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Research Application Summary

Evaluation of incorporation of hydrolyzed *Prosopis juliflora* pods in indigenous chicken layers feed

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Abstract

In developing countries, cereals are the major source of human food and non-ruminant livestock feed. They are usually in short supply and their use in feed manufacture leads to increased prices. There has been much interest over recent years to explore alternative feedstuffs because of the challenges associated with reliance on conventional feed ingredients. Consequently, it is essential to explore alternative feed resources that are locally available and affordable. *Prosopis juliflora* pods are among the alternative feed resources identified and studied in Kenya. It is locally referred to as 'Mathenge'and its pods have a Crude fiber (22%CF). The soluble fiber increases the viscosity of the intestinal digesta therefore making it difficult for the chyme to mix thoroughly with enzymes for purpose of digestion and absorption of nutrients. This is because of lack of indigenous non starch hydrolyzing enzymes in the gut of poultry. Non convectional feed resources like *Prosopis juliflora* pods can be used to feed livestock and reduce competition with humans on cereals and hence ensure a food security for animals. The objectives were to determine the nutrient composition of 'mathenge' compared to maize with emphasis on fiber, minerals and energy and also look at performance of layers based on feed intake and egg production of feeds compounded with up to 50% 'mathenge' substituting maize. Proximate analysis and gross energy determination was done at Egerton University while minerals were determined at Kenya agricultural and livestock research organization, Njoro. Enzymes at the rate of 720g/tonne of feed were used. The metabolizable energy and crude fiber was 15.54 MJ/kg DM and 3.52% for maize and 15.68 Mj/kg DM and 21.53% for *prosopis juliflora* pods. Feed containing 0, 20, 30, 40, and 50% *prosopis juliflora* pods substituting maize were offered to indigenous layer for twelve weeks. Feed intake was not significantly different for treatment one and two but different from treatment 3, 4, and 5. Egg production was not significantly different in all treatments. Utilization by management of *Prosopis juliflora* pods by making poultry feeds will reduce the invasion by the tree in arid and semi-arid areas.

Keywords: Crude fiber, 'Mathenge', metabolizable energy, Non convectional feed resources, proximate analysis

Résumé

Dans les pays en développement, les céréales constituent la principale source d'alimentation humaine et de nourriture pour le bétail non ruminant. Elles sont généralement en quantité limitée et leur utilisation dans la fabrication d'aliments pour animaux entraîne une hausse des prix. Ces dernières années, l'exploration d'aliments alternatifs pour animaux a suscité beaucoup d'intérêt en raison des difficultés liées à la dépendance à l'égard des ingrédients conventionnels. Par conséquent, il est essentiel d'explorer des ressources alimentaires alternatives qui sont localement disponibles et abordables. Les gousses de *Prosopis juliflora* font partie des ressources alimentaires alternatives identifiées et étudiées au Kenya. On l'appelle localement 'Mathenge' et ses gousses contiennent des fibres brutes (22%). Les fibres solubles augmentent la viscosité du digesta intestinal, ce qui rend difficile le mélange du chyme avec les enzymes pour la digestion et l'absorption des nutriments. Ceci est dû au manque d'enzymes indigènes non hydrolysant de l'amidon dans l'intestin de la volaille. Les ressources alimentaires non conventionnelles comme les cosses de *Prosopis juliflora* peuvent être utilisées pour nourrir le bétail et réduire la concurrence avec les humains sur les céréales et donc assurer la sécurité alimentaire des animaux. Les objectifs étaient de déterminer la composition nutritionnelle du 'mathenge' par rapport au maïs, en mettant l'accent sur les fibres, les minéraux et l'énergie, et d'examiner les performances des pondeuses sur la base de la consommation d'aliments et de la production d'œufs à partir d'aliments composés jusqu'à 50% de 'mathenge' en remplacement du maïs. L'analyse de proximité et la détermination de l'énergie brute ont été effectuées à l'Université d'Egerton tandis que les taux de minéraux ont été déterminés au Kenya agricultural and livestock research organization, Njoro. Des enzymes ont été utilisées à raison de 720g/tonne d'aliment. L'énergie métabolisable et les fibres brutes étaient de 15,54 MJ/kg de MS et 3,52% pour le maïs et de 15,68 Mj/kg de MS et 21,53% pour les cosses de *Prosopis juliflora*. Des aliments contenant 0, 20, 30, 40 et 50% de gousses de *Prosopis juliflora* en remplacement du maïs ont été proposés aux pondeuses indigènes pendant douze semaines. La consommation d'aliments n'était pas significativement différente pour les traitements 1 et 2 mais différente pour les traitements 3, 4 et 5. La production d'oeufs n'était pas significativement différente parmi les différents traitements. L'utilisation des gousses de *Prosopis juliflora* pour la fabrication d'aliments pour volailles réduira l'invasion de l'arbre dans les zones arides et semi-arides.

