A COMPARISON OF THE PERFORMANCE OF CAGED LAYERS FED SORGHUM GRAIN OR PEARL MILLET*

J.Y. ODIBA** and P.E. SANFORD

*Department of Animal Sciences and Industry,
Kansas State University,
Manhattan, Kansas 66506, USA.*

(Received 8 June 1988; accepted for publication 23 June 1988)

ABSTRACT

Two 280-day trials, each involving 468, 22-week-old caged commercial egg-strain pullets were conducted to compare millet and sorghum grain as the main source of energy in laying diets. Diets containing 59.2 and 0, 41.0 and 24.0, 31.2 and 36.3 and 0 and 72.5% of sorghum grain and pearl millet, respectively, were studied in both trials.

The diets containing millet supported egg production, egg weight, feed conversion, and egg shell thickness equivalent to those of the all-sorghum diet. Except in Trial 1, feed consumption of the pullets fed the millet-containing diets was not significantly lower than that of the pullets fed the all-sorghum diet. Haugh unit values tended to decrease as the level of millet was decreased. Feeding millet at a level as high as 72.5% of the diet may have adverse effects on egg specific gravity and Haugh units.

Key Words: Sorghum grain, millet, caged layers.

INTRODUCTION

Cereal grains form the major components of poultry rations. In some countries, one of the main sources of energy in poultry diets is sorghum grain. However, as locally grown millet becomes more readily available, and in view of the difficulty in obtaining sorghum grain for poultry feed, millet may be used to replace some or all of the sorghum grain.

Information pertaining to the feeding performance of millet in the laying diet is very meager. Many of the feeding trials have employed rats, poult, or broilers as the test animals (Pushpamma, 1968; Pushpamma *et al.*, 1972; Kurien *et al.*, 1962; Lloyd, 1964; Qureshi, 1967; Simhae *et al.*, 1971; Sanford

et al., 1973; Luis *et al.*, 1982a,b). These reports have shown that millet is as good as and may even be better than corn, sorghum grain, rice, and wheat in terms of rate of weight gain and feed efficiency.

Luis *et al.* (1982c) fed diets based on corn, sorghum grain, and millet alone to egg-strain pullets. All the millet diets, except those containing dehydrated alfalfa meal, performed as well as corn or sorghum grain diets in terms of egg production, egg weight, feed consumption, feed efficiency, and egg specific gravity. According to them, adding alfalfa meal might have aggravated the marginal level of linoleic acid and amino acid balance of the millet-based diets, and could

* Contribution 85-477-J, Department of Animal Sciences and Industry, Agricultural Experiment Station, Kansas State University, Manhattan, KS 66506.

** Present address: Agricultural Extension and Research Liaison Services, Ahmadu Bello University, Zaria, Nigeria.

have also increased the bulkiness of the diets to such a level as to physically reduce intake.

Thus, in terms of broiler or turkey diets, millet is a good feedstuff for poultry. However, there is the need for more research on the performance of millet in the laying diet.

In the two trials reported herein, diets containing pearl Millet (*Pennisetum typhoides*) as the sole cereal grain or in combination with sorghum grain (*Sorghum bicolor*) as the main cereal grain were fed to hens to determine if millet can be used to replace sorghum grain as the main source of energy in laying diets.

MATERIALS AND METHODS

Two trials, consisting of 10, 28-day periods, were conducted using a commercial egg-strain pullets. Four hundred sixty eight 22-week old pullets at approximately 10% egg production were housed 3 per cage in double deck stair-step type of 30.5 x 45.8 cm cages. Thirteen adjacent cages containing 39 birds constituted a lot (a replicate). Three lots were randomly assigned to each dietary treatment. All cages were equipped with common feeding troughs and Hart cup waterers. Feed and water were supplied ad libitum, and a 14-hour light period was provided daily.

