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# EVALUATION OF PERFORMANCE OF BROILER CHICKEN FED ON CASSAVA FLOUR AS A DIRECT SUBSTITUTE OF MAIZE

O. TADA, A. MUTUNGAMIRI[1], T. RUKUNI[1] and T. MAPHOSA[2]
Department of Livestock and Wildlife Management, Faculty of Natural Resource Management and Agriculture, Midlands State University, P. Bag 9055, Gweru, Zimbabwe
[1]Development Technology Centre, University of Zimbabwe, Box MP167, Mount Pleasant, Harare, Zimbabwe
[2]Department of Animal Science, Faculty of Agriculture, University of Zimbabwe, Box MP167, Mount Pleasant, Harare, Zimbabwe

## ABSTRACT

Maize *(Zea mays)* plays a key role in the poultry industry in Zimbabwe. Because maize is increasingly becoming expensive, it is imperative that alternative ingredients are sought in order to bolster this industry. One hundred and eighty (180) Cobb-500 day-old chicks were used to assess the opportunity of reducing the cost of maize-based diets for broiler production. Effects of incorporating cassava *(Manihot esculenta)* flour into diets at proportions of 0, 25, 50, 75 and 100% on the performance and carcass composition were investigated under natural conditions in Zimbabwe. Live-weight, feed intake and mortality were recorded and feed conversion efficiency calculated. At 6-week age, carcass samples were analysed for dry matter, ash, crude protein, crude fibre and ether extractable fat. Increased proportion of cassava flour in the diet resulted in a decrease in weight gain, feed conversion efficiency and dressed weight. Crude fibre content of chicken mince increased as maize content decreased in the diets. It is viable to substitute maize for cassava though profit margins fall. Cassava's nutritive value limits its inclusion level and maize will continue to be the major proportion of broiler diets.

*Key Words*: Carcass quality, *Manihot esculenta,* visceral organs, *Zea mays,* Zimbabwe

## RÉSUMÉ

Le maïs *(Zea mays)* joue un rôle important dans l'industrie des poules au Zimbabwe. Comme le prix du maïs augmente avec le temps, il est impératif que les ingrédients alternatifs soient fournies pour stimuler cet industrie. Cent quatre vingts épis, et les poussins vieux de 500 jours étaient utilizés pour évaluer l'opportunuité de réduire le coût de la diète sur base du maïs pour la production des poulets. Les effets de l'incorporation de la farine du manioc *(Manihot esculenta)* dans la diète avec la proportion de 0, 25, 50, 75 et 100% sur la performance et la composition de la carcasse étaient évaluées dans des conditions naturelles au Zimbabwe. Le poids du poulet vivant, la ratio alimentaire et la mortalité étaient enregistrées et l'efficacité de conversion était calculée. A l'âge de 6-semaines, des échantillons de carcasses étaient analysés pour la matière sèche, le cendre, les protéines brutes, des fibres bruts, et l'efficacité de l'ether à extraire de la graisse. L'augmentation de la farine de manioc dans la diète entraina une réduction du poids du gain, l'efficacité de la conversion de la ratio alimentaire, et le poids de la volaille parée. Le contenu en fibre brut du poulet haché augmenta avec la réduction de la farine de maïs dans la diète. Il est viable de substituer le maïs par le manioc malgré que la marge de profit décroit. La valeur nutritive du manioc limite son niveau d'inclusion, par consequent, le maïs restera la proportion major dans la diète des poulets.

*Mots Clés*: Qualité carcasse, *Manihot esculenta*, organes visceraux, *Zea mays*, Zimbabwe

## INTRODUCTION

Cassava has not been fully exploited in poultry production in Zimbabwe. Among other developing countries, Zimbabwe primarily devotes most of its hectarage to maize, simply because it is the main consumed crop as well as the basic dietary component in the poultry industry. Zimbabwe is sometimes drought stricken and imports maize grain to overcome shortages. This increases the cost of poultry production (Mtetwa, 1996).