Mots-clés : Fibres brutes, 'Mathenge', énergie métabolisable, ressources alimentaires non convectionnelles, analyse proximale.

Introduction

The current world population of 7.3 billion is expected to reach 8.5 billion by 2030, 9.7 billion in 2050 and 11.2 billion in 2100 (UN 2015). Currently there are 1.2 billion people in Africa, more than five times the population in 1950. By 2050, Africa's population will double to 2.4 billion, eventually reaching 4.2 billion by the end of the century just about the entire world population in 1977 (UNICEF, 2014). According to UN projections, Kenya's population will grow by around one million per year over the next forty years and will reach about 85 million by 2050 (UN 2010). This makes agriculture a very crucial part of any economy in order to ensure world food security. The estimated standing populations was 1.43 billion cattle , 1.87 billion sheep and goats, 0.98 billion pigs, and 19.60 billion chickens, (Robinson *et al.,* 2014). This increases the competition between human beings and livestock for food especially the cereals. In august 2009, Kenya had a population of 17.5 million cattle, 27.7 million goats, 17.1 million sheep, 334.6 thousand pigs, 2.9 million camels, 1.8 million donkeys, 31.8 million chicken out of which 25.7 million were indigenous and 6.1 million were commercial type (KNBS 2009).

The supply of adequate, good quality and cost effective livestock feeds is a major challenge in Kenya. This is because of reliance on cereals and agro-industrial by-products as livestock feed ingredients whose availability is dependent on rainfall and the cereals are also put to other uses which include biofuel production. It is therefore essential to explore alternative feed ingredients. These include diverse non-conventional feeds, such as products from trees (Odero *et al.,* 2015). Such feeds are not effectively utilized in Kenya due to lack of information on their nutritive values which is useful in determining their feed inclusion levels (Donkoh *et al.,* 2009). *Prosopis juliflora* named 'Mathenge' in Kenya, is widely available in the arid and semi- arid lands of Kenya. *Prosopis juliflora* pods have been incorporated into feeds for cattle, sheep, camel, buffalo, rabbits, poultry and rats especially in South America, Africa and India (Sawal *et al.,* 2004).

Chicken are the most abundant and widely kept livestock in the world (Moreki *et al.,* 2010). Indigenous chicken (Gallus domesticus) are widely distributed in rural and peri-urban areas where they play an important role in income generation and food production (Moreki *et al.,* 2010). Moreover, poultry will account for about 40% of the global increase in demand for meat by the year 2020, showing a shift in taste from red to white meat (FAO 2011). In Africa, over 70% of the poultry population is made up of indigenous chicken (IC) (FAO 2011). Compared to other livestock species, IC rearing remains attractive to poor households because the IC are hardy, adapt well to the rural environment, require less startup capital and have low maintenance costs. They are a cheap source of animal protein for financially unstable households. Poultry sub sector creates employment and promotes overall economic development.

The presence of anti-nutritive factors like high fiber and phytic acid limit *Prosopis juliflora* digestion and utilization. Biotechnologies like use of enzymes can be supplemented to improve utilization and may increase inclusion levels beyond 20 % as recommended by (Odero *et al.,* 2015) and improve utilization as a result of improved digestion. The use of biotechnology would improve utilization of prosopis pods and therefore address the challenge of feeding poultry and consequently help alleviate hunger through increased meat and eggs production. This study aimed at determining the effects of non-starch polysaccharides hydrolyzing enzymes inclusion in mature milled *prosopis juliflora* pods based diets fed to indigenous chicken on feed intake and egg production.

Materials and methods

Experimental site. The study was conducted at the poultry research unit (Centre of Excellence in Livestock Innovation and Business) COELIB at Tatton Agriculture Park, Egerton University. The study was conducted between mid-December 2017 and April 2018.

