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RESEARCH OPINIONS IN ANIMAL & VETERINARY SCIENCES

Replacing agro-ecological and conventional millets for corn and their effect on performance, ileal protein digestibility and TMEn of broiler chickens

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Abstract

Foxtail millet is well suited to climatic conditions in semi-arid tropic regions where it is cultivated using both agro-ecologic and conventional cultivation practices. This study evaluated the nutritional value, digestibility and physiological effects of agro-ecologic and conventional cultivated foxtail millet in comparison with maize used in poultry diet. Chemical and TMEn analysis of foxtail millet cultivated conventionally and agro-ecologically indicated similar nutritional value. A total of 432 eight-day-old Ross broiler chicks, using a 2×3 factorial arrangement were randomly assigned to 4 replicates. Experimental diets were formulated by replacing maize with conventional or agro-ecologic millet at levels of 33, 66 and 100%. Body weight at 21 and 42 days of age was higher ($P<0.05$) at the 100% millet inclusion versus the lower inclusion levels. At 42 days of age, feed intake and feed conversion ratio were also improved ($P<0.05$) at the 100% millet inclusion. Similarly, the apparent ileal digestibility of crude protein and ether extract increased ($P<0.05$) for 100% millet inclusion. There were no differences in ileal protein and dry matter digestibility between the groups. Foxtail millet is a suitable replacement for corn as the principal energy source in broiler diets.

Keywords: Foxtail millet; broiler; agro-ecological millet; ileal digestibility

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Introduction

Foxtail millet is one of the most important grains suitable to semi-arid regions in the world, therefore it plays an important role in agriculture and food industries, specially in developing countries. Regarding higher protein content (10.4-15.6%) and good metabolizable energy for poultry (3300 Kcal/Kg) and also, lack of anti-nutritional factors, it can be a suitable substitution for corn in poultry diets (Ravindran, 1991; Ravindra, 1992; Rama Rao et al., 2004). According to Rama Rao et al. (2004) foxtail millet can be replaced for corn (100 % substitution) in broiler diets without any negative effect on performance.

In agro-ecologic agriculture, chemical inputs are omitted or reduced. These products are safer for consumers. It seems that nutritional value of these kind of agricultural products are similar to conventional one, but due to different cultivation conditions this assumption is not acceptable (Hall et al., 2007). There is limited reports regarding the use of organic products in poultry nutrition. Some reports indicated that use of organic agricultural products in poultry diets, showed their effects on immune system (Huber et al., 2010). The aim of the present study was to evaluate the effects of replacement of agro-ecological and conventional millet for corn on performance, ileal digestibility and immune response of broiler chickens.

Materials and Methods

Foxtail millet was produced under conventional and agro-ecological conditions. No chemical fertilizer, herbicide and insecticide were used in ecological

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system. Millet seeds used in both systems were genetically identical. Samples from both kind of millets were subjected to proximate analysis and dry matter, crude protein, ether extract, crude fiber and ash were determined (AOAC, 1955). The amino acids contents were estimated according to their protein contents (NRC, 1994). Metabolizable energy of millets was determined by the method of Sibbald (1986) and corrected method of McNab and Blair (1988).

Chicks (Ross 308) were grown under standard conditions until 7th day. At 8th day, 216 male and 216 female were selected from the main flock. Chicks were divided into 24 groups, 18 chicks (9 male and 9 female) per group. In a completely randomized design with 2×3 factorial arrangement, chicks were allocated to six experimental treatments. Each treatment consisted of four replicates of 18 birds. The experiment lasted until 42 days of age. Basal diets for starter and grower periods were formulated according to NRC (1994). Experimental diets were formulated by replacing 33, 66 and 100 % of two kinds of millet (agro-ecological and conventional) for corn (Tables 1 and 2). Experimental period was 5 weeks and body weight of chicks was determined at days 8, 21 and 42. Feed intake was recorded and feed conversion ratio was determined. At day 28 from each pen 2 males and 2 females were randomly selected and killed by cervical dislocation. Ileum was separated (Meckel's diverticlum- ileo-caeco-colic junction) and digesta from second part of it was collected for digestibility measurement. Ileal contents were kept at -20ºC. Ileal contents of 2 birds were mixed, then dry matter, acid insoluble ash and crude protein were determined (AOAC, 1955). Chicks were vaccinated against Newcastle at day 16 and 31 of age and Gumboro at days 12 and 23.

From each pen, one male and one female were selected and marked one day before and 6 day after vaccination. Blood samples were taken from wing vein. Blood samples were kept at -20ºC until antibody determination. HI test was used for determination of Newcastle antibody (Marquardt et al., 1984), and Gumboro antibody was determined using ELISA (IDEXX Laboratory Inc. Westbrook ME 04092 USA). Data was subjected to analysis of variance using SAS by GLM method and means were compared.