The trends in the poultry industry in the last ten years show a marked decrease in both producers and production (CSO, 2001). Day-old broiler chick sales in the last quarter of 1999 were 13.7% less than previous (CSO, 2001). Egg sales in the communal areas in 1999 were 58,839 dozens and decreased to 31,447 dozens in 2000 indicating a 47% reduction. The major cause of the drop in production is the cost of production, particularly the cost of feeds.

Cassava is one of the non-conventional sources of energy in the mostly tropics. It outstrips maize in terms of starch content per unit mass (Teles *et al.*, 1995). As the most important root crop in terms of world production, cassava is ideal for lowland tropical cultivation. Economically, cassava gives high returns from limited labour and other inputs associated with smallholder farmers (Hew, 1995). Cassava, therefore, has potential to serve as livestock feed. This could possibly reduce the competition of poultry and man for maize. It is possible to completely replace grain in the diets of ruminants with cassava resulting in little reduction in animal performance (Gohl, 1991). This opens a window in non-ruminant research with cassava. This constitutes the objective of this study.

## MATERIALS AND METHODS

This study was conducted at the poultry unit of the University of Zimbabwe (UZ) Farm. One hundred and eighty Cobb 500 day-old chicks purchased from a reputable commercial breeder were used in the experiment. The broiler chicks were randomly allocated to the five different diets. With a total number of 20 cages, the five different diets were randomly allocated to the cages. The experimental unit was a replicate of nine birds in a cage. The experimental design was a completely randomised design (CRD). The birds were raised in the cages from day-old to six weeks.

Natural and artificial light was used for 24 hours per day. Ventilation was natural due to the appropriate walling system of the house that had less than one-metre brick-wall and wire meshes to the roof.

The starter diet was offered in the first three weeks and the finisher diet in the subsequent three weeks. Tap water was offered *ad libitum* as the formulated diets throughout the experiment. The daily feed intake and weekly live-weights were recorded. A digital Salter Electroscale (Salter Industrial Measurements Ltd, West Bromwich, West Midlands) was used for weighing the birds and feed. A vaccination programme for the birds followed the recommendation of the breeder.

Cassava tubers used in this study were knife-chopped into manageable small slices. The slices were sun-dried for two weeks with constant turning once a day. A hummer miller with a 5 mm sieve was used to grind the cassava chips into a fine powder. Yellow maize was obtained from the UZ Farm. Grinding was effected to give maize mash with a same miller as for the cassava.

Analytical figures for maize and cassava are presented in Table 1. The five formulated treatment

TABLE 1. Comparison (%) of the proximate nutritional qualities of cassava flour and maize meal

| Feed | DM | Ash | EE | CP | CF | GE (MJ kg$^{-1}$) |
|---|---|---|---|---|---|---|
| Cassava | 84.70 | 1.90 | 0.31 | 2.04 | 3.50 | 17.05 |
| Maize | 86.40 | 1.20 | 3.80 | 8.16 | 2.00 | 18.64 |

DM = Dry Matter, EE = Ether Extract, CP = Crude Protetin, CF = Crude Fibre, GE = Gross Energy diets tested in this study consisted of 0, 25, 50, 75 and 100% of cassava flour substituting maize meal. These were iso-nitrogenous at the starter and finisher level, i.e., 22 and 18% crude protein (CP), respectively. The difference was the amount of cassava flour substituting for maize on a weight-to-weight basis. The other ingredients common to most chicken feeds (Tables 2 and 3) were incorporated. The composition and proportions of the starter and finisher diet are presented in Tables 2 and 3, respectively.

At the end of the six-week period, a chicken from each cage was randomly selected and weighed for dressed weight, gizzard, liver, gall bladder, pancreas, heart and kidney. The length of the intestines was also measured. The minced chicken samples were subjected to Proximate Analysis for dry matter (DM), ash, ether extract (EE), crude fibre (CF) and CP. All the laboratory analysis followed the Association Official Analysis Chemistry (1990).

