Feed Conversion and Growth of Broiler Chickens fed Cassava blended with a Universal Concentrate diet during the finishing-phase: an On-farm study in Jiwaka Province, Papua New Guinea

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ABSTRACT

Using greater proportions of local ingredients in poultry diets to improve profitability of small-scale farming has been a high priority in the PNG livestock sector for over 15 years. This study examined the growth and feed efficiency of Ross 308 broiler chickens fed cassava flour blended with a universal concentrate (UC+Cas) during the finishing-phase. The growth of broilers fed the UC+Cas ration (12.4 % MJ/kg ME, 22.4 % CP and 4.2 % CF) was compared to a commercial finisher diet (12.2 % MJ/kg ME, 19 % CP and 5.0 % CF) made mainly from imported ingredients. The trial was conducted on 6 smallholder village farms; each farm being considered a replicate. Broilers at 21 days-of-age were weighed and allocated to two floor pens on each farm in naturally ventilated sheds built of woven reed walls and grass-thatched roofs. Feed intake and conversion, weight gain and feed costs were measured from 22-42 day-of-age. Dry matter intake (g/day) of broilers fed the commercial finisher and the UC+Cas diet (99.1 vs. 97.7) were similar ($P>0.05$). Likewise, weight gain (g/day) for broilers fed the UC+Cas and commercial diet (21.0 vs. 20.40) and feed conversion (1.75 vs. 1.84) did not differ significantly ($P>0.05$). Final body weights (kg/bird) were also similar (2.50 vs. 2.49; $P>0.05$) except for feed costs (K/bird) which differed significantly (6.15 vs. 4.89; $P<0.05$) with higher costs observed for birds fed the commercial ration. The UC+Cas diet was 12.97 % cheaper, signifying a potential feed option for use by small-scale poultry enterprises to finish broiler chickens. Further evaluation is needed to verify costs and profit margins over consecutive production cycles.

Key words: Cassava flour, Universal concentrate, Ross 308 broiler strain, Feed conversion, Feed costs.

INTRODUCTION

Broiler chickens remain the fastest source of providing animal protein because of their rapid growth, ability to utilize feed efficiently and quick turn-over rate (Jiya *et al*., 2014). However, attempts to increase production have long been hampered by availability and high cost of conventional feed ingredients (Babatunde, 2013). In PNG most of the conventional feed ingredients are imported and therefore are relatively expensive (Maxwell *et al*., 2014).

As in most developing nations, the informal poultry sector in Papua New Guinea (PNG) is driven by small-scale farmers. This industry is valued at AU$67m with lowland provinces 60 % of broiler production with the remaining 40 % in the highland provinces (Glatz *et al*., 2013). However, the industry is largely constrained by the rising cost of commercial stockfeed thus the use of locally available feedstuffs to improve profitability of small-scale broiler production has been a high priority in the PNG' livestock sector for over 15 years (Glatz *et al*., 2013). The feed production sector in PNG is not localized, as most of the raw materials are sourced externally. This situation creates a heavy dependency on the more expensive imported products such as sorghum and wheat to produce compounded animal feed. The prices of these products are also affected by the increasing global demand for its use in both human and livestock consumption (Iyayi, 2009

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production. The growth of this industry is also being slowed by the depreciating value of the Kina (Black & Yalu, 2010). As pointed out by Glatz *et al.* (2013), the viability of village broiler farms in both geographical regions has been continually threatened by the rising costs of imported ingredients used in commercial feeds. Thus there is a need for alternative sources of feed that are cheap and affordable (Oluremi *et al*., 2007 cited by Jiya *et al*., 2014).

In poultry farming, feed accounts for up to 70 % of total production costs (Haitook, 2006; Maxwell *et al*., 2014; Anggorodi, 1990 cited by Hasanuddin & Rusdi, 2014), and is a very important component in determining the extent of poultry industry sustainability and profitability (Olugbemi *et al*., 2010 cited by Ngiki *et al*., 2014). It is therefore necessary to formulate inexpensive diets by using cheap ingredients (Tesfaye *et al.,* 2013) that do not attract competition between humans and livestock (Kana *et al*., 2014) to reduce costs and yet attain acceptable production levels.

