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Research Application Summary

Growth and carcass traits in broiler chicken fed on low-tannin grain sorghum in Kenya

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Abstract

A feeding trial was performed to evaluate response of grower broiler chicken (*Gallus gullus domesticus*) to dietary replacement of maize (*Zea mays*) with low-tannin grain sorghum, *Sorghum bicolor* (LTS) in a small-holder poultry farm setting in Kenya. One hundred and twenty mixed-sex broiler chicks were allocated to three dietary treatments (1, 2 and 3) prepared by replacing maize with LTS at 0, 40 and 80 per cent (w/w), respectively. Forty broilers were allocated to each dietary treatment in four replications (n =10) and fed on the trial diets for 30 days. At five-day intervals, feed intake, weight gain and feed conversion efficiency were determined while five broilers from each treatment were assessed for carcass traits at the end of the feeding trial. Body weight gain, carcass yield and feed conversion efficiency was higher in broilers fed on the control (maize-based, without LTS) than on diets containing LTS; however, performance was similar between broilers on diets containing LTS. Although feed intake was higher – and feed conversion efficiency lower- for LTS diets, the cost of broiler production and carcass yield were not affected by the dietary level of inclusion of LTS but weight of breast and right limb were lower in birds fed on diets 2 and 3. Attainment of market weight by broilers fed on diets containing moderate-to-high levels of LTS in the grower-finisher phase, raises possibility for enhancing replacement of maize with LTS in commercial broiler feed production.

Key words: Dietary level, *Gallus gullus domesticus*, market weight, trial diets

Ré**sum**é

Un essai d'alimentation a été effectué pour évaluer la réponse du poulet de chair (Gallus gullus domesticus) a un regime alimentaire de substitution du maïs (Zea mays) avec du sorgho à faible teneur en tanins, Sorghum bicolor (LTS) dans une petite ferme de volaille au Kenya. Cent vingt poussins mixtes ont été soumis à trois régimes alimentaires (1, 2 et 3) préparés en remplaçant le maïs par LTS à 0, 40 et 80 pour cent, respectivement. Quarante poulets de chair ont été soumis à chaque régime suivant quatre répétitions (n = 10) et ont été alimentés pendant 30 jours. À intervalle de cinq jours, l'apport alimentaire, le gain de poids et l'efficacité de la conversion alimentaire ont été déterminés pendant que cinq poulets de chair de chaque traitement ont été évalués pour des caractéristiques de carcasse à la fin de l'essai d'alimentation. Le gain de poids corporel, le rendement en carcasse et l'efficacité de la conversion alimentaire étaient plus élevés chez les poulets de chair nourris au régime contrôle (à base de maïs, sans LTS) que chez les poulets nourris au régime contenant le LTS; cependant, la performance était similaire entre les poulets de chair nourris au régime contenant LTS. Bien que l'apport alimentaire soit plus élevé - et l'efficacité de la conversion alimentaire moins élevée - pour les poulets nourris au régime LTS, le coût de la production et le rendement de la carcasse n'ont pas été affectés par le niveau d'inclusion de LTS, mais le poids de la poitrine et de la cuisse droite était plus faible chez les poulets nourris avec des régimes alimentaires 2 et 3. L'obtention du poids de vente chez les poulets de chair nourris avec des régimes contenant des niveaux modérés à élevés de LTS dans la phase de finissage du producteur, soulève des possibilités pour améliorer le remplacement du maïs par le LTS dans la production commerciale d'aliments pour poulets à griller.