A partial budget analysis was used to evaluate the economic viability of the substitution diets. The chicken performance, carcass composition and economics cost data were subjected to the Analysis of variance (SAS, 1999) using the models that take into account the different levels of cassava inclusions. The individual treatment means were separated using the LSD procedure at 5% probability level.

## RESULTS

Cassava flour used in this study was higher in ash and crude fibre but lower in crude protein and ether extract than maize meal (Table 1). The low values of weekly live weights were associated with increased cassava inclusion levels (Table 4). The weekly feed intake per bird was nearly the same (P<0.05) (Table 5). The diet with 100% maize and 0% cassava gave the highest weight gain per week. The FCE estimates are set out in Table 5. The values decreased with increase in cassava content in the diets. Eleven deaths were observed across the diets during the course of the trial. Treatments with 0, 25, 50 and 100% had two cases of death each, while treatment with 75% cassava level recorded three deaths. On average, this was 5.5% bird mortality per diet. There was no significant differences (P<0.05) in this case.

TABLE 2. Ingredients and composition of the experimental starter diet for the broiler chickens (g kg$^{-1}$)

| Feed composition | % Cassava added | | | | | |
|---|---|---|---|---|---|---|
| | 0 | 25 | 50 | 75 | 100 | |
| Maize | 620 | 465 | 310 | 155 | 0 | |
| Cassava | 0 | 155 | 310 | 465 | 620 | |
| Ex. SBM | 300 | 300 | 300 | 300 | 300 | |
| Meat meal | 40 | 40 | 40 | 40 | 40 | |
| Wheat meal | 20 | 20 | 20 | 20 | 20 | |
| Limestone | 9 | 9 | 9 | 9 | 9 | |
| MCP | 4 | 4 | 4 | 4 | 4 | |
| Vit/min. | 5 | 5 | 5 | 5 | 5 | |
| Salt | 2 | 2 | 2 | 2 | 2 | |
| **Chemical composition** | | | | | | Mean (s.e) |
| DM | 91.6$^{a}$ | 90.9$^{c}$ | 91.3$^{b}$ | 91.5$^{a}$ | 91.2$^{b}$ | 91,3 (0.23) |
| Ash | 2.4$^{b}$ | 2.4$^{b}$ | 2.5$^{b}$ | 2.6$^{ab}$ | 2.6$^{a}$ | 2,5 ( 0.61) |
| EE | 1.5$^{a}$ | 1.3$^{b}$ | 0.9$^{c}$ | 0.7$^{d}$ | 0.7$^{d}$ | 1,02 (0.12) |
| CP | 22.4$^{a}$ | 22.3$^{a}$ | 22.1$^{b}$ | 21.9$^{bc}$ | 21.8$^{a}$ | 22,1 (0.35) |
| CF | 2.7$^{d}$ | 2.8$^{cd}$ | 2.9$^{bc}$ | 3.1$^{ab}$ | 3.2$^{a}$ | 2,94 (1.21) |
| GE | 18.25$^{a}$ | 16.72$^{b}$ | 16.34$^{c}$ | 15.89$^{d}$ | 15.19$^{e}$ | 16,48 (0.01) |

Ex. SBM = Extra Soyabean Meal, MCP =Mono Calcium Phosphate, DM = Dry Matter, EE = .Ether Extract, CP = Crude Protein, CF = Crude Fibre, GE = Gross Energy

Values with same superscript in each row are not significantly different (P<0.05)

The weight of the internal visceral organs the heart, gizzard and the liver decreased with increase in cassava inclusion level (Table 6). Ash, ether extract and crude protein also decreased with increasing cassava inclusion in the formulated diets. In contrast, crude fibre content of the chicken mince increased as maize content decrease in the diets (Table 6). Basing on the average current prevailing unit price per kilogram of dressed chicken of Zimbabwean dollar (Z$) 227.50, a partial budget was computed as shown on Table 7. The profit margins of the average bird in diet decreased with cassava inclusion level.

