FEED UTILIZATION OF FOXTAIL MILLET (*SETARIA ITALICA*) GRAIN IN BROILER DIETS

JAKUB NOVOTNÝ, MICHAL ŘIHÁČEK, ONDŘEJ ŠŤASTNÍK, EVA MRKVICOVÁ, MILENA BIELANOVÁ

Department of Animal Nutrition and Forage Production, Faculty of AgriSciences, Mendel university in Brno, Zemědělská 1, 613 00 Brno, Czech Republic

Corresponding email address: jakub.novotny@mendelu.cz

ABSTRACT

The aim of the study is the determination of the retention of crude protein (CP) and crude fat in the organism of broiler chickens after the addition of Foxtail millet (*Setaria italica (L.) Beauv.*) to the diet. At the same time, the performance parameters (live weight, carcass weight, feed conversion ratio (FCR)) were evaluated. Ross 308 male broiler chickens were included in the 36-day experiment, which were fed ad libitum diet of control (C), 5% of Foxtail millet (FM5) and 40% of Foxtail millet (FM40). In addition, their composition included the chromium oxide indicator (0.3%), which was used to determine the coefficients of apparent digestibility and retention of the already mentioned nutrients. The retention of CP was 67.78 % in the control mixture, 66.19% in the mixture FM5 and 68.62% in the mixture FM40. For crude fat, it was on average 84.95% (control mixture), 86.57% (FM5) and 90.21% (FM40). The CP retention of Foxtail millet was set at an average 73.15% over the observed period. There were no significant differences in the biochemical analysis of the blood

https://doi.org/10.11118/978-80-7509-994-5-0318

($p > 0.05$) as well as in the production qualities of broiler chickens (assessed by the Scheffe test). The average carcass content was 69.07% for the control group, 69.05% for the FM5 group and 68.93% for the FM40 group. Feed conversion ratio was average 1.28 for control group, 1.32 for FM5 and 1.34 for FM40. Foxtail millet can therefore be included to the diet without negative impact on the health of the chickens or the nutrient retention, which increased compared to the control diet when 40% of the foxtail millet was added to the diet.

Keywords: nutrient retention; poultry nutrition; alternative crop; performance parameters

INTRODUCTION

Verma, Srivastava, and Tiwari (2015) describe millet as a multipurpose crop. It is suitable for human consumption (grain) and animal feed (grain, forage). For human consumption, the grain must be hulled in mills, as the kernel and hull are fused together. Published studies indicate that it has a higher nutritional value than rice.

Millet is primarily used for silage and hay production (University of Kentucky, ©2017). However, it can also be harvested for green mass production. In such cases, harvesting should occur during the early or full heading stage (Hermuth et al., 1997, as cited in Hermuth, Janovská, and Prohasková, 2015).

Rao et al. (2004) identified foxtail millet as a viable option for completely replacing corn in broiler diets without any negative impact on production. Boroojeni et al. (2011) reported that the inclusion of millet in broiler feed positively affected nutrient digestibility and significantly increased body weight at both 21 and 42 days. The presence of essential amino acids important in poultry nutrition is high

in millet, making it suitable for the production of feed mixtures. This is particularly true for methionine, cysteine, threonine, and lysine (Pack, Hoehler, and Lemme, 2003)

In an experiment focused on other objectives, Tirajoh et al. (2014a) examined the effects on breast muscle quality and blood profile in broilers when foxtail millet was gradually incorporated into feed as a replacement for corn. The experiment involved 250 one-day-old chicks, which were divided into 25 groups of ten birds each, with 5 groups receiving one of 5 different feed mixtures: a control mixture, a mixture with 2.5% corn replaced by millet, 5% corn replaced by millet, 7.5% corn replaced by millet, and 10% corn replaced by millet. Depending on the amount of millet used in the feed, the tenderness of broiler meat improved. However, the color of the meat noticeably lightened with the use of feed containing more than 5% millet. No excessively pale or yellowish breast muscle was observed. The experiment concluded that millet can be used as a 10% replacement for corn, resulting in increased meat tenderness.

Batonon-Alavo et al. (2015) also evaluated the response of broilers to the partial or complete substitution of corn with sorghum and millet. They found that feeds containing millet resulted in performance similar to that of corn, while feeds containing sorghum led to a reduction in growth parameters. No impact on feed intake was observed when corn was replaced with sorghum. The results obtained with sorghum substitution highlight the need to develop technological methods that could enhance the utilization of these feeds in broilers.

