infections.

Parameters measured

Weekly feed intake and weight changes were recorded and corresponding total and daily feed intakes and weight gains were calculated. The feed conversion ratio (FCR) was calculated as the ratio of feed consumed to the weight gained by each rabbit. They were taken off feed for 24 hours and humanely slaughtered, defurred and eviscerated for carcass evaluation. All the rabbits were used for carcass evaluation and blood samples were taken for haematological and serum Biochemical parameters. The carcass parameters considered were Chilled carcass weight, liver, kidney, lung, full and empty stomach, full intestine, and large intestine. Two blood samples (5 ml each) were collected from each rabbit by cardiac puncture into two labelled, sterilized bottles containing EDTA (anti-coagulant) and clot activator. The first sample was subsequently analysed for haematological parameters whilst serum was obtained from the second sample for biochemical studies.

Statistical Analysis

All data obtained were subjected to Analysis of Variance (ANOVA) using the GenStat Statistical Software (12th Edition, 2009) and differences between treatment means separated by the Tukey's range test at an alpha level of $p < 0.05$.

RESULTS AND DISCUSSION

Growth performance

There were no recorded mortalities nor signs of ill health observed during the feeding trial period. The quantity of feed consumed by the rabbits was similar (p >0.05) among the different dietary treatments (Table 2). It has been reported that feed intake is influenced by the energy, fibre, and total digestible nutrient of the diet (Gouri *et al*., 2016) and this was confirmed when rabbits were fed with different energy diets and those on low energy diet consumed more feed (77.61g/day) than their counterparts on high energy diet (67.87g/day) (Gouri *et al*., 2016). Amoah *et al.* (2017) stated that there is a direct relationship between the energy content of a diet and feed intake, in that, the higher the energy value of a diet, the lower the quantity of feed consumption

Table 1: Composition of the experimental feed (%, as-fed)

Ingredients	Dietary treatment			
	Control	CWM 50%	CWM 75%	CWM 100%
Maize	26.0	13.0	6.50	0.00
Cassava whey meal	0.00	13.0	19.5	26.0
Soyabean meal	19.0	19.0	19.0	19.0
Rice bran	40.0	40.0	40.0	40.0
Wheat bran	10.0	10.0	10.0	10.0
Oyster shells	2.00	2.00	2.00	2.00
Fishmeal	2.39	2.39	2.39	2.39
Salt	0.30	0.30	0.30	0.30
Vit-min. premix*	0.25	0.25	0.25	0.25
Methionine	0.06	0.06	0.06	0.06
Total	**100**	**100**	**100**	**100**
Calculated composition, %				
Crude protein	17.9	17.1	16.7	16.2
Ether extract	4.18	4.24	3.18	3.20
Crude fibre	8.00	8.00	8.00	8.00
Calcium	0.50	0.50	0.50	0.50
Available Phosphorus	0.21	0.20	0.20	0.42
Salt	0.40	0.40	0.40	0.43
Methionine	0.30	0.30	0.30	0.30
Lysine	0.79	0.79	0.80	0.80
Metabolizable energy (kcal/kg)	2462	2463	2485	2487

**Vit-min. premix: Vit.A, 12,000,000 IU; Vit.E, 15000 mg; Vit.B1, 1500 mg; Niacin 30,000 mg; Vit.B6, 1500 mg; Vit.D3, 4500,000 mg; Vit. K3, 3,000 mg; Pantothenic acid,12000 mg; Vit.B12, 10,000 mg; Vit. B2,6000 mg; Folic acid, 800 mg, Iron, 60,000 mg; Copper 75,00 mg; Iodine, 750 mg; Manganese, 130,000 mg; zinc, 70,000 mg; Selenium, 300mg; Calcium,17.50%, Lysine,1,330 mg; Methionine, 1,075 mg; B-Corotenic acid, 350 mg.*

and vice versa. The similar feed intake (*p* >0.05) among the rabbits on the different diets obtained in this study could be attributed to the similar metabolizable energy (kcal/kg) of the diets (Table 1). However, Shaahu *et al.* (2020) observed that replacing maize with different inclusion levels of composite cassava meal (i.e., 0, 25, 50, 75 and 100%) in the diets of weaner rabbits led to increased feed intake (*p* <0.05).

Rabbits fed the CWM-100% diet recorded the highest weight gain (*p* <0.05) compared to their counterparts offered the other cassava whey meal diets (i.e., CWM-50% and CWM-75%). One has to note that this was similar (*p* >0.05) to the weight gain by the rabbits fed the control diet.

On the other hand, it was reported that rabbits offered the maximum inclusion level of cassava starch residue diet recorded the lowest gain (*p* <0.05) compared to those on the maize diet (Oloruntola *et al.*, 2018). According to Olafadehan (2011) lower weight gained by rabbits fed with an ensiled cassava peel meal diet could be linked to the presence of the innate higher HCN content. Therefore, it could be inferred in this study that the HCN content in the CWM-100% diet did not have any adverse effect on the weight gain of the rabbits.

The feed conversion ratio value obtained for the rabbits fed the CWM-100% diet was similar to those fed the Control and CWM-50% diets but substantially (*p* <0.05) better than rabbits fed diet CWM-75%. The FCR is the ratio of feed intake to weight gain and therefore the poor weight gain recorded by the rabbits fed the CWM-75% could have accounted for the worst FCR value recorded.