Mots clés: niveau alimentaire, *Gallus gullus domesticus*, poids du marché, régime alimentaire

Introduction

Poultry farming in Kenya depends mainly on commercially produced chicken feed which is heavily reliant on maize (*Zea mays*) as the main energy ingredient (MLD, 2011). However, a rising demand of maize as human food has led to a steady increase in cost of poultry feed. This high cost of commercial diets for chicken has resulted in lower income to small holder poultry farmers due to increased cost of production. One important measure that can be taken to alleviate such a threat to livelihoods and incomes of small holder poultry farmers is the use of relatively low priced alternative energy sources like sorghum (*Sorghum bicolor*) in poultry feed. As the only cereal species indigenous to Kenya, sorghum cultivation is possible between sea level to 2,500 meters, but is mainly grown in marginal areas that are unsuitable for production of most crops. Despite maize and sorghum having close similarities in chemical composition, a number of sorghum cultivars contain significant amounts of condensed tannins – a plant secondary metabolite found in negligible quantities in maize (Bravo, 1998). Tannins bind to proteolytic enzymes in the digestive tract, starch and protein in sorghum forming indigestible complexes manifested by decreased digestibility of dietary nutrients when coloured high-tannin sorghum is taken by man, swine or poultry (Dicko *et al.,* 2006; Medugu *et al.,* 2011). In the past decade, the Kenya Agricultural Research Institute (KARI) in collaboration with East African Breweries Limited (EABL) has actively promoted the use of low tannin sorghum (LTS) varieties, such as Gadam and Kari Mtama I, mainly to supplement barley in beer production (ACET, 2015). In addition, agronomic trials on imported sweet sorghum varieties support possibility for local adoption and production of most low-tannin sorghum varieties (Owino *et al.,* 2013). Consequently, increased availability of LTS has spurred interest in exploring possibility for partial or full replacement of maize in broiler chicken feeding. Irrespective of the tannin content, protein content in sorghum varies and ranges between 6 to 15 % with about 80, 16, and 3% of the protein in the endosperm, germ, and pericarp, respectively (Rooney and Serna-Saldivar, 2000). Alcohol soluble kafirins constitute the major protein fraction in grain sorghum (Bryden *et al.,* 2009). Kafirins bind to starch and tannins forming stable protease resistant complexes which are responsible for the low digestibility of sorghum protein and starch in monogastric animals (Duodu *et al.,* 2002). The LTS is reported to have higher protein (and probably higher kafirin) but lower starch compared to traditional coloured varieties (Kiprotich *et al.,* 2015). The lower tannin content of LTS enables inclusion of the grain at higher levels in broiler rations but, relative to maize, the nutritive value of LTS could be affected by Kafirins, among other anti-nutritive factors. The objective of this study was to determine growth and carcass traits in broilers fed on a moderate-to-high dietary inclusion of low-tannin grain sorghum.

Materials and methods

One hundred and twenty broiler chickens, aged 12 days, were housed in wire-netting pens on deep litter at a small-scale poultry farm in Kiambu County, Kenya. Three broiler grower diets were prepared by replacing maize in the control diet (Treatment 1; without LTS) with low-tannin sorghum (gadam) at 40 % and 80 % (w/w in Treatments 2 and 3, respectively) (Table 1).

Table 1: Composition of trial diets containing low-tannin grain sorghum

Ingredient (kg)	Trt 1*	Trt 2	Trt 3
Maize	653	391	130
LT- sorghum	0	262	523
Soybean meal (44 % CP)	300	300	300
Methionine	1.0	1.2	1.4
Vitamin Premix	2.5	2.5	2.5
Salt	2.5	2.5	2.5
Steamed bone meal	23	23	23
Limestone	18	18	18
Coccidiostat	0.5	0.5	0.5
Total (kg)	1000	1000	1000
Nutrient composition (estimated)			
ME (kcal/kg)	2957	2952	2950
CP %	18.67	18.70	18.80
CF %	3.86	3.90	4.00
Ca %	1.0	1.0	1.0
P (available) %	0.44	0.45	0.46
Lysine %	1.02	1.01	1.01
Methionine %	0.40	0.40	0.40

Diets 1, 2 and 3 contain 0, 40 and 80 per cent (w/w) LT-Sorghum, respectively

Trt = Treatment

Forty broiler chicks, aged 12 days, were allotted to each treatment in four replications (n=10) and fed on the trial diets for 30 days. The daily feed intake, live-weight gain and feed conversion efficiency (FCE) were determined. On day 30 and 42, five chickens were sampled from each treatment, slaughtered and assessed for carcass yield, weight of the liver, breast and right limb.