Four diets, formulated to contain equal amounts of feed ingredients other than the grains and soyabean meal, contained 59.2 and 0 (control, diet 1), 41.0 and 24.0 (diet 2), 31.2 and 36.3 (diet 3), and 0 and 72.5% (diet 4) of sorghum grain and pearl millet, respectively (Table 1). An attempt was made to maintain a constant 18% level of protein in all the diets by varying the level of soyabean meal. Based on calculated analysis, the diets were formulated to meet the nutritional requirements of the laying birds as recommended by the NRC (1977).

Data collection commenced after the pullets had been on the diets for 2 days. Daily egg production was recorded for each lot and total eggs per period (28 days) was used to calculate hen-day egg production. Twelve eggs were selected randomly from each lot on each of the last 3 days of each period. Eggs selected each day were stored in a refrigerator until a day after the 3rd day, when the various determinations were made. Doing the determinations on the same day was more convenient and it saved time and labour. The eggs were weighed and their specific gravity determined by the saline solution flotation method of Olsson (1934). Two eggs were selected randomly from each lot, broken out, their contents deposited on a smooth, flat glass surface, and their albumen heights measured with a micrometer to determine Haugh unit values, a measure of the condition (firmness) of egg albumen. Shells with their intact shell membranes were used for shell thickness determination by taking three measurements along their equatorial regions with an Ames shell thickness gauge. The amount of feed consumed each period was used to calculate feed conversion (feed/dozen eggs). Mortality was recorded daily. Four representative samples of the diets were analyzed for chemical composition, using standard procedures (AOAC, 1975).

Trial 2, which also lasted for 280 days, used the same type and number of caged pullets of similar age, diets, and procedures described in the first trial.

Data were analyzed as repeated measures with diet as whole plot and period and diet X period interactions as subplot (Steel and Torrie, 1960). Differences between treatment means were tested statistically by the least significant difference procedure (Snedecor and Cochran, 1967).

Table 1
Composition of experimental diets (Trials 1 and 2)

Ingredients	Diet			
	1	2	3	4
	(g/kg mash)			
Soybean meal, expeller (44% P)	283.0	225.0	200.0	150.0
Sorghum grain, ground	592.0	410.0	312.0	—
Millet, ground	—	—	240.0	363.25.0
Dehydrated alfalfa meal (17%)	24.0	25.0	25.0	25.0
Dicalcium phosphate	25.0	25.0	25.0	25.0
Limestone	60.0	60.0	60.0	60.0
Iodized salt (NaCl)	5.0	5.0	5.0	5.0
Trace mineral premix ¹	.5004	.5004	.5004	.5004
Vitamin A (10,000 IU/g)	.3307	.3307	.3307	.3307
Vitamin D (15,000 ICU/g)	.1323	.1323	.1323	.1323
Vitamin B ₁₂ (0.044 mg/g) ²	.2646	.2646	.2646	.2646
B-complex vitamin premix	.7496	.7496	.7496	.7496
D-L methionine	.7496	.7496	.7496	.7496
Corn, ground	10.0	10.0	10.0	10.0
Determined analysis:				
Metabolizable Energy, Kcal/kg	2785	2750	2702	2695
Crude Protein, %	20.51	19.49	19.01	19.05
Lysine, %	.82	.83	.80	.78
Methionine plus Cystine, %	.77	.80	.90	.82
Crude fiber, %	4.31	3.87	3.73	3.22
Calcium, %	3.56	3.42	3.29	3.34
Phosphorus, %	.998	1.018	.986	.987

¹ Trace mineral premix supplied the following in parts per million or milligrams per kilogram of diet: Mn, 50; Zn, 50; Fe, 50; Cu, 5; I, 1.5; and Co, .5.

² B-complex vitamin premix supplied the following in mg/kg of diet: riboflavin, 13.2; d-pantothenic acid, 24.3; niacin, 39.6; and choline chloride, 132.1.

RESULTS AND DISCUSSION

Trial 1. A significant diet X period interaction occurred in Haugh units, showing that the difference in Haugh units between any two diets was not constant but changed from period to period (Table 2). Under such an interaction, an error variance different from the error mean square in the analysis was calculated and used to arrive at the critical value for comparing any two diet means.