Results from this study showed that as the quantity of CWM in the feed was increased, the unit cost of the feed decreased (Table 2). This is similar to several reports that increasing the inclusion level of agro-industrial by-products (AIBP) in the diets of farm animals led to a decrease in unit cost (Amoah *et al.*, 2017; Essien and Sam, 2018). It cost more (*p* <0.05) for rabbits fed CWM-75% diet to gain a kg weight compared to those fed the CWM-100% diet.

Carcass characteristics

The carcass characteristics of rabbits fed the four different dietary treatments is shown in Table 3. All the parameters studied were similar (*p* >0.05) across the treatments. The kidney and liver are known to be susceptible to toxicity because they are organs of toxin filtration.

Therefore, it could be implied that, the CWM diets fed to the rabbits in this study had no deleterious effects on the organs. Similar observation was also made by Oloruntanyan *et al.* (2007) in their study where maize was replaced with sun-dried cassava waste meal.

Table 2: Growth response of rabbits fed cassava whey meal diets

Parameter	Dietary treatments					
	Control	CWM-50%	CWM-75%	CWM-100%	SEM	p-value
Initial weight (kg)	0.71	0.71	0.70	0.70	0.004	0.90
Final weight (kg)	2.06^{ab}	1.91^{a}	1.91^{a}	2.17^{b}	0.04	0.001
Total feed intake (kg)	6.12	6.04	6.14	6.14	0.19	0.97
Daily feed intake (kg)	0.10	0.10	0.11	0.11	0.003	0.97
Total weight gain (kg)	1.35^{ab}	1.25^{a}	1.19^{a}	1.45^{b}	0.04	<.001
Daily weight gain (kg)	0.024^{ab}	0.022^{a}	0.021^{a}	0.026^{b}	0.008	<.001
Feed conversion ratio (FCR)	4.50^{ab}	4.90^{ab}	5.20^{b}	4.20^{a}	0.21	0.015
Feed Cost (GH¢/kg)	0.92	0.89	0.87	0.86	-	-
Feed cost per kg gain (GH¢)	4.15^{ab}	4.36^{ab}	4.54^{b}	3.60^{a}	0.20	0.014

[a,b]*Means with different superscripts within the same row are different (p <0.05)*

Table 3: Mean carcass characteristics of rabbits fed cassava whey meal diets

Parameters	Dietary treatments					
	Control	CWM-50%	CWM-75%	CWM-100%	SEM	p-value
Chilled carcass weight (kg)	1.38	1.34	1.44	1.35	0.05	0.43
Liver (kg)	0.06	0.05	0.05	0.05	0.003	0.27
Kidney (kg)	0.02	0.01	0.01	0.01	0.002	0.16
Lung (kg)	0.02	0.02	0.02	0.02	0.003	0.42
Full stomach (kg)	0.04	0.04	0.05	0.06	0.02	0.66
Empty stomach (kg)	0.02	0.01	0.02	0.02	0.004	0.39
Full intestine (kg)	0.47	0.39	0.40	0.42	0.03	0.25
Large intestine (kg)	0.17	0.11	0.12	0.11	0.02	0.08
Small intestine (kg)	0.13	0.12	0.14	0.13	0.01	0.87
Heart (kg)	0.01	0.01	0.01	0.01	0.43	0.14

Table 4: Blood indices of rabbit fed cassava whey meal diets

Parameters	Dietary treatments					
	Control	CWM-50%	CWM-75%	CWM-100%	SEM	P
Haematological						
Hb (g/dl)	9.75	10.5	10.3	10.1	0.32	0.45
HCT	31.8	34.7	26.8	32.8	2.74	0.27
RBC (x10^6/uL)	5.84	6.19	4.61	5.87	0.44	0.12
WBC (x10^3/uL)	8.65	9.32	7.35	7.32	1.07	0.49
MCV (FL)	55.0	56.1	57.4	56.1	1.32	0.63
MCH (%)	16.9	16.9	26.1	17.3	3.52	0.24
MCHC (%)	30.6	30.1	46.6	30.8	7.29	0.35
PLT (x10^3/DL)	625	570	510	532	48.2	0.40
Serum Biochemistry						
Urea (mmol/L)	7.40	6.88	7.17	9.78	0.92	0.17
Total protein (g/L)	55.8	58.0	56.3	51.3	1.86	0.13
GGT (u/L)	5.25	7.75	7.33	7.25	0.72	0.13
AST (u/L)	74.0	61.5	87.0	113.5	31.3	0.68
ALT (u/L)	99.8	80.3	129	74.8	20.9	0.31
Creatine (ng/dl)	124	125	123	124	10.3	0.99
Albumin (g/l)	29.3	29.5	30.3	29.0	0.97	0.78
Globulin (g/L)	26.5	28.5	26.0	22.3	1.53	0.09

Blood profile

Similar mean values (*p* >0.05) were recorded for the haematological and serum biochemical indices across the treatments indicating that the different diets had no detrimental effects on the health status of the rabbits (Table 4).

CONCLUSION

The complete replacement of maize with cassava whey meal (CWM-100%) in the diet of rabbits did not affect their health, growth performance, internal organs and economics of production and therefore could be used to replace maize in rabbit production without any adverse effect.

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