Results and Discussion

Analysis of chemical composition and TMEn of two kind millets indicated that the nutritional value of agro-ecologic millet was slightly higher than conventional one. Agro-ecologic millet contained lower crude fiber and higher crude protein and ether extract, which resulted in higher TMEn value for agro-ecologic millet (Table 3).

Effects of cultivation conditions and substitution of millet for corn on body weight, feed intake and feed conversion ratio is indicated in Table 4. Increasing

Table 1: Composition of experimental diets (starter)

Substitution level (%)	33		66		100	
Cultivation conditions	Organic	Conventional	Organic	Conventional	Organic	Conventional
Ingredients (%)						
Corn	43.21	46.62	21.84	21.24	00.00	00.00
Soybean meal (44%)	29.97	30.40	28.63	29.54	27.05	28.68
Organic millet	21.61	00.00	43.68	00.00	66.46	00.00
Conventional millet	00.00	21.31	00.00	42.47	00.00	63.52
Sunflower oil	1.27	1.75	1.88	2.82	2.46	3.85
Oystershell	1.28	1.28	1.25	1.25	1.22	1.22
Dicalcium phosphate	1.04	1.04	1.07	1.06	1.09	1.08
Vitamin premix	0.35	0.35	0.35	0.35	0.35	0.35
Mineral premix	0.35	0.35	0.35	0.35	0.35	0.35
Methionine	0.21	0.21	0.19	0.19	0.16	0.17
Lysine	0.13	0.13	0.21	0.18	0.28	0.21
Theronine	0.02	0.02	0.01	0.01	0.02	0.02
Salt	0.20	0.20	0.20	0.20	0.20	0.20
Na-bicarbonate)	0.20	0.20	0.20	0.20	0.20	0.20
Phytase premix (Natuphos)	0.05	0.05	0.05	0.05	0.05	0.05
Chemical analysis						
ME (Kcal/Kg)	2900	2900	2900	2900	2900	2900
Protein (%)	19.4	19.4	19.4	19.4	19.4	19.4
Fat (%)	4.55	5.00	5.80	6.60	7.10	8.20
Ca (%)	0.83	0.83	0.83	0.83	0.83	0.83
Available P (%)	0.41	0.41	0.41	0.41	0.41	0.41
Lysine (%)	1.14	1.14	1.14	1.14	1.14	1.14
SAA (%)	0.87	0.87	0.87	0.87	0.87	0.87
Methionine (%)	0.54	0.54	0.56	0.56	0.56	0.56
Theronine (%)	0.77	0.77	0.77	0.77	0.77	0.77

Table 2: Composition of experimental diets (grower)

Substitution level (%)	33		66		100	
Cultivation conditions	Organic	Conventional	Organic	Conventional	Organic	Conventional
Ingredients (%)						
Corn	46.75	46.11	23.63	22.99	21.64	23.40
Soybean meal (44)	24.79	25.26	23.34	24.33	21.64	23.40
Organic millet	23.73	00.00	47.25	00.00	71.90	00.00
Conventional millet	00.00	23.53	00.00	45.95	00.00	68.72
Sunflower oil	1.31	1.82	1.97	2.98	2.60	4.10
Oystershell	1.24	1.24	1.21	1.21	1.19	1.18
Dicalcium phosphate	0.98	0.98	1.00	1.00	1.02	1.03
Vitamin premix	0.35	0.35	0.35	0.35	0.35	0.35
Mineral premix	0.35	0.35	0.35	0.35	0.35	0.35
Methionine	0.14	0.14	0.12	0.12	0.10	0.10
Lysine	0.12	0.14	0.17	0.20	0.21	0.28
Theronine	0.02	0.02	0.02	0.02	0.02	0.02
Salt	0.20	0.20	0.20	0.20	0.20	0.20
Na-bicarbonate	0.20	0.20	0.20	0.20	0.20	0.20
Phytase (Natuphos)	0.05	0.05	0.05	0.05	0.20	0.20
Chemical analysis						
ME (Kcal/Kg)	2963	2963	2963	2963	2963	2963
Protein (%)	17.53	17.53	17.53	17.53	17.53	17.53
Fat (%)	4.80	5.24	6.15	7.00	7.54	8.75
Ca (%)	0.80	0.80	0.80	0.80	0.80	0.80
Available P (%).	0.40	0.40	0.40	0.40	0.40	0.40
Lysine (%)	1.00	1.00	1.00	1.00	1.00	1.00
SAA (%)	0.77	0.77	0.77	0.77	0.77	0.77
Methionine (%)	0.47	0.47	0.48	0.48	0.48	0.48
Theronine (%)	0.70	0.70	0.70	0.70	0.70	0.70

