Indian Journal of Animal Sciences **84** (7): 779–782, July 2014/Article

Effect of dietary inclusion of full fat maize germ on carcass characteristics of broilers

LASNA SAHIB[1], M R PURUSHOTHAMAN[2] and D CHANDRASEKARAN[3]

Veterinary College and Research Institute, Namakkal, Tamil Nadu 637 001 India

Received: 15 October 2012; Accepted: 17 February 2014

ABSTRACT

This study was undertaken to evaluate the effect of dietary inclusion of full fat maize germ (FFMG) at different levels on the carcass characteristics of broilers. A feeding trial of 42 days consisting of 6 dietary treatments – 0 (control), 5, 10, 15 FFMG, 9 % defatted maize germ (DFMG) and 7 to 10 % of maize germ oil (MGO) was conducted. Eight birds per treatment were slaughtered and serum samples, liver, breast and thigh muscle tissue, abdominal fat pad, intestinal contents and left tibial bone were preserved at –20°C for analyses. Serum total and HDL cholesterol, muscle cholesterol, liver and muscle lipid content were analyzed, and characterization of muscle fat and abdominal fat was done. Cooking loss of breast meat was determined. Intestinal lipase activity and bone ash including Ca and P were estimated. Muscle lipid content, iodine number and saponification number of breast meat fat and abdominal fat, per cent cooking loss of breast meat, serum total and HDL cholesterol, muscle cholesterol, intestinal lipase activity and bone ash content of birds fed different levels of FFMG were comparable with control. The percentage of linoleic acid and total PUFA increased linearly with increasing level of FFMG. Calcium % in birds fed FFMG was significantly higher than the control. The results indicated that the inclusion of FFMG at 5 to 15 % does not have any adverse effect on the carcass characteristics of broilers.

Key words: Broiler, Carcass characteristics, Feed, Full fat maize germ

Full fat maize germ (FFMG) is a by-product of maize starch extraction unit and has the potential to be used in the poultry feed as an alternative to expensive oils to increase the energy density of the ration. The inclusion of FFMG in poultry diet not only reduces the need for supplementing costly fat or oils but can also reduce the risk of rancid fats or oils in poultry feeds. Furthermore, maize germ oil (MGO) is rich in polyunsaturated fatty acid (Lasna 2006) and broilers fed diets rich in PUFA are reported to have lower total body fat than those fed diets rich in saturated fatty acids (Sanz *et al*. 2000). In addition to the above mentioned benefits maize oil contains 0.77% phytosterols (Ostlund *et al*. 2002), which was reported to reduce plasma total cholesterol and low density lipoprotein in animals (Ling and Jones 1995).

Though there are few works on the effect of feeding FFGM on production performance of broilers, the response to feeding FFMG on the carcass characteristics of broilers is lacking. Hence the present study was undertaken to evaluate the effect of feeding FFMG, containing about 45% ether extract, on the carcass characteristics of broilers.

Present address: [1]Veterinary Surgeon (lasnasaif@yahoo.co.in), Veterinary Dispensary, Thenkurissi, Palakkad, Kerala. [2]Professor (m.r.purushothaman@tanuvas.org.in), [3]Professor and Head (d.chandrasekaran@tanuvas.org.in), Department of Animal Nutrition.

MATERIALS AND METHODS

Forty-eight birds (from a trial conducted with 180, day-old broiler chicks, which were divided into 6 groups and fed isocaloric and isonitrogenous, prestarter, starter and finisher diets, containing 0% (control), 5, 10 and 15% FFMG, 9% defatted maize germ (DFMG) and 7 to 10% MGO for 42 days (Lasna 2006)), belonging to 6 groups with 8 birds (4 males and 4 females) per treatment, were slaughtered at the end of 6 weeks of age for carcass study. Serum samples, liver, breast and thigh muscle tissue, abdominal fat pad, intestinal contents and left tibial bone were preserved at –20°C for analyses.

Liver tissues, breast and thigh muscles were oven-dried at 60°C and analyzed for their lipid content using petroleum ether. From the breast meat samples, fat was extracted using petroleum ether and analyzed for its characters, viz. acid number, iodine number and saponification number as per AOAC (2000). Abdominal fat pad was analysed for iodine number and saponification number (AOAC 2000). The cooking loss of breast muscle sample was estimated as per Pearson and Dutson (1994).

For the assay of fatty acids, 4 g of thigh meat was homogenized, the lipid was extracted (Folch *et al*. 1957) and analysed using gas chromatograph. The sample was

methylated by direct methylation procedure using tricosanoic acid as internal standard (Wang *et al*. 2000). The methyl esters of fatty acids were separated in the column and quantified based on the retention time for fatty acids using flame ionization detector.