Chemical analysis. The proximate composition and gross energy of feed ingredients was determined at the animal nutrition laboratory in the department of animal sciences, Egerton University. The standard procedure of the association of official analytical chemists (AOAC 1990) for proximate analysis was used. dry matter (DM) using an oven set at 105 ^{0}C, crude protein (CP) by kjeldal method, ether extract(EE) using soxhlet extractor method, ash using muffle furnace set at 550 0 C for four hours and fiber determining method of (AOAC 1990). The bomb calorimeter e2k was used for gross energy determination. Samples of prosopis juliflora pods were taken to the Kenya agricultural and livestock research organization, Njoro for mineral determination using the atomic absorption spectrophotometer. Samples were sent to Evonik Industries Company based in Germany for amino acid profiling of *prosopis juliflora* pods.

Experimental birds and diets. Forty five Kenbro layers aged 32 weeks were used. The birds were allowed to adapt to new feed for 14 days and experiment conducted for three months. Five treatments were used, 0, 20, 30, 40, and 50 *prosopis juliflora* pods substituting maize in layers diets. Fiber hydrolyzing enzymes at the rate of 720g/tonne of feed were used. The *prosopis juliflora* pods were obtained from Marigat, Baringo County in Kenya. The remaining feed ingredients were purchased from Nakuru County. Nine birds were used per treatment.

A high quality and multi-activity feed enzyme formulated specifically for broiler, layer, duck, turkey, ruminant and aqua feeds to enable better nutrient utilization, resulting in more high quality meat, eggs or milk with lower total costs was used. The enzymes included contained cellulase, xylanase, beta-glucanase, mannanase, alpha-amylase, protease, lipase and phytase. Many plant based feeds contain substrates with Anti-Nutritional Factors (ANFs) that reduce animal performance. The enzymes used improve the digestibility of these ANFs by degrading fibres, proteins, starches and phytates in feed to become digestible enabling the use of cheaper and often locally produced feeds while maximizing egg productivity. The benefits conferred by these enzymes include Release phosphorus stored in phytate, Improve protein digestibility, Breaks down indigestible Pectin (reduces digestive viscosity), Breaks down fibre, Improves starch digestibility and Improve fat absorption. Five isocaloric and isonitrogenous experimental diets were prepared at egerton feed mill. The metabolizable energy was 2700kcal/kg while the crude protein was 17% for all treatments.

Data analysis. Data analysis was done using proc glm of SAS version 9.0 (2002). The treatment means that were significantly different were separated using the Least Significant Difference (LSD) at P<0.05.

Results

Table 1. Composition of experimental diets with 0,20,30,40, and 50% Prosopis j pods substituting whole maize

Ingredient	diet 1 (control)	diet 2 (20% pj pods)	diet3(30% pj pods)	diet 4(40% pj pods)	diet 5%(50% pj pods)
Whole maize	65.5	52.4	45.9	39.3	32.78
Prosopis j pods	0.00	13.1	19.7	26.2	32.8
Fishmeal	8.70	8.50	8.30	8.00	7.80
Soybean meal	15.0	15.0	15.0	15.0	15.0
Lysine	0.80	0.80	0.80	0.80	0.80
Methionine	0.40	0.40	0.40	0.40	0.40
DCP	2.50	2.50	2.50	2.50	2.50
Limestone	7.00	7.00	7.00	7.00	7. 00
Salt	0.30	0.30	0.30	0.30	0.30
Layers Premix	0.25	0.25	0.25	0.25	0.25
Mycotoxin Binder	0.10	0.10	0.10	0.10	0.10
Enzyme	0.0720	0.0720	0.0720	0.0720	0.0720
Total	100	100	100	99.9	99.7
Diet CP	17.0	17.0	17.5	17.9	18.0
Diet ME/Kg	2753	2756	2757	2758	2760
Diet CF	4.00	5.60	6.80	8.10	9.30

Table 2. Amino acids profile of *prosopis juliflora* pods from Marigat in Baringo County, Kenya