Replacing part or all of the sorghum grain in the laying diet with millet had no significant effect on egg production, egg weight, feed conversion, or egg shell thick-

ness (Table 2). Egg production results are in agreement with those of Luis *et al.* (1982c). Contrary to the results reported by Luis *et al.* (1982c), egg weight and feed efficiency were not significantly affected by adding millet to the diet, whereas feed consumption was. Feed consumption of the hens fed diets 2, 3 and 4 was similar, but significantly ($P < 0.05$) lower than that of the hens on diet 1. Specific gravity of eggs from birds fed diets 1, 2 and 3 was significantly ($P < 0.05$) greater than that of hens fed diet 4. Contrary to what Luis *et al.* (1982c) observed, feeding diet 4 significantly ($P < 0.05$) depressed egg specific gravity. However, we

noted that the diets did not differ significantly in terms of egg shell thickness. This may indicate that millet had no effect on egg shell quality. The Haugh units of eggs from birds given diets 4. Other comparisons were not significantly different. The data on the internal quality of the eggs clearly showed that Haugh units decreased with an increase of millet in the diet. Millet when fed in excess of 36.3% of the diet adversely affected Haugh units.

Trial 2. Significant diet X period interactions occurred in all the responses except specific gravity and shell thickness (Table 3). These interactions were treated in the same manner as in Trial 1.

As was observed in Trial 1, diets 2, 3 and 4 supported egg production, egg weight, egg shell thickness, and feed conversion equivalent to those of diet 1. The results on egg weight are contrary to those of Luis *et al.* (1982c). Adding millet to the diets had no adverse effect on linoleic acid level, neither did it reduce the protein quality nor the amino acid adequacy of the diets. The lack of a significant effect of millet on feed conversion in this study is in agreement with Singh and Barsaul (1976) and Luis *et al.* (1982a,b). Contrary to the results of Luis *et al.* (1982c), addition of alfalfa meal did not adversely affect efficiency of feed utilization, nor did complete replacement with millet

Table 2
Effect of feeding diets based on sorghum and/or pearl millet on laying performance (Trial 1)

Diet	Sorghum and/or millet in diet, %	Egg prod %	Egg weight g	Feed consum g/hen/day	Feed conver kg/doz eggs	Spec gravity	Shell thickness mm	Haugh unit
1	Sorghum	59.2	79.05 ^a	57.85 ^a	119.13 ^b	1.81 ^a	1.081 ^a	81.16 ^a
2	Sorghum	41.0	77.39 ^a	58.82 ^a	114.56 ^a	1.78 ^a	.401 ^a	79.73 ^a
3	Millet	24.0	78.65 ^a	59.01 ^a	113.71 ^a	1.083 ^a	.399 ^a	77.19 ^{ab}
4	Sorghum	31.2	78.64 ^a	58.79 ^a	114.63 ^a	1.74 ^a	1.082 ^a	74.28 ^b
	Millet	36.3				1.75 ^a	.399 ^a	
	Millet	72.5				1.080 ^b	.391 ^a	

Statistical analysis

Source of variation	df	(Mean square)						
Diet 3	15.27	8.08	180.06**	.14	1.02*	.09000008	274.34**	
Error (diet)	8	42.30	4.46	17.05	.13	.17	.00000003	19.28
Diet x period	9	505.49***	69.31***	1333.81	.11*	13.54***	.00000004*	304.53***
Error (period)	27	11.73	.57	20.56	.03	.07	.00000002	15.60*
	72	11.57	.56	31.16	.05	.05	.00000017	7.93

a,b Each value is the average of three replications with 39 birds per replicate. Values within the same column bearing different superscripts differ significantly ($P < 0.05$).
* = $P < 0.05$ ** = $P < 0.01$ *** = $P < 0.005$

Table 3
Laying performance as influenced by feeding diets based on sorghum and/or
pearl millet (Trial 2)