In most developing countries, there exists a wide spectrum of agricultural by-products and feedstuffs, some of which are available in large quantities and have considerable nutritional potential (Ravindran, 1993). Cassava (*Manihot esculenta* Crantz) leaves and roots are exemplary of such a feedstuff with unrealized potential for livestock feeding (Tewe & Manner, 1977 cited by Ironkwe & Ukanwoko, 2012). Cassava is a high yielding starchy root crop of the tropics (Essers *et al*., 1994 cited by Tesfaye *et al*., 2013) and its wide acceptability in the tropics makes it a possible alternative to cereals as feed for poultry (Tesfaye *et al*., 2013). It is cheaper and easily accessible in both geographical regions of PNG. Cassava has been in use as an energy source in place of cereal grains for livestock feeding in the past (Eruybetine *et al*., 2013 cited by Ngiki *et al*., 2014) and its continued use is foreseeable in the 21st century and beyond (Ngiki *et al*., 2014).

Considerable work has been done on the nutrient composition and feeding value of cassava roots especially in broiler chickens' feed in place of cereal grains. Maxwell *et al*. (2014) reported heavier weight and a 13.25 % cost reduction in birds fed with the cassava-based diet compared to birds fed a commercial ration Ngiki *et al*. (2014) observed no significant differences in weight gain and feed conversion ratio (FCR) of broiler chickens fed cassava-root -leaf meal mixture (CRLFM) or a commercial ration during both the starter and finisher phases when the maize component was replaced with CRLFM. Average daily weight gains of broilers did not differ significantly when maize was substituted with cassava root chips at various levels (Tesfaye *et al.,* 2013). Black & Yalu (2010) also showed that all broiler rations where cassava is substituted for part of a commercial feed have distinct cost advantages for feeding broilers. Feeding a protein concentrate mix blended with local produce such as cassava and sweet potato (*Ipomoea batatas* L.) for finishing broilers is feasible (Glatz *et al*., 2013). Though proven to have increased farm profitability by 25-30 % (Pandi, 2007), extra effort is needed for cooking and preparation. Additional costs may be incurred where fuel is not easily accessible or in cases where sweet potato or cassava is not grown purposely for feeding poultry.

In the surge to harness the potential of using local ingredients in poultry diets, a universal concentrate (Table 1) for use with cassava flour was developed for small-scale poultry farmers. This can be used to finish broiler chickens or as a compound feed for laying genotypes. This study evaluated the feed conversion and growth of broiler chickens fed a broiler ration with 40 % cassava inclusion compared to a commercial broiler ration during the finishing-phase.

MATERIALS AND METHODS

Study area

Six farms from the Domil Cooperative with similar research experience with NARI were used in this study. The farms are situated at an elevation of 1531 m above sea level in the highlands region of PNG; within the Nondugl Rural Local Level Government District (North Waghi) at latitude -5° 52' 7.5144" South and longitude 144° 44' 45.6324" East (Domil Destinations Guide, 2015). The minimum and maximum temperatures during the study period, 24 December 2014 to February 04 2015, were 24 °C and 28 °C respectively. The annual rainfall varies between 2200 mm and 4000 mm with average relative humidity ranging from 80 to 86 % (Western Highlands Provincial Government, 2015).

Experimental animals

A total of 312 day-old Ross 308 broiler chicks of mixed sex were obtained from the hatchery at the Christian Leaders Training College (CLTC) in Banz for this study. The birds were distributed to the six farms with 52 birds per farm.

Housing and experimental design

The study was conducted on six different farms that used similar broiler sheds. Each farm had a similar open naturally ventilated shed with thatched roof made from grass (*Imperata cylindrica*). Reeds (*Miscanthus floridulus*) were split and woven together to construct the walls of these sheds. Each shed had two experimental pens measuring 2 m x 2 m in dimension and housed a total of 52 birds; with 26 birds per pen. The study used two treatment diets with each farm being considered a replicate of the treatment diets. Natural daylight was supplemented with artificial light provided from 1800 h to 0800 h using large hurricane lanterns throughout the study period.

Diet preparation, feeding and management

Cassava roots were sourced locally, cleaned and chipped, sun-dried and milled into powdered form (particle size of <0.2 mm) using a hammer mill at Domil's community mini-mill. The dietary treatments tested were a universal concentrate blended with cassava flour and a commercial finisher ration (Table 2).The commercial starter and finisher rations were obtained in bulk from Lae Feed Mills (LFM) in Lae, Morobe province supplied under LFM's Flame® brand.