## DISCUSSION

The reduced performance observed with an increase in the inclusion level of cassava in the diets can be attributed to the associated poor digestibility. As postulated by Muller *et al.* (1994),

TABLE 3. Ingredients and composition of the experimental finisher for the broiler chicken (g $kg^{-1}$ )

| Feed composition | % Cassava added | | | | | |
|---|---|---|---|---|---|---|
| | 0 | 25 | 50 | 75 | 100 | |
| Maize | 650 | 487.5 | 325 | 162.5 | 0 | |
| Cassava | 0 | 162.5 | 325 | 487.5 | 650 | |
| Extra Soyabean meal | 270 | 270 | 270 | 270 | 270 | |
| Meat meal | 40 | 40 | 40 | 40 | 40 | |
| Wheat meal | 20 | 20 | 20 | 20 | 20 | |
| Limestone | 9 | 9 | 9 | 9 | 9 | |
| MCP | 4 | 4 | 4 | 4 | 4 | |
| Vit/mineral premix | 5 | 5 | 5 | 5 | 5 | |
| Salt | 2 | 2 | 2 | 2 | 2 | |
| Chemical composition | | | | | | Mean (s.e) |
| DM | $90.4^{a}$ | $90.3^{ab}$ | $90.3^{ab}$ | $89.7^{ab}$ | $89.6^{b}$ | 90.1(0.11) |
| Ash | $2.8^{b}$ | $3.0^{ab}$ | $3.2^{ab}$ | $3.2^{ab}$ | $3.4^{a}$ | 3.12(0.09) |
| EE | $2.9^{a}$ | $2.8^{ab}$ | $2.8^{ab}$ | $2.6^{b}$ | $2.6^{b}$ | 2.7(0.04) |
| CP | $18.7^{a}$ | $18.4^{a}$ | $18.3^{a}$ | $18.0^{a}$ | $17.8^{a}$ | 18.2(0.16) |
| CF | $3.2^{b}$ | $3.3^{ab}$ | $3.3^{ab}$ | $3.4^{ab}$ | $3.5^{a}$ | 3.3(0.04) |
| GE | $18.36^{a}$ | $17.92^{b}$ | $17.64^{c}$ | $17.25^{d}$ | $16.97^{e}$ | 17.63(0.03) |

MCP = Mono Calcium Phosphate, DM = Dry Matter, EE = Ether Extract, CP = .Crude Protein, CF = Crude Fibre, GE = Gross Energy

Values followed by the same superscript in each row are not significantly different (P<0.05)

TABLE 4. Weekly live weights of broiler chicken in kilogrammes in response to cassava dietary content

| Age (weeks) | Cassava inclusion level (%) | | | | | Mean (se) |
|---|---|---|---|---|---|---|
| | 0 | 25 | 50 | 75 | 100 | |
| 1 | $0.096^{a}$ | $0.091^{b}$ | $0.094^{ab}$ | $0.093^{ab}$ | $0.087^{c}$ | 0.092(0.50) |
| 2 | $0.228^{a}$ | $0.212^{b}$ | $0.204^{c}$ | $0.190^{d}$ | $0.162^{e}$ | 0.199(1.52) |
| 3 | $0.393^{a}$ | $0.365^{b}$ | $0.349^{c}$ | $0.312^{d}$ | $0.255^{e}$ | 0.335(1.24) |
| 4 | $0.653^{a}$ | $0.581^{b}$ | $0.520^{c}$ | $0.465^{d}$ | $0.384^{e}$ | 0.521(2.59) |
| 5 | $0.994^{a}$ | $0.911^{b}$ | $0.795^{c}$ | $0.688^{d}$ | $0.563^{e}$ | 0.790(1.15) |
| 6 | $1.235^{a}$ | $1.134^{b}$ | $0.975^{c}$ | $0.777^{d}$ | $0.638^{e}$ | 0.952(2.48) |

Values followed by the same superscript in each row are not significantly different (P<0.05)