Diet	Sorghum and/or millet in diet, %	Egg Prod %	Egg Weight &	Feed consum. g/hen/day	Feed conver. kg/doz eggs	Spec gravity	Shell thickness mm	Haugh unit	
1	Sorghum	59.2	73.23 ^a	59.77 ^a	113.72 ^a	1.87 ^a	1.083 ^c	.417 ^a	79.97 ^a
2	Sorghum	41.0	71.43 ^a	60.13 ^a	112.24 ^a	1.90 ^a	1.082 ^{bc}	.401 ^a	79.68 ^a
	Millet	24.0							
3	Sorghum	31.2	71.27 ^a	59.83 ^a	115.88 ^a	1.97 ^a	1.080 ^a	.401 ^a	78.86 ^a
	Millet	36.3							
4	Millet	72.5	71.67 ^a	58.62 ^a	108.63 ^a	1.92 ^a	1.081 ^{ab}	.404 ^a	77.74 ^a

Statistical analysis								
Source of variation	df	(Mean square)						
Diet 3	24.36	12.69	279.04	.28	.49 ^a	.0000022	30.51	
Error (diet)	8	28.19	3.38	26.69	.14	.10	.0000008	24.20
Period 9	447.64***	126.54***	819.78***	.90***	11.42***	.0000046***	132.50***	
Diet x period	27	20.14***	1.88***	54.67**	.28***	.09	.0000001	13.92***
Error (period)	72	5.49	.45	23.76	.07			

a,b,c Each value is the average of three replications with 39 birds per replicate. Values within the same column bearing different superscripts are significantly different ($P < 0.05$).

* = $P < 0.05$ ** = $P < 0.01$ *** = $P < 0.005$

(Baghel and Netke, 1982; Simhae *et al.*, 1971; Qureshi, 1967). Also, contrary to the results of Sanford *et al.* (1973), these results do not give any clear indication that millet is superior to sorghum grain in terms of efficiency of feed utilization.

Feed consumption and Haugh units were not significantly different among the diets. The feed consumption of the groups on diets 1 and 4 compares favourably with the 114 and 109 g/hen/day reported by Luis *et al.* (1982c) for their sorghum grain-based and millet-based diets, respectively. In their study, the hens fed the millet-based diets containing 2.5% alfalfa meal consumed 5-7 g/hen/day less feed compared to those fed the corn or sorghum-based diets containing the same level of dehydrated alfalfa meal. However, the bulkiness of the millet-containing diets due to the added alfalfa meal,

which physically reduces intake, cannot explain the differences in the present study, since diet 4 contained less crude fibre than diet 1 (Table 1).

Haugh units also tended to decrease with an increase in millet in the diet. The lack of a significant relationship between the results on Haugh units in Trial 1 and Trial 2 cannot be explained.

The birds fed diets 3 and 4 produced eggs with significantly ($P < 0.05$) lower specific gravity than those fed diet 1. Also, feeding diet 2 resulted in significantly ($P < 0.05$) higher egg specific gravity than feeding diet 3. Most of the eggs had specific gravity values ranging between 1.080 and 1.085, irrespective of the type of diet fed. Eggs with specific gravity above 1.075 are considered to have good shell quality (Moreng and Avens, 1985). Thus, even

though millet may have some adverse effect on egg specific gravity, it is doubtful if this effect is sufficient to have any practical significance on shell quality.

As was observed in Trial 1, the diets did not differ significantly in terms of egg shell thickness, although the value for diet 1 was numerically higher than that for any of the other diets. A shell thickness above 0.330 mm is considered by Stadelman and Cotterill (1977) to be good. The results obtained in this study, showing shell thickness ranging from 0.391 to 0.401 (Trial 1) and from 0.401 to 0.147 mm (Trial 2), indicate that millet is equal to sorghum grain in producing eggs with good shell thickness. The eggs used were held for a period of 1 to 4 days before the specific gravity determination. The fact that significant differences occurred in egg specific gravity and not in egg shell thickness may not be surprising, since specific gravity and shell thickness are closely related only when the egg is freshly laid.