Table 3: Chemical analysis of millets cultivated under different conditions (agro-ecological vs conventional)

Parameters (%)	Agro-ecological	Conventional
Dry matter	90.80	90.50
Crude protein	11.00	10.40
Ether extract	6.60	6.50
Crude fiber	6.50	7.14
Ash	3.16	3.60
TMEn (Kcal/Kg)	3161	3075

replacement of millet for corn especially at 100% substitution improved broiler performance significantly (P<0.05). Millet kind (agro-ecological vs. conventional) had not any significant effect on body weight and feed intake, but birds which consumed agro-ecologic millet had better feed conversion ratio at days 21 and 42 (P<0.02) comparing with those consumed conventional millet. Ileal digestibility for protein and dry matter is indicated in Table 5. Protein digestibility was improved due to increasing millet inclusion in the diet, and 100% replacement showed the highest protein digestibility (P<0.05). Level of millet inclusion had not significant effect on dry matter digestibility. Kind of millet and cultivation conditions had not significant effect on ileal digestibility. Antibody production (Newcastle and Gumboro) were not affected by level of inclusion and cultivation condition of millet. The results indicated that substitution of foxtail millet for corn in broiler diets can improve performance without any negative effect on ileal digestibility and bird health. Both kind of millet (agro-ecological vs conventional) used in this experiment had similar chemical composition which is in agreement with the report of Monteiro et al. (1988). Rama Rao et al. (2004), Mader et al. (2007) and Jacob (2007) indicated that there is no difference in chemical composition between agro-ecological and conventional grains, which is in consistence with the results of the present experiment. Better performance of broilers used diets contained foxtail millet compared with corn is in agreement with the findings of Davis et al. (2003). Adeola and Orban (1995), Davis et al. (2003) and Garcia et al. (2005) reported that millet can be used as a main source of energy for poultry. Improvement in broilers performance with 100% replacement of millet is related to better ileal digestibility of protein, therefore, provided more essential amino acids like methionine, lysine and argentine. Although, agro-ecological millet had higher TMEn than conventional one, but it is rather hard to make an assumption in benefit of agro-ecological millet, but lower crude fiber in agro- ecological millet may caused higher TMEn for this grain. Absence of significant differences of two kind of millet regarding broiler performance is in agreement with the report of Bourn and Prescott (2002). Although some reports indicated better immune system when using organic grains (Lauridsen et al., 2007; Huber et al., 2010) but, we could not find indications which show that agro-ecological millet is more

Table 4: Effect of experimental diets on broiler performance

Criteria	Level of inclusion (%)				Cultivation conditions			P Value		
	33	66	100	SE	Organic	Conv.		Inclusion level	Cultivation condition	Interaction
Body weight at 21 (g)	560[b]	554[b]	598[a]	8.74	577	564	7.14	0.00	0.23	0.22
Feed intake at 21 (g/b/d)	53	52	54	0.70	52	53	0.56	0.20	0.17	0.16
Feed conversion ratio at 21 (feed/gain)	1.22	1.22	1.17	0.02	1.18[b]	1.23[a]	0.02	0.10	0.02	0.27
Body weight at 42 (g)	1655[b]	1696[b]	1897[a]	36.40	1770	1730	29.70	0.00	0.36	0.32
Feed intake at 42 (g/b/d)	77[b]	78[b]	83[a]	1.72	79	80	1.40	0.03	0.69	0.76
Feed conversion ratio at 42 (feed/gain)	1.57[a]	1.56[a]	1.49[b]	0.02	1.51[b]	1.56[a]	0.01	0.00	0.01	0.21

Standard error of means; a-b Means value in a row with no common superscripts differ significantly (P<0.05)

Table 5: Effect of experimental diets on apparent ileal digestibility

Inclusion level (%)	Dry matter	Protein
33	71.80	73.40[b]
66	72.00	76.05[b]
100	73.40	81.79[a]
SE [1]	1.77	1.91
Cultivation conditions	71.80	78.40
Organic Conventional	73.00	75.60
SE	1.45	1.56
P Value		
Inclusion level	0.78	0.02
Cultivation condition	0.58	0.24
Interaction	0.91	0.78

[a,b]Means value in each column with no common superscripts differ significantly (P<0.05)

effective than conventional millet in antibody production (date no given). Finally, foxtail millet is a good replacement for corn in poultry diets and millets produced under ecological and conventional cultivation conditions have nearly similar chemical composition and have no superiority to each other regarding broiler chickens performance.

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