MATERIAL AND METHODS

Animals and experimental conditions

In 3 replicates, a total of 54 one day old male broiler chickens of Ross 308 were randomly divided into 3 different experimental groups (in total 18 chickens per feeding group) with 6 birds per cage. The lighting program, temperature and humidity was set according to the technological instruction (Aviagen, 2018). Broilers were fed with experimental starter diets until 12 days of age. Chickens were fed with experimental grower diets from 13th day until 36th day of age. The chickens were fed ad libitum. The feed intake of each group was daily recorded. The body weight was regularly noticed. The experimental lasted 36 days. At the end of the trial, broilers were slaughtered, and the carcass parameters were evaluated.

Diets and experimental design

Starter diets were fed until the 11th day of age, and grower diets were fed from the 12th day of age until the end of fattening. For the experiment, 3 variants of the diets were prepared – control C (without Foxtail millet), FM5 (with 5% representation of Foxtail millet-variety Rucereus) and FM40 (with 40% representation of Foxtail millet). The diets were created as isonitrogenous and isocaloric. The diets were non-pelleted and their composition is shown in the Table 1. The chromium oxide indicator was mixed into the diets to determine the retention of nutrients by the indicator method.

Table 1. Compounds and chemical composition of used diets

	STARTER			GROWER		
Component	**C**	**FM5**	**FM40**	**C**	**FM5**	**FM40**
Maize (g/kg)	173.8	171.45	130.0	190.1	170.0	135.5
Soybean meal (g/kg)	438.0	438.0	438.0	300.0	290.0	290.0
Wheat (g/kg)	383.0	343.4	450.0	373.8	353.4	44
Rapeseed oil (g/kg)	42.1	40.0	32.2	57.0	54.1	50.0
Premix* (g/kg)	30.0	30.0	30.0	30.0	30.0	30.0
Limestone milled (g/kg)	6.1	6.0	5.8	4.4	4.4	4.1
Monocalcium phosphate (g/kg)	8.0	8.1	8.7	7.4	7.4	7.9
DL-Methionine (g/kg)	1.2	1.25	1.25	1.5	1.5	1.5
L-lysine	2.0	2.4	2.95	0.0	0.2	0.7
Wheat gluten (g/kg)	50.1	53.7	50.4	33.4	36.4	33.9
Foxtail Millet	0.0	50.0	400.0	0.0	50.0	400.0
Sodium chloride	0.7	0.7	0.7	0.7	0.7	0.7
Chromium oxide (g/kg)	3.0	3.0	3.0	3.0	3.0	3.0
MEN (MJ/kg)**	12.39	12.41	12.49	12.76	12.75	12.91
Crude protein (g/kg)	264.75	231.24	237.33	224.26	219.05	221.68
Ether extract (g/kg)	60.18	60.59	61.22	774.29	72.62	75.19
Crude fibre (g/kg)	30.50	31.38	44.56	30.76	30.29	47.98
Crude ash (g/kg)	64.74	67.02	69.99	62.63	62.60	63.42

Legend: **Premix for starter contains (per kg): L-lysine 2.34 g; DL-Methionine 2.4 g; Threonine 0.99 g; calcium 5.25 g; phosphorus 1.95 g; sodium 1.44 g; copper 15 mg; iron 84 mg; zinc 99 mg; manganese 99 mg; iodine 0.99 mg; selenium 0.18 mg; retinol 13,500 IU (international units); calciferol 5,001 IU; tocopherol 45 mg; phylloquinone 1.5 mg; thiamine 4.2 mg; ri-boflavin 8.4 mg; pyridoxin 6 mg; cobalamin 30 µg; biotin 0.21 mg; niacinamid 36 mg; folic acid 1.8 mg; calcium pantothenate 13.5 mg; cholin chloride 180 mg.*

Premix for grower contains *(per kg): L-lysine 2.58 g; DL-Methionine 2.52 g; Threonine 1.47 g; calcium 5.04 g; phosphorus 1.65 g; sodium 1.38 g; copper 15 mg; iron 75 mg; zinc 99 mg; manganese 99 mg; iodine 0.9 mg; selenium 0.36 mg; retinol 9,900 IU (international units); calciferol 5,001 IU; tocopherol 45 mg; phylloquinone 1.5 mg; thiamine 4.2 mg; ri-boflavin 8.4 mg; pyridoxin 6 mg; cobalamin 28.8 µg; biotin 0.18 mg; niacinamid 36 mg; folic acid 1.71 mg; calcium pantothenate 13.35 mg; cholin chloride 180 mg. ** Apparent metabolize energy, calculated value.;); C-control group; FM5-5% of Foxtail millet in diet; FM40-40% of Foxtaill millet in diet*

At the end of the experimet at 36 days of age, the chickens were weighed and slaughtered. Subsequently, the weight of the carcass without giblets, and neck was determined and the percentage. In selected 12 individuals from each group, breast and thighs muscles were deboned, and the percentage of breast and thighs muscles in live weight was determined by calculation. During the experiment, excreta was regularly collected to determine CP and fat retention (calculation using the indicator method) (Zeman et al., 2006).