Results

At the end of the feeding trial, feed intake was higher, while daily weight gain and feed conversion efficiency was lower in broilers fed diets containing LTS (Table 2). Relative to the control, increasing dietary level of LTS did not affect the cost of feeding but the weight of entire breast and right limb was lower in birds fed on the two LTS diets (Table 3).

Table 2: Feed intake of broilers on trial diets

	Cumulative feed intake (g/bird)		
Age (days)	Trt 1*	Trt 2	Trt 3
15	425.25	467.25	485.20
20	720.35	690.25	755.15
25	1020.35	1085.25	1073.20
30	1540.80	1724.10	1780.60
35	1980.40	2264.30	2336.35
41	2636.60 ^{a}	2914.50 ^{b}	3025.30 ^{b}
FCE	1.72^{a}	1.95^{b}	2.02^{b}

a, b: Means followed by the same letter within a row are not significantly different ($p<0.05$).
Trt = Treatment

Table 3: Live weight change of broilers fed on trial diets

	Cumulative weight (g)		
Age (days)	Trt 1*	Trt 2	Trt 3
15	284.75	285.25	300.25
20	475.75	446.50	459.75
25	725.60	715.15	708.20
30	1017.25	986.20	967.10
35	1322.10	1262.20	1224.24
42	1532.90^{a}	1494.60 ^{b}	1496.65 ^{b}

a, b: Means followed by the same letter within a row are not significantly different ($p<0.05$).
Trt = Treatment

Table 4: Carcass traits of broilers fed on trial diets

Carcass traits	Trrt 1*	Trt 2	Trt 3
Production cost (KES/kg)	158.20	160.30	159.80
Carcass yield (%)	69.90	68.60	68.30
Breast (g)	715.80[a]	650.80[b]	641.40 [b]
Right limb (g)	275.60 [a]	260.60 [b]	251.8 [b]
Liver (g)	31.4	30.30	25.00

a, b: Means followed by the same letter within a row are not significantly different (p<0.05).
Trt = Treatment

Discussion

Scarcity of market outlets for low-tannin grain sorghum has been identified as the main constraint limiting widespread production of the cereal in the vast semi-arid regions of Kenya (Kilambya and Witmer, 2013). In addition to beer production, wider acceptance and application of LTS in commercial feeding of poultry could further expand market outlets, enhance production and lower market prices of the grain.

In Kenya, evaluation of chemical composition of local low-tannin sorghum varieties (Kiprotich *et al.,* 2015) indicates that the grain could be used as a source of dietary energy in broiler nutrition. In regions that practise extensive production of low-tannin sorghum, acceptable performance in growth, feed conversion efficiency and carcass quality has been reported when maize is partly or wholly substituted by LTS in broiler rations (Medugu *et al.,* 2010; Fernandes *et al.,* 2013). However, a higher feed intake observed in broilers fed on the two sorghum diets in this study could be a manifestation of compensatory response by the birds to lower dietary energy concentration relative to the control; the amount of starch in low-tannin sorghum has been reported to be lower than in maize (Kiprotich *et al.,* 2015). Similarity in the cost of broiler production between sorghum and maize, regardless of the feed intake, is attributed to lower purchase price of LTS than maize (KES 26 against 38, respectively) used to prepare trial diets. Apart from tannins, presence of anti-nutritive factors such as kafirins, indigestible starch, phytates and non-starch polysaccharides in sorghum (Dicko *et al.*, 2006) could have contributed to the diminished broiler response in the present and comparable studies (Medugu *et al.,* 2010).

Conclusion

Although replacement of maize with low-tannin grain sorghum in broiler rations slightly compromised growth and efficiency of chicken-meat production, this study demonstrates possibility for enhanced utilization of low-tannin grain sorghum as a source of dietary energy during the grower-finisher phase of broiler production. In Kenya, availability of low-priced LTS to the feed industry is likely to improve following increased production of this cereal grain driven by an expanding demand for low-tannin sorghum by the beer industry.

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