Parameter	Mg/g DM in pods
Essential amino acids	
Lysine	4.25
Methionine	9.10
Leucine	5.97
Isoleucine	3.02
Cysteine	1.31
Phenylanine	3.39
Tyrosine	Didn't do
Threonine	3.02
Valine	4.21
Tryptophan	Didn't do
Non-essential amino acids	
Alanine	4.41
Arginine	7.94
Glycine	5.17
histidine	2.37
Proline	7.21
Serine	4.65
Aspartic acid	13.8
Glutamic acid	13.9

Tables 3 and 4. Shows and minerals and proximate analysis of *prosopis juliflora* pods from Marigat in Baringo County, Kenya

Mineral	PPM
phosphorus	252
Potassium	652
calcium	292
magnesium	92.2
sodium	66.3
iron	93.3
copper	32.1
zinc	74.4
manganese	17.9

Nutrient	*Prosopis juliflora* pod %DM	White maize %DM
Dry matter	90.4	88.6
Crude protein	15.5	10.1
Crude fiber	21.5	3.50
Ether extract	1.9	3.10
Ash	4.4	1.00
Average Gross Energy MJ/kg	15.7	15.5
moisture	9.62	11.4

Table 5. Average feed intake in grams per treatment (nine layers) per week in the five treatments

Treatment	Feed Intake Lsmeans	SEM	p
1 (control)	12169[b]	88.8	<.0001
2(20% pj pods)	12205[b]	88.8	<.0001
3(30% pj pods)	13087[a]	88.8	<.0001
4(40% pj pods)	13132[a]	88.8	<.0001
5(50% pj pods)	13194[a]	88.8	<.0001

Means in same column that do not share a superscript letter are significantly different (at 5% level of significance)

Table 6. Egg production per treatments (nine layers) per week

Treatment	Egg Production Lsmeans/ Week	SEM	p
1 (control)	50.8[a]	0.76	<.0001
2(20% pj pods)	50.6[a]	0.76	<.0001
3(30% pj pods)	50.2[a]	0.76	<.0001
4(40% pj pods)	50.3[a]	0.76	<.0001
5(50% pj pods)	50.3[a]	0.76	<.0001

Means in same column that do not share a superscript letter are significantly different (at 5% level of significance)

Table 7. Average weight of the layers per treatment in kilograms

Treatment	Weight lsmeans ±		SEM	p
1 (control)	3.18[a]	±	0.16	<.0001
2(20% pj pods)	3.01[a]	±	0.16	<.0001
3(30% pj pods)	3.14[a]	±	0.16	<.0001
4(40% pj pods)	3.03[a]	±	0.16	<.0001
5(50% pj pods)	3.01[a]	±	0.16	<.0001

Means in same column that do not share a superscript letter are significantly different (at 5% level of significance)

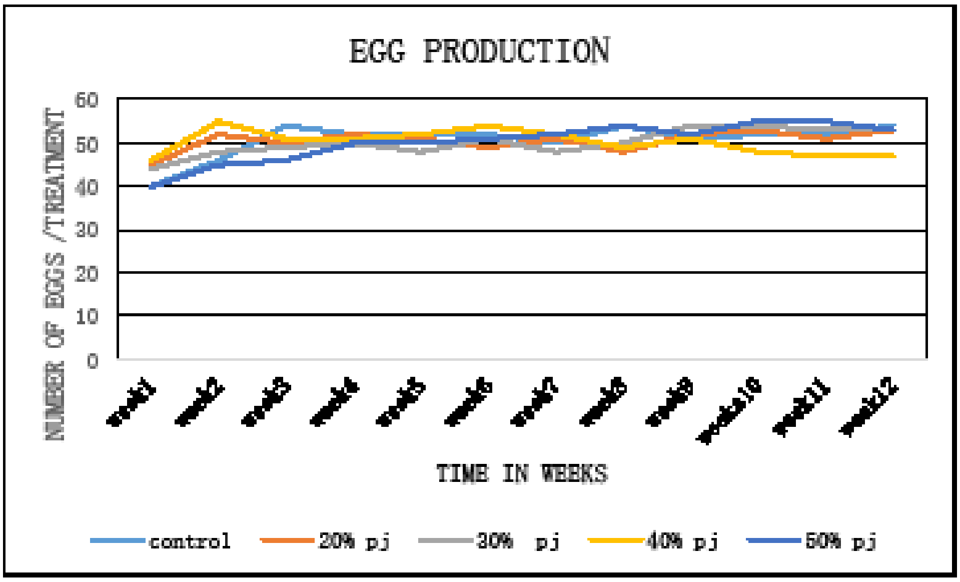

Figure 1. Egg production per treat (nine layers)

