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Are millet and sorghum good alternatives to maize in layer's feeds in Niger, West Africa?

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Niger is one of the West African country producing pearl millet (*Pennisetum glaucum, Setaria italica*) and sorghum (*Sorghum bicolor*). While pearl millet and sorghum are for human consumption, corn is imported and its high production costs are the main constraint to poultry production in Niger (Issa *et al.* 2015) As feed is the major input in poultry production and ever increasing cost and scarcity of feedstuffs are the major constraints in poultry production (Sheikh *et al.* 2016). A strong increasing trend and a high variation of the prices of cereals grains have spurred interest in using other feed ingredients produced in large scale (Ravindran 2013). Although possible alternatives for corn substitution by sorghum in poultry diet has been extensively studied in India, US, and West Africa (Parthasarathy *et al.* 2005, Issa 2009, Kawari *et al.* 2011, Bulus *et al.* 2014, Yunus *et al.* 2015). However, pearl millet, the cereal grain produced and used primarily as a human food in Niger, is little tested as poultry feed ingredient. Thus, the objective of this study was to evaluate performance, egg quality and egg cost in layers fed isocalorific and isonitrogenous diets in which corn is replaced by pearl millet or sorghum up to 50%.

Pullets Harco line (120, 19-week-old) with a mean of 1,050±11 g, were used in a 3-month experiment until February 2015 to determine the effects of diets with corn vs sorghum, pearl millet, corn + millet and corn + sorghum on growth performance and egg production and quality. For sorghum, Sepon 82, an improved sorghum variety with no tannin (Abdoulaye and Sanders 2006), and HKP an improved pearl millet variety, while for maize, a commercial variety was selected. There were 6 pullets/pen (1.2 m^2) and 4 pens/treatment having groundnut hulls as beddings in a naturally-ventilated house with humidity at 24.6±0.4%, wind speed at 1.6±0.4m/sec, and temperature at 18±3°C in the morning, 28±4°C at midday and 29±3°C in the afternoon. The control diet (Table 2) was corn-based with fishmeal and peanut meal as the primary protein supplements. The diet (Table 2) was formulated to 0.6 for Lys, 0.3 for Met and 2,783 Mcal/kg for ME (NRC 1994). Sorghum and millet were used to replace the corn on a wt/wt basis with treatments: (i) a corn-based control; (ii) 50% corn + 50% millet; (iii) 50% corn+50% sorghum; (iv) pearl millet; and (v) sorghum. Ingredients samples were collected and analysed through proximate analysis. Performance response criteria were egg production rate, average daily feed intake (ADFI), egg weight, and feed conversion C g of feed/dozen eggs), egg yolk colour measured with Roche colour score, and feed cost. Data were analysed as a randomized complete block design using the Proc Mixed procedure of R.

Data from pullet body weight, feed intake, egg production, egg weight, egg yolk colour, feed conversion and feed cost were normal (P>0.30). In addition, pearl millet and sorghum chemical composition were similar to those of corn. Cereals grains had similar dry matter, crude fibre and minerals; corn and pearl millet had higher fat content than sorghum, as well as crude protein was higher in sorghum and millet than in corn. Consequently, nitrogen free extract was 73.6% in corn, 72.6% in sorghum and 71.2% in pearl millet (Table 1).

Pullet's initial weight was similar (P>0.57, Table 4) and layers fed on the 5 diets, started laying eggs in the same

Table 1. Proximate analysis of the cereals fed in the layer's experiment at Maradi, Niger

Ingredient	Dry matter (%)	Ash (%)	Crude fibre (%)	Crude protein (%)	Ether extract (%)	Nitrogen free extract (%)
Corn	92.1	1.2	2.3	10.0	5.0	73.6
Sorghum Sepon 82	92.1	2.1	2.0	12.3	3.1	72.6
HKP - Pearl millet	92.2	2.2	2.1	11.4	5.3	71.2

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Table 2. Corn-, millet- and sorghum-based diets fed to layers at Maradi, Niger