TABLE 5. Feed intake and FCE of the broiler chicken as influenced by cassava inclusion in the diets

| Age (weeks) | Cassava inclusion level (%) | | | | | Mean | SE |
|---|---|---|---|---|---|---|---|
| | 0 | 25 | 50 | 75 | 100 | | |
| 1 | 127$^{b}$ | 114$^{b}$ | 128$^{ab}$ | 120$^{b}$ | 143$^{a}$ | 125.2 | 2.58 |
| 2 | 128$^{b}$ | 162$^{a}$ | 174$^{a}$ | 183$^{a}$ | 163$^{a}$ | 159.8 | 3.70 |
| 3 | 243$^{b}$ | 243$^{b}$ | 273$^{a}$ | 277$^{a}$ | 225$^{b}$ | 249.6 | 4.03 |
| 4 | 798$^{a}$ | 604$^{c}$ | 804$^{a}$ | 609$^{c}$ | 716$^{b}$ | 706.2 | 5.46 |
| 5 | 996$^{b}$ | 1052$^{a}$ | 1038$^{a}$ | 1038$^{a}$ | 982$^{b}$ | 1022 | 5.00 |
| 6 | 1280$^{d}$ | 1386$^{b}$ | 1357$^{bc}$ | 1446$^{a}$ | 1350$^{c}$ | 1363.6 | 4.81 |
| **Starter diet** | | | | | | | |
| Weight gain | 0.337 | 0.307 | 0.293 | 0.256 | 0.199 | | |
| Feed consumed | 0.493 | 0.507 | 0.565 | 0.578 | 0.53 | | |
| FCE | 0.68 | 0.61 | 0.52 | 0.44 | 0.38 | | |
| **Finisher diet** | | | | | | | |
| Weight gain | 0.842 | 0.769 | 0.626 | 0.465 | 0.383 | | |
| Feed consumed | 3.070 | 3.060 | 3.191 | 3.094 | 3.044 | | |
| FCE | 0.27 | 0.25 | 0.20 | 0.15 | 0.13 | | |

FCE = Feed Conversion Efficiency
Values followed by the same superscript in each row are not significantly different (P<0.05)

TABLE 6. The average weight of the internal visceral organs and carcass composition of chickens per treatment diet

| Organ | Cassava inclusion level | | | | | Mean | SE |
|---|---|---|---|---|---|---|---|
| | 0 | 25 | 50 | 75 | 100 | | |
| Heart (g) | 9.725$^{a}$ | 8.625$^{ab}$ | 7.450$^{ab}$ | 6.475$^{b}$ | 6.050$^{b}$ | 7.670 | 0.600 |
| Gizzard (g) | 39.900$^{a}$ | 33.050$^{ab}$ | 30.725$^{ab}$ | 30.825$^{ab}$ | 22.850$^{b}$ | 31.470 | 2.320 |
| Liver (g) | 37.075$^{a}$ | 35.125$^{a}$ | 32.75$^{a}$ | 31.275$^{a}$ | 30.000$^{a}$ | 33.250 | 2.390 |
| Kidney (g) | 1.800$^{ab}$ | 2.175$^{a}$ | 1.350$^{b}$ | 1.225$^{b}$ | 1.100$^{b}$ | 1.530 | 0.180 |
| Pancreas (g) | 3.950$^{ab}$ | 4.400$^{a}$ | 3.350$^{ab}$ | 3.200$^{b}$ | 3.425$^{ab}$ | 3.670 | 0.240 |
| Gall bladder (g) | 1.225$^{ab}$ | 1.500$^{a}$ | 0.638$^{b}$ | 0.950$^{ab}$ | 0.795$^{ab}$ | 1.020 | 0.160 |
| Intestine length (m) | 1.755$^{a}$ | 1.690$^{a}$ | 1.775$^{a}$ | 1.700$^{a}$ | 1.668$^{a}$ | 1.720 | 0.050 |
| **Carcass composition** | | | | | | | |
| DM | 35.1$^{a}$ | 34.9$^{ab}$ | 34.7$^{b}$ | 33.9$^{c}$ | 33.4$^{c}$ | 34.4 | 0.08 |
| Ash | 1.5$^{a}$ | 1.4$^{ab}$ | 1.3$^{bc}$ | 1.3$^{bc}$ | 1.1$^{c}$ | 1.3 | 0.02 |
| EE | 3.2$^{a}$ | 3.0$^{b}$ | 2.8$^{c}$ | 2.7$^{d}$ | 2.5$^{e}$ | 2.8 | 0.04 |
| CP | 23.0$^{a}$ | 22.6$^{ab}$ | 22.1$^{ab}$ | 21.9$^{b}$ | 19.6$^{c}$ | 21.9 | 0.14 |
| CF | 3.0$^{b}$ | 3.1$^{ab}$ | 3.2$^{ab}$ | 3.2$^{ab}$ | 3.3$^{a}$ | 3.2 | 0.05 |