Statistical analysis

Data has been processed by Microsoft Excel (USA) and StatSoft Statistica (USA). It was used one-way analysis of variance (ANOVA). For evaluate statistically differences between groups was used the Sheffé´s test and $p < 0.05$ was regarded a level of statistically significant difference.

RESULTS AND DISCUSSION

Table 2 shows the weights of broilers during the experiment. There were no statistically significant differences between the groups in the individual terms ($p > 0.05$). The final weight at 36 days of age corresponds to the performance parameters of Aviagen (2 332 kg) for the given ROSS 308 hybrid (Aviagen, 2019).

Table2. Live weight of broilers fed diet with foxtail millet during the experiment

Age (days)	C	FM5	FM40
n	18		
	Mean (g) ± SD		
1	46 ± 5.2	45 ± 2.7	44 ± 4.4
8	171 ± 26.4	173 ± 21.4	154 ± 23.7.
12	316 ± 51.5	341 ± 46.7	301 ± 54.3
15	463 ± 65.5	501 ± 67.0	448 ± 87.7
22	980 ± 129.3	1 000 ± 114.2	922 ± 207.2
29	1 648 ± 202.2	1 670 ± 181.4	1 655 ± 241.3
36	2 440 ± 303.8	2 435 ± 261.6	2 411 ± 319.9

n.s. ($p > 0.05$); C-control group; FM5-5% of Foxtail millet in diet; FM40-40% of Foxtaill millet in diet; SD-standard deviation

Also, no statistically significant differences were found between the values of average feed consumption per 1 chicken and feed conversion ($p > 0.05$). The FCR value was 1.23 vs. 1.32 vs. 1.35 (C vs. FM5 vs. FM40, respectively). The FCR for all groups was lower than that reported in AVIAGEN (2019) at 1.45. This may be due to the laboratory conditions and minimal movement of the chickens in the cages.

In the experiment conducted by Bugalia et al. (2009), weight gain and feed conversion increased as the millet content in the feed mixture increased. Similar results were obtained by Shekhawat, Mathur, and Kumar (2013), who used millet as a substitute for corn. They observed that both body weight and weight gain increased with the higher levels of millet replacing corn. Likewise, Reddy and Narahari (1997)

achieved similar results when using 40% millet in the feed mixture, with weight gains increasing as the millet level rose. Boroojeni et al. (2011) also confirmed a linear increase in body weight corresponding to higher millet content in the feed. However, in this experiment, the results showed only minimal differences, and with a higher proportion of millet in the feed, there was a decrease in the chickens' weight.

Tirajoh et al. (2014b) evaluated millet as a potential replacement for corn in broiler feeds. However, due to its high phytic acid content, millet may not be able to fully replace all the corn in the feed.

Table 3. Carcass, breast and thighs yield of broiler chickens fed diet with foxtail millet

	C	**FM5**	**FM40**
n		12	
Yield		Mean (%) ± SD	
Carcass	69.07 ± 2.03	69.05 ± 2.2	68.93 ± 1.48
Breast	21.30 ± 1.37	20.59 ± 2.04	20.17 ± 1.44
Tighs	14.14 ± 0.70	14.06 ± 0.83	14.48 ± 0.89

n.s. ($p > 0.05$); C-control group; FM5-5% of Foxtail millet in diet; FM40-40% of Foxtaill millet in diet; SD-standard deviation

The Table 3 presents the carcass yield values of the chickens. No statistically significant differences were found between the groups ($p > 0.05$). Shekhawat and Kumar (2016) reported similar findings. In their study, they replaced corn with millet and did not observe significant changes in the eviscerated carcass weights.

Table 4. Retention of nutrients of boiler chickens fed diet with foxtail millet

	C	FM5	FM40
n	21		
Retention of:		Mean (%) ± SD	
Crude protein	67.78 ± 3.95	66.19 ± 3.61	68.62 ± 3.59
Crude fat	84.95 ± 11.12	86.57 ± 8.36	90.21 ± 6.07

n.s. ($p > 0.05$); C-control group; FM5-5% of Foxtail millet in diet; FM40-40% of Foxtaill millet in diet; SD-standard deviation

The values in the Table 4 for nitrogen and fat retention were evaluated as statistically insignificant ($p > 0.05$). However, slight changes were observed, with a slight increase in the retention of both nitrogen and fat when 40% millet was included in the feed mixture.

Boroojeni et al. (2011), who studied the effects of replacing corn with millet, concluded that incorporating millet into the feed mixture does not adversely affect the digestibility of crude protein. The apparent ileal digestibility of crude protein was, on average, 73.35% with a 33% replacement of corn by millet, 76.05% with a 66% replacement, and 81.73% with a 100% replacement.