Ingredient	Corn	Corn 50%+ Sorghum 50%	Corn 50% + Millet 50%	Millet	Sorghum
Corn	67.50	33.50	33.75	0.00	0.00
Sorghum	0.00	33.50	0.00	0.00	67.00
Millet	0.00	0.00	33.75	67.50	0.00
Wheat bran	9.50	9.50	9.50	9.50	9.50
Peanut meal	6.00	6.00	6.00	6.00	6.00
Fishmeal	8.00	8.00	8.00	8.00	8.00
D-L Methionin	0.20	0.20	0.20	0.20	0.20
Lysine HCl	0.20	0.20	0.20	0.20	0.20
Bone meal	8.00	8.00	8.00	8.00	8.00
Salt	0.30	0.30	0.30	0.30	0.30

Table 3. Feed components cost (F CFA) for corn, millet and sorghum-based layers diets at Maradi, Niger

Item	Price/k, F CFA	Corn	Corn 50%+ Sorghum 50%	Corn 50%+ Millet 50%	Millet	Sorghum
Corn	178	120	60	60	0	0
Sorghum	160	0	54	0	0	107
Millet	150	0	0	51	101	0
Wheat bran	180	17	17	17	17	17
Peanut meal	550	33	33	33	33	33
Fish meal	600	48	48	48	48	48
D-L Methionin	4000	8	8	8	8	8
Lysine HCl	3000	6	6	6	6	6
Bones meal	100	8	8	8	8	8
Salt	200	1	1	1	1	1
Vit/Min premix	2000	6	6	6	6	6
Soy oil	850	0	4	0	0	4
Grinding and mixing	20	20	20	20	20	20
Total	-	247	244	237	228	238

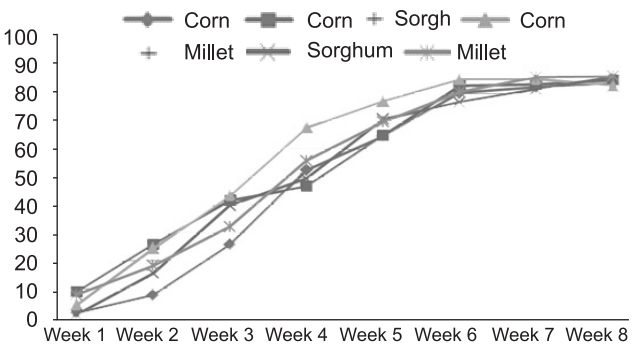

Fig. 1. Egg production rate (%) for layers fed corn, sorghum or millet at Maradi, Niger.

week. In addition, laying tendency was similar for egg production along week 1 to 8 among birds fed all diets (Fig. 1). Along weeks 6–8 when birds were in optimal laying, the overall mean of egg production rate was 84%. There was no significant difference (P>0.78) in egg production rate. The results agreed with data reported by Mehran *et al.* (2010) who reported that replacing maize by pearl millet in layer diets up to 75% had no statistical difference in egg production, feed intake, feed conversion and egg weight. In addition, in a 112-d experiment, Garcia *et al*. (2010) reported similar egg production with commercial layer fed corn-based diets, sorghum based diets, sorghum+0.5% *Bixa orellana* L. based diet or sorghum +1% *Bixa Orellana* L. based diet. However, egg production was higher than data (55%) reported by Issa *et al*. (2010), when layers were reared at 39°C. Thus, in this experiment egg production data would be considered typical for birds exposed to normal environmental conditions.

Layer's average daily feed intake (ADFI) was 107 g. ADFI was significantly (P<0.02) different among treatments during the laying period. Birds fed corn- and sorghum-based diets consumed 5% more feed compared to those fed the other diets. The results were different from data reported by Mehran *et al*. (2010) and Garcia *et al.* (2010) who reported that increasing inclusion of millet and sorghum in layer diets had no statistical difference in feed intake. However, feed intake was higher than 70 to 79 g/d/hen reported by Issa (2009) when layers were reared under heat stress condition. Total egg weight average was 49 g.

Table 4. Harco layers egg production and quality performances when fed corn, sorghum or millet at Maradi, Niger

Item	Feed						
	Corn	Corn + Sorghum	Corn + Millet	Sorghum	Millet	SE	Significance
Pullet initial weight, g	1,059	1,012	1,061	1,058	1,062	28	P > 0.57
Egg laying rate, egg/hen/d	83.8	85.5	84.4	82.7	84.2	1.8	P > 0.78
Feed intake, g/hen/d	112	105	106	109	105	2	P < 0.02
Egg weight, g	49	48	48	48	50	1	p < 0.01
Feed conversion (g of feed/dozen eggs)	1628	1511	1550	1639	1582	50	P > 0.03
Feed cost/dozen eggs, F CFA	402	369	367	390	376	12	P < 0.03
Egg yolk colour, Roche colour unit	8.2	8.0	7.8	2.3	3.8	0.4	P < 0.01