Table 1: Ingredient composition of the universal concentrate (g/kg)

Universal concentrate*	
Ingredient	**Quantity (g/kg)**
Meat Meal	140.6
Blood meal	96.5
Fish Meal	105.3
Tallow	43.8
Soybean mill	219.3
Millrun	384
Choline Chloride	1
Rhodimet-88 Liquid (Methionine)	6.3
Avizyme	0.7
Mycostat	0.855
Sorbasafe	1.75
Universal concentrate blended with cassava	
Cassava flour	400
Universal concentrate	570
Broiler pre-mix	4
Palm oil	30

Each pen was equipped with a hanging tube feeder (6 kg) and drinker (6 L). Wood chips were used as litter material on the floors of all experimental pens to a depth of 3-5 cm to absorb droppings and spilled water from drinkers. A two-phase feeding regime was used across all farms in this study. The day-old birds were raised on a starter ration (Table 2) from day 0 to day 21 in a brooder. Lighting and heat were provided throughout the brooding-phase using hurricane lanterns in all sheds. Heat was supplemented with small fires on 3 sheds but no differences were observed in chick mortality across all farms. A total of 24 mortalities were recorded on only 2 farms as a result of predation by dogs. This was quickly rectified by reinforcing the woven walls at the base of each shed with timber closely nailed together to prevent further incidences. At day 22, the birds were weighed and 26 birds were randomly allocated to each of the two pens in each of the six individual sheds on each farm. The birds were introduced to the experimental diets after the allocation to individual pens.

Table 2: Nutrient specification of the diets expressed as percentage DM (metabolizable energy ME, MJ/kg)

Feed Type	DM	Ash	CF	Fat	CP	Ca	P	NFE	ME (MJ/kg)
Starter	89.8	9.81	4.1	7.7	21.0	1.26	0.70	47.19	12.13
Finisher	89.7	5.89	5.0	7.5	19.0	1.28	0.71	52.31	12.20
UC+Cas	90.1	7.80	4.2	8.3	22.4	1.23	0.92	47.40	12.44

DM= Dry Matter, Ash= mineral content estimate, CF=Crude Fibre, CP=Crude Protein, Ca=Calcium, P=Phosphorus, NFE= Nitrogen Free Extracts; consisting of carbohydrates, sugars, starches, and a major portion of materials classed as hemicelluloses in feeds, ME=Metabolizable Energy. Source: specifications from LFM and Carey Nutrition.

All diets were offered in mash form. Diets and water were supplied *ad libitum* throughout the experimental period of 20 days with over 200 g per bird fed every morning to ensure feed was available throughout the day. The test and control diets (Table 2) were fed from day 22-42. Drinkers and feeders were checked daily, cleaned and refilled with clean water and feed accordingly. The litter was turned when soiled and replaced with dry litter when necessary.

Feed cost

Feed costs were calculated based on feed intake of chickens on each diet. The unit costs (K/kg) for each feed type were determined before calculating costs;

$$\textbf{Unit cost of feed (K/kg)} = \frac{\text{Cost per bag of feed (K)}}{\text{Total weight of feed (kg)}}$$

Total cost of feed = Unit cost of feed (K/kg) x Total feed intake (kg)

Cost of producing a chicken on each diet was then calculated based on the 2014 selling price of stock feed and live meat birds in Banz (Table 4).

Data collection and analysis

Data on feed intake, body weight gain and cost of feed for each diet were recorded over 20 days commencing at day 22. Group body weights for birds in each pen were measured weekly. Feed offered and refusals were recorded daily with a kitchen scale (10 kg ±0.025 kg). Data on all parameters; dry matter intake (DMI), feed conversion ratio (FCR), average daily weight gain (ADG), final body weight (FBW) and feed costs were sorted using MS Excel® 2007 version. DMI was calculated based on feed intake of broilers while weight gain and FBW were derived as daily weight differences of birds and end weights at day 42 accordingly. FCR was calculated as amount of feed converted to body weight;

DMI = (%DM content of feed) x feed intake (as fed basis)

$$ADG = \frac{\text{weight of birds at day 42-ave weight of birds at day 22}}{\text{number of days}}$$

$$FCR = \frac{\text{feed intake (g)}}{\text{weight gain (g)}}$$

The data collected were then analysed using an analysis of variance (one-way ANOVA) in GenStat® discovery edition 3 to determine the main effects of diets on production variables. Least significant difference (LSD) was then used to separate differences between means where significant dietary effects were detected in the ANOVA.