In the case of the initial feed mixtures, where the average coefficients of balance digestibility for the FM5 group were 66.19% for crude protein and 86.57% for fat, and for the FM40 group were 68.62% for crude protein and 90.21% for fat over the observed 36-day period, it can be said that the best nutrient utilization for both crude protein and fat was observed in the FM40 group.

CONCLUSION

From the results of the experiment, it can be claimed that Foxtail millet can be included in the broiler´s diet in low and high (40%) proportions, without having a negative impact on productivity or retention of nutrients (NL and fat). Nutrient retention (CP and fat) compared to the control mixture even increased when 40% foxtail millet was included in diet.

REFERENCES

Aviagen. 2018. Technologický postup pro výkrm brojlerů Ross. In: Aviagen®. Huntsville (Alabama): Aviagen.

Aviagen. 2019. Ross 308 and Ross 308 FF Broiler Performance Objectives. In: Aviagen®. Huntsville (Alabama): Aviagen.

Batonon-Alavo, D. I.; Umar Faruk, M.; Lescoat, P.; Weber, G. M., BastianellI, D. 2015. Inclusion of sorghum, millet and cottonseed meal in broiler diets: a meta-analysis of effects on performance. Animal. 9(7): 1120–1130.

Boroojeni, G. F.; Samie, A. H.; Edriss, M. A.; Khorvash, M.; Sadeghi, G.; Van Kessel, A., Zentek, J. 2011. Replacement of corn in the diet of broiler chickens using foxtail millet produced by 2 different cultivation strategies. Poultry Science. 90(12), p. 2817–2827.

Bugalia, H. L.; Mathur, M. C.; Yadav, C. M., Upendra, K. 2009. Influence of Different Levels of Foxtail Millet (Setaria italica) on the Performance of Broiler Chicks. Indian Journal of Animal Nutrition. 26(3): 280–282.

Hermuth J.; Janovská, D., Prohasková, A. 2015. Bér vlašský Setaria Italica (L.) Beauv.: vhodná plodina do měnícího se klimatu České republiky, Praha: Výzkumný ústav rostlinné výroby. Metodika pro praxi.

Pack M.; Hoehler, D., LemmE, A. 2003. Economic assessment of amino acid responses in growing poultry. In: D'Mello, J. P. F. (ed.). Amino acids in animal nutrition. 2nd ed. Willingford, Oxon, UK; Cambridge, MA, USA: CABI Pub. 459-484.

Rao, S.V.R.; Reddy, M. R.; Prarharaj, N. K., Sunder, G. S. 2000. Laying Performance of Broiler Breeder Chickens Fed Various Millets or Broken Rice as a Source of Energy at a Constant Nutrient Intake. Tropical Animal Health and Production. 32(5): 329–338.

Reddy, P. S., Narahari, D. 1997. Utilization of foxtail millet (Setaria italica) and its processed forms on performance of broilers. Indian Journal of Animal Sciences. 67(3): 237–240.

Shekhawat, R. S. a Kumar, U. 2016. Effect of replacing maize by Kangni (Setaria italica) on body measurement and carcass traits of broilers. Annals of Agricultural Sciences. 38(3): 342-346.

Shekhawat, R. S.; Mathur, M. C., Kumar, U. 2013. Effect of replacing maize by Kangni (Setaria italica) on performance of broilers. Veterinary Practitioner, c/o Dr. A. K. Gahlot. 14(1): 20-22.

Tirajoh, S.; Achmanu, Sjofjan, O., Widodo, E. 2014a. Effect of gradual inclusion of papua foxtail millet (Setaria italica sp) to substitute yellow corn on breast meat quality and blood profiles in broilers. International Journal of Agronomy and Agricultural Research (IJAAR). 4(6): 104–109.

Tirajoh, S.; Achmanu, Sjofjan, O. a Widodo, E. 2014b. Evaluation of nutritive values of Papua foxtail millet (Setaria italica sp) and its substitutive effect for yellow corn on broiler performances. International Journal of Agronomy and Agricultural Research (IJAAR). 4(5): 195–201.

University of Kentucky. ©2017. Millets. University of Kentucky College of Agriculture, Food and Environment. Lexington (Kentucky).

Verma, S.; Srivastava, S. a Tiwari, N. 2015. Comparative study on nutritional and sensory quality of barnyard and foxtail millet food products with traditional rice products. Journal of Food Science and Technology. 52(8):5147–5155

Zeman, L. a kolektiv. 2006. Výživa a krmení hospodářských zvířat. Praha: Profi Press. ISBN 978-80-86726-17-5.