Layers fed millet- and millet-based diets produced eggs with 2 to 4% more weight than birds fed sorghum, 50% corn + 50% sorghum or 50% corn + 50% millet based diets ($P < 0.01$). Eggs weight data were similar to those reported by Issa (2009) and Partharathy *et al*. (2005). But the results were different from data reported by Mehran *et al*. (2010) eggs weight mean was 60 g when corn was replaced by millet at 25, 50, 75% and 100%. In addition, Garcia *et al*. (2010) reported that in an experiment where fed a corn based diet and 6 sorghum based diets egg weight mean was 61 g. Overall feed conversion, g of feed/dozen eggs, was 1,582 g. Owing to their high feed intake, birds fed on corn and sorghum had the highest feed conversion ($P<0.03$) compared to the other birds. These data were different from results reported by Issa (2009) and Collins *et al*. (1997). Total mean for feed cost was 381 F CFA/kg (Table 4). Feed cost was lower for 50% corn + 50% sorghum, 50% corn + 50% millet or millet based diets ($P<0.03$) compared to corn- or sorghum-based diets. For feed cost in this study, increasing millet in layer diets was associated with feed cost reduction, because millet is the main cereal produced in Niger, and during years with normal rainy season, its price is cheaper than for those for corn.

For all treatments, egg yolk colour mean was 6 according to Roche colour score. However, bird fed corn- or corn associated with sorghum- or millet-based diets had similar egg yolk colour value with doubled value for birds fed millet-based diet and almost 4 times scores for birds fed sorghum based diets ($P<0.01$) (Table 4). The results agreed with previous data and those reported by Issa (2009) and Collins *et al*. (1997) who reported that increasing inclusion millet in layer diets had no statistical difference in egg production, feed intake and feed conversion and egg weight, but yolk colour decreased.

Uptake of pearl millet, and sorghum in poultry diet is a challenge until the production of millet and sorghum is made surplus in context of Niger, specifically pearl millet is grown mostly on marginal lands, production varies widely year to year because of rainfall variability and drought in the production areas. Therefore, there is a pressing need of early maturing, drought tolerant high yielding varieties. This can facilitate a closer integration of millet production with intensive livestock operations. Higher millet yield can be used for commercial production in more favourable environments. Thus, local production of pearl millet and sorghum can address the high import costs of corn. Another important factor in uptake is consumer preference. In general, yellow yolk is preferred by consumers in Niger and wherever white colour is more preferred by consumer's, sorghum, pearl millet is valued ingredient in some compound rations for poultry. Consequently, layers fed on corn versus those fed on 50% corn + 50% sorghum, or 50% corn + 50% millet, or sorghum or millet had similar egg production rate. In addition, birds fed corn, 50% corn + 50% sorghum and 50% corn + 50% millet had the best egg pigmentation. However, feed cost was higher for layer fed on corn or sorghum based diets and egg pigmentation was poor in sorghum and millet based diets. Therefore it is recommended that in Niger, poultry producers could replace corn up to 50% by millet or sorghum in layer diets.

SUMMARY

The effects of diets with corn, sorghum, or pearl millet on growth performance and egg production and quality in poultry were determined on pullets (120), 19-week-old (with a mean of 1,050±11 g) in a 3-month experiment. The control diet was corn-based with fishmeal and peanut meal as the primary protein supplements. Sorghum and millet were used to replace the corn on a wt/wt basis so that treatments are: (i) a corn-based control; (ii) 50% corn + 50% millet; (iii) 50% corn+50% sorghum; (iv) pearl millet; and (v) sorghum. Ingredients samples were collected and analyzed through proximate analysis. Performance response criteria were egg production rate, average daily feed intake (ADFI), egg weight, feed conversion c g of feed/dozen eggs), egg yolk colour and feed cost. Data were analyzed as a randomized complete block design. Results indicated that layers fed corn versus those fed 50% corn + 50% sorghum, 50% corn + 50% millet, sorghum or millet had similar egg production rate. Feed cost was higher for layer fed corn or sorghum based diets and egg pigmentation was poor in sorghum and millet based diets. Therefore, it is recommended that in Niger, the poultry producers could replace corn up to 50% by millet or sorghum in layer diets.

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