Values followed by the same superscript in each row are not significantly different (P<0.05)

TABLE 7. Partial budget of the different cassava inclusion levels in maize basal diets

| 0 & 25% | | 0 & 50% | | 0 & 75% | | 0 & 100% | |
|---|---|---|---|---|---|---|---|
| Losses ($) | Gains ($) | Losses ($) | Gains ($) | Losses ($) | Gains ($) | Losses ($) | Gains ($) |
| 267.77 | 250.93 | 267.77 | 233.64 | 267.77 | 211.58 | 267.77 | 187.92 |
| 183.87 | 185.88 | 183.12 | 185.88 | 181.12 | 185.88 | 177.73 | 185.88 |
| 451.64 | 436.81 | 450.89 | 419.52 | 448.89 | 397.46 | 445.50 | 373.80 |
| - | 14.83[a] | - | 31.37[b] | - | 51.43[c] | - | 71.70[d] |
| 451.64 | 451.64 | 450.89 | 450.89 | 448.89 | 448.89 | 445.50 | 445.50 |

s.e = 0.09
Values followed by the same superscript in each row are not significantly different (P<0.05)

the amylolytic activity of cassava is 30% that of maize. This results in poor nutrient absorption and assimilation, and less protein accretion.

The appearance and feel (Kusina, Pers. commun., October, 2001, UZ) control feed intake in chicken. A hedonic response of the broiler chicken to the feed rations resulted in a decline in feed intake (though not significant, P<0.05). This could have been due to the powdery texture of cassava flour. Nambayo (1990) reported similar results from high levels of cassava inclusion in the rations; typically there was a depression in CF and reduced live weight gains.

In the same study, high starch content also found to reduce energy in cassava diets.

Cassava inclusion had no significant effect on mortality. Sun-drying the cassava tubers for two weeks likely eliminated toxic elements including bound and free cyanide (HCN), as deduced by Cooke and Madnagwa (1994).

Cassava inclusion in the formulated diets had no significant effect (P<0.05) on growth and development of the intestines and the liver. The significant differences observed among the hearts and gizzards could be attributed to the organs functions as to cope with the decreasing substrates with decrease in maize inclusion level. The kidney, pancreas and gall bladder varied in weights across the treatment diets to a less extend. A decline in carcass CP is due to low CP concentration in the diets. An increase in mince CF is conversely due to high CF content associated with the formulated diets. Chicken mince had lower ash and EE (P<0.05) values possibly due to poor mobilisation of cassava flour (Nambayo, 1990).

The cost of producing chicken with increasing levels of cassava inclusion decreased mainly due to the decreasing costs incurred during maize grinding and the cost of the feed. The cost of cassava as well as grinding is cheaper than that of maize; it is crudely set at 70% that of maize under commercial circumstances in Zimbabwe (Rukuni, T, Pers. Comm., October, 2001, DTC).

There is a significant difference associated with the inclusion levels on profit margins such that high cost of production has high profit margins. It is economically viable to produce chicken at all cassava inclusion levels, but a profit of Z$10.19 is not lucrative compared to Z$81.89 per bird. It can be said that the levels of cassava inclusion level in the broiler diets should be minimised to maximize returns.

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