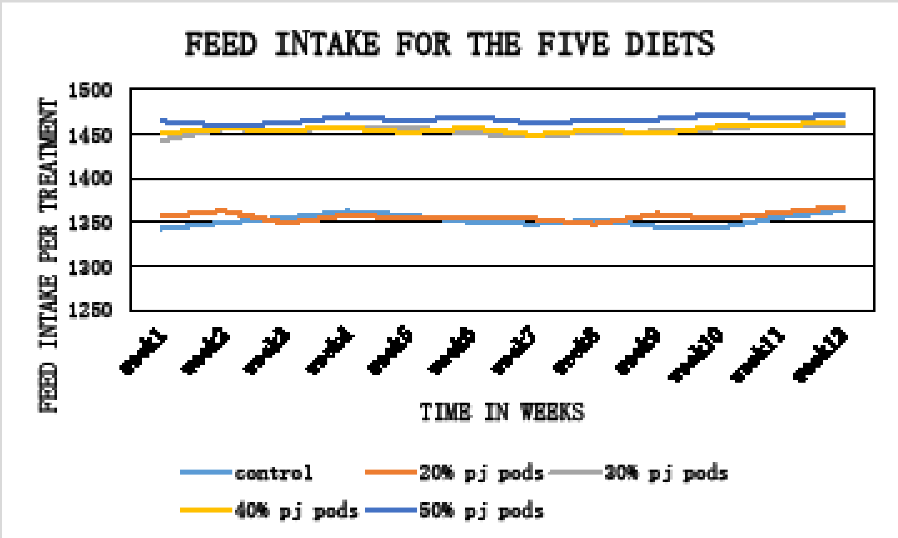

Figure 2. Feed intake per bird per week between the treatments

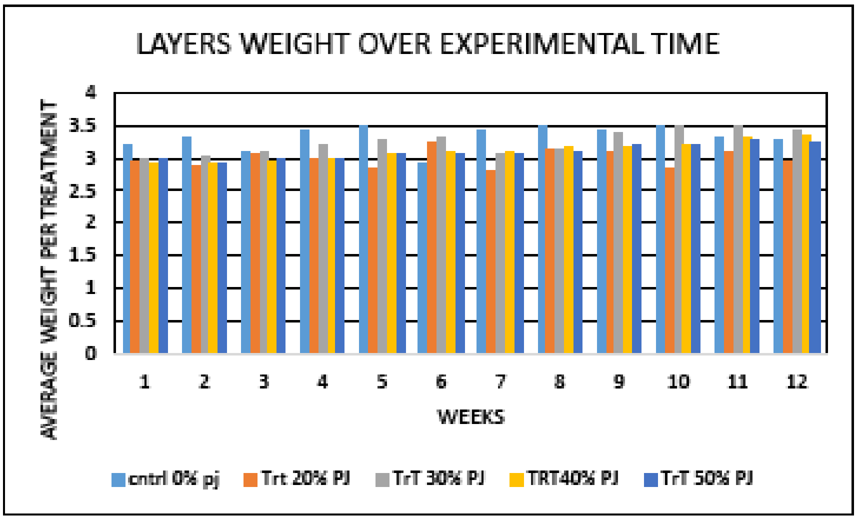

Figure 3.Weight of layers over the experimental period

Discussion

The amount of fishmeal which is an expensive animal protein is decreasing across the treatments. This is because the *prosopis juliflora* pods that replace maize in the diets.is superior to maize in terms of the crude protein. The amino acids profile shows high level of essential and limiting amino acids lysine and methionine. The amino acids results are in tandem with results by (Odero *et al.,* 2015).The proximate analysis shows *prosopis juliflora* pods being a source of both energy and protein. This this is crucial because of the high cost of proteins and competition on cereals as energy sources between man and animals. This results are in agreement with the findings of (Mahnique *et al.,* 2017) and, (Wanjohi *et al.,* 2017). The high fiber limits the use of *prosopis* *juliflora* pods as a feed ingredient in monogastric. This is because non ruminants are not able to digest fiber beyond 7% of the total diet. Feed intake increased across the treatments, i.e., diet 1 to diet 5. This is in agreement with (Ngeno *et al.,* 2014) that concluded that chicken anatomical and physiological adaptation to increase volume of low nutrient density, so that required nutrients can be obtained. This is because as fiber was increasing in the feed ,layers had to fed more to get same nutrients as a feed with low fiber < 7% crude fiber. This research was trying to look at what effect would fiber hydrolyzing enzymes have on highly fibrous layers feed. *Prosopis juliflora* pods are a source of phosphorus, potassium and calcium. Calcium and phosphorus are paramount minerals for egg shell formation. The live weights of the experimental birds increased across the study period but were not statistically different between the treatments.