RESULTS AND DISCUSSION

DMI, FCR, ADG, FBW, feed costs and bird mortality

There were no significant differences observed in feed intake and feed conversion for finishing-broilers on both diets. With the exception of feed cost, no growth parameters measured differed between the diets. The costs (K/kg) of feeding finishing broilers differed significantly with the least cost observed for the UC+Cas diet (Table 3). Maxwell *et al*. (2014) observed broiler chickens fed with cassava diets were heavier than birds fed a maize-based control diet (1882 ± 12 g vs. 1730 ± 15 g). No significant (*P>0.05*) differences were observed by Ngiki *et al.* (2014) in daily weight gain (41.76 g vs. 41.88 g) and feed conversion (3.15 vs.3.80) for birds fed a cassava root-leaf mixture as a substitute for maize during the finishing-phase.

Table 3: Growth performance data of the broilers

Parameters	DMI (g/day)	FCR (kg/kg)	ADG (g/day)	FBW (kg)	Costs (K)[†]
BR_STD	99.1[a]	1.84[a]	20.4[a]	2.50[a]	6.15[a]
UC+Cas	97.7[a]	1.75[a]	21.0[a]	2.49[a]	4.89[b]
S.E.M	2.31	0.12	1.09	0.09	0.13
Significance					
F pr.	0.667	0.609	0.707	0.941	0.001
CV (%)	5.8	16.8	13.0	9.1	6.2

[a] Means within columns with similar superscripts are not significantly different at *P<0.05*. S.E.M = Standard Error of Mean. BR_STD = standard broiler finisher (LFM). UC+Cas = universal concentrate (56.8%) blended with cassava flour (39.8%) including broiler pre-mix (0.4%) and palm oil (3.0%). [†]Cost of feeding based on feed intake of broilers during finishing-phase

The ADG (20.4 g vs. 21.0 g) observed in this study was higher than the values reported by Tesfaye *et al*. (2013). These authors recorded ADGs of 16.6 g, 15.7 g and 16.8 g when substituting maize with cassava root chips at 25 %, 50 % and 75 % respectively. No mortalities were observed within the experimental period (day 22 to day 42). Despite the UC+Cas diet having high DM and CP levels (Table 2) than the commercial finisher-ration, DM feed intake was not affected. Tesfaye *et al*. (2013) reported DM intake of two cassava-based finisher rations with 19.9 % and 20.5 % CP respectively to be lower than a similar ration having 19.3 % CP. El Boushy & van der Poel (2000) reported feed with dusty mash characteristics has lower acceptance by birds than wet mash. A similar trend was observed for the UC+Cas diet, however this did not have any noticeable effects on bird growth and feed efficiency. The high cost per bird for the commercial finisher reflects the high unit cost of this feed (Table 4).

Feed costs

Substituting commercial feed with local carbohydrate sources has cost reduction advantages for village broiler enterprises (Black & Yalu, 2010). The inclusion of cassava flour at 40 % proved to be economical with costs savings of up to 12.97 % observed for chickens fed the UC+Cas diet during the finishing-period (Table 4). Similar cost savings of 13.25 % were reported by Maxwell *et al.* (2014) when maize was substituted with cassava in chicken diets.

Table 4: Feed cost of production of broiler chickens during the finisher phase

Feed Type	Cost/b (K) Starter	Cost/b (K) Finisher	Total Cost/b (K)	Selling Price/b (K)	Profit Margin/b (K)
BR_STD	4.15	6.15	10.30	30.00	19.70
UC+Cas	4.15	4.89	9.05	30.00	20.95

These figures were less than the 25-30 % cost savings observed by Pandi (2007) who fed broilers a high energy concentrate blended with boiled and mashed cassava (HEC+Cas) in the finishing-phase. However, since the UC+Cas ration is fed as dry-mash it has a longer shelf-life and does not require use of fuel or extra efforts in cooking and preparation.

CONCLUSION

This study showed that the UC+Cas ration supported feed conversion and growth of broiler chickens without any adverse effects but with distinctive cost advantages. Cassava flour could therefore be an alternate source of energy to use as a substitute for wheat and sorghum in broiler diets. The UC+Cas diet has some beneficial potential that can be utilized to reduce costs of feeding broilers during the finisher-phase. However, further analysis inclusive of all associated costs of production is needed to determine the economic viability of using cassava with the universal concentrate in producing finisher feed for use by small-scale broiler farmers. These findings need to be supported by further studies that use cassava flour in starter and broiler grower rations and the associated costs of the diet. Attention also needs to be given to measuring the cyanogenic glycosides content of cassava flour after drying and milling and to reduce its dusty characteristics in the diet.

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