It can be concluded from this study that replacing sorghum grain with pearl millet, either partially or completely, has no significant effect on the overall performance of the laying chicken. However, because of its effect on egg quality, millet should be fed in combination with sorghum grain rather than as the sole grain.

REFERENCES

- ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTS (1975) Official Methods of Analysis. 12th ed. A.O.A.C., Washington, D.C.
- BAGHEL, R.P.S. and NETKE, S.P. (1982) Studies on the incorporation of kangni (*Seteria italica*) in starter chick diets. *Indian J. Anim. Sci.* 52: 411-417.
- KURIEN, P.P., RAO, M.N., SWAMINATHAN, M., SANKARAN, A.N. and SUBRAHMANYAN, V. (1962) The effect of partial or complete replacement of rice in poor rice diet by bajra (*Pennisetum typhoides*) on the growth and composition of blood, body and liver of albino rats. *Ann. Biochem. Exp. Med.* 22: 245-248.
- LLOYD, G.L. (1964) Use of manga to replace maize in a broiler ration. *Rhodesia Agr. J.* 61: 50-51.
- LUIS, E.S., SULLIVAN, T.W. and NELSON, L.A. (1982a) Nutrient composition and feeding value of proso millets, sorghum grains and corn in broiler diets. *Poultry Sci.* 61: 311-320.
- LUIS, E.S., SULLIVAN, T.W. and NELSON, L.A. (1982b) Nutritional value of proso millets, sorghum grains, and corn in turkey starter diets. *Poultry Sci.* 61: 321-326.
- LUIS, E.S., SULLIVAN, T.W. and NELSON, L.A. (1982c) Nutritional value of proso millet in layer diets. *Poultry Sci.* 61: 1176-1182.
- MORENG, R.E. and AVENS, J.S. (1985) Poultry Science and Production. Reston Publishing Co., Inc. A Prentice-Hall Company, Reson, VA.
- NATIONAL RESEARCH COUNCIL (1977) Nutrient requirements of Domestic Animals. 1. Nutrient Requirements of Poultry. 7th revised ed. Washington, D.C.
- OLSSON, N. (1934) Studies on specific gravity of hen's eggs. A new method of determining the percentage of shell in hens' eggs. Otto Harrassowitz, Leipzig 1-64.
- PUSHPAMMA, S. (1968) Protein quality and nutritive value of three Indian millets. *KSU Diss. Abstr.* 29: 1931B.
- PUSHPAMMA, S.D., PARRISH, D.B. and DEOYE, C.W. (1972) Improving protein quality of millet, sorghum and maize by supplementation. *Nutr. Rep. Int.* 5: 93-100.
- QURESHI, M.S. (1967) To assess the value of maize and bajra alone and in combination in the starting and growing ration for chicken. *Agr. Pakistan* 18: 519-529.
- SANFORD, P.E., CAMACHO, F., KNAKE, R.P., DEYEO, C.W. and CASADY, A.J. (1973) Performance of meat-strain chicks fed pearl millet as a source of energy and protein. *Poultry Sci.* 52: 2081.
- SIMHAEE, E., GHORBAN, K. and MAKARECHIAN, M. (1971) Com-

- parison of the nutritive value of corn, wheat, and millet in broiler diet. *Iranian J. Agr. Res.* 1: 51-55.
- SINGH, S.D. and BARSAL, C.S. (1976) Replacement of maize by coarse grains for growth production in White Leghorn and Rhode Island Red birds. *Indian J. Anim. Sci.* 46: 96-99.
- SNEDECOR, G.W. AND COCHRAN, W.G. (1967) Statistical Methods. 6th ed. Iowa State Univ. Press, Ames, IA.
- STADELMAN, W.J. and COTTERILL, J.O. (1977) Egg Science and Technology. 2nd ed. Avi Publishing Co., Inc., Westport, CONN.
- STEEL, R.G. and TORRIE, J.H. (1960) Principles and Procedures of Statistics. McGraw-Hill Book Co., Inc., New York, NY.