Conclusion

Prosopis juliflora pods can be used as energy and protein source for layers. The higher the fiber in layer diet, the higher the feed intake. Hydrolyzed *prosopis juliflora* pods can substitute maize up to 50% in layers diets without affecting egg production.

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References

AOAC.1990 Association of official analytical chemist: official methods of analysis. (Volume1).

Donkoh, A. and Attoh-Kotoku, V. 2009. Nutritive value of feedstuffs for poultry in Ghana: chemical composition, apparent metabolizable energy and ileal amino acid digestibility. *Livestock Research for Rural Development* 21 (3): 1-9.

Wanjohi, D.M., King'ori, A.M., Wachira, A.M. and Guliye, A. Y. 2017. Effect of replacing complete grower diet with ground Prosopis juliflora pods on performance of improved indigenous chicken in Kenya. *Livestock Research for Rural Development*. 29 (8) Article #157.

Food and Agriculture Organisation. 2011. State of food and agriculture report.

King'ori, A. M., Odero-Waitituh, J. A. and Guliye, A. Y. 2011. Mathenge (*Prosopis juliflora*): An underutilized Livestock feed resource in Kenya. *Research Journal of animal sciences* 5 (4-6): 43-51.

Kenya National Bureau of Statistic (KNBS). 2009. The 2009 kenya population and housing census.

Manhique, A. J., King'ori, A.M. and Wachira, A. M. 2017. Effect of ground mature prosopis (*Prosopis juliflora*) pods inclusion in layer diets on performance of improved indigenous chicken in Kenya. *Livestock Research for Rural Development* Volume 29, Article #19.

Moreki, J.C. 2010. Village poultry production in Serowe-Palapye sub-district of Botswana. *Livestock Research for Rural Development* 22 (3): Article #46.

Morek, J. C., Dikeme, R. and Poroga, B. 2010. The role of village poultry in food security and HIV/AIDS mitigation in Chobe District of Botswana. *Livestock Research for Rural Development* 22 (3): 1-7.

Ngeno, K., Vander Waaij, E.H. and Kahi, A. K. 2014. Indigenous chicken genetic resources in Kenya: their unique attributes and conservation options for improved use. *World's Poultry Science Journal* 70 (01): 173–184.

Odero, J.A, Kingori, A. M. and Uliye, A.Y. 2015. *Prosopis juliflora* Pods as sources of energy, protein, vitamins and minerals in livestock diets in Kenya. *Egerton Journal of Science and technology* 15: 132–140.

Odero-Waitituh, J. A. 2015. Evaluation of inclusion levels of milled mature pods of *Prosopis juliflora* (Mathenge) in broiler finisher.´ diets. MSc thesis, Egerton University, Kenya.

Robinson, T.P., William, W. G.R., Conchedda, G., Van Boeckel, T.P., Ercoli, V., Palamara, E. and Gilbert, M. 2014. Mapping the global distribution of livestock. *PLoS ONE* 9 (5): e96084.

Sawal, R.K., Ram, R. and Yadav, S B. 2004. Mesquite (*Prosopis juliflora*) pods as a feed resource for livestock: a review. *Asian-Australian Journal of Animal Science* 17 (5): 719-725.

United Nations (UN). 2010. Demographic transition and growth in Kenya. World bank group.

United Nations (UN). 2015. Sustainable development goals. World poluation projection.

UNICEF. 2014. Generation 2030/ child demographics in Africa. Department of data,research and policy

Kondra, P.a., Sell, J.L. and Guenter, W. 1974. Response of meat-and egg-type chickens to a high fibre diet. *Canadian Journal of Animal Science* 54: 651-658.