The lipid extracted from thigh muscle tissues was quantified for total cholesterol (Wybenga *et al*. 1970). Serum samples were also assayed for total and HDL cholesterol by one step method of Wybenga *et al*. (1970).

The left tibial bones were cleaned of adhering flesh and placed in boiling water for 30 min, cleaned, dried at 100°C for 24 h, defatted with petroleum ether, dried, weighed and ashed at 550°C for 3 h. Calcium and phosphorus were estimated (AOAC 2000) and expressed as percentage in total ash. The lipase activity in the small intestine content was assessed as per Boutwell (1962).

The data collected on various parameters were statistically analyzed as per Snedecor and Cochran (1989) and the means of different experimental groups were tested for statistical significance by Duncan's multiple range test (Duncan 1955).

RESULTS AND DISCUSSIONS

The lipid % in thigh and breast muscle was comparable in all the treatments (Table 1). Similarly no significant difference in the liver lipid content of birds fed different levels of FFMG was observed except that in the MGO fed group (Table 1). The reduction in the lipid content in liver of birds fed MGO was in agreement with the reports of Sanz *et al.* (2000) who reported reduction in liver lipid content due to feeding of unsaturated oils.

The serum total and HDL cholesterol and muscle total cholesterol were not significantly different among the groups fed different levels of FFMG or MGO (Table 1). Addition of fat rich in PUFA was reported to reduce serum cholesterol (Crespo and Esteve-Garcia 2003). But the comparable cholesterol content among groups observed in this trial might be because of the inclusion of predominantly unsaturated oil (rice bran oil) up to 7.36% in the control feed. Thus both maize germ oil and rice bran oil being unsaturated, no differences could be observed between the control and other experimental groups. There is no apparent explanation for the higher level of serum total cholesterol in the group fed DFMG when compared to all other groups (Table 1).

The bone ash content of birds fed FFMG was not significantly different from the control, whereas the birds fed MGO had significantly higher bone ash percentage when compared to control (Table 1). In contrary, Atteh *et al.* (1983) reported that maize oil significantly reduced bone ash. Calcium content (as percentage of bone ash) was significantly higher in birds fed FFMG and DFMG whereas it was comparable in control and MGO fed group (Table 1). However, Atteh *et al*. (1983) reported that maize oil supplementation significantly reduced calcium retention when compared to birds fed diets without supplemental fat. They reasoned it to the high level of linoleic acid in maize oil, the soap of which is less utilized. No significant effects of diets were observed on phosphorus content (Table 1). Atteh and Leeson (1983) also reported similar results. They concluded that phosphorus retention and bone phosphorus content were not affected by the supplementation of different fatty acids presumably because the product of reaction between fatty acids and phosphorus is soluble and readily absorbed.

The acid number and iodine number of breast meat fat and iodine number of abdominal fat were not different among treatment groups (Table 2). The acid number of the breast meat fat was higher in all the groups, which may be due to the exposure to heat during the extraction of fat from the meat. The comparable iodine number among different groups, in both breast meat fat and abdominal fat may be due to the fact that all the groups were having either rice bran oil or maize germ oil in the diet, having almost similar iodine number of 105 (Tahira 2007) and 112.06 (Lasna 2006), respectively. The chain length of fatty acids in the

Table 1. Effect of feeding maize germ and maize germ oil on liver and meat lipid content, serum and muscle cholesterol, bone ash and bone mineral content

Parameters	Control	5% FFMG	10% FFMG	15% FFMG	9% DFMG	MGO
Lipid (%)						
Liver*	7.04^{a}±1.14	5.19^{ab}±0.58	5.34^{ab}±0.42	6.62^{ab}±1.04	6.41^{ab}±0.93	4.58^{b}±0.24
Breast muscle*	1.33±0.24	1.43±0.35	0.78±0.07	1.01±0.22	1.03±0.23	1.28±0.23
Thigh muscle*	2.32±0.50	2.37±0.30	2.53±0.42	2.26±0.10	3.06±0.60	2.87±0.48
Serum total cholesterol (mg/dl)*	144.66^{b}±13.04	156.70^{b}±9.12	157.06^{b}±6.42	159.31^{b}±8.23	196.49^{a}±9.58	165.11^{b}±7.60
Serum HDL cholesterol (mg/dl)*	77.78^{ab}±12.83	87.96^{a}±6.68	74.07^{ab}±2.45	81.02^{a}±4.42	62.96^{b}±4.04	74.07^{ab}±4.04
Muscle (thigh) Total cholesterol (mg%) **	123.68^{ab}±2.63	110.90^{b}±15.12	102.50^{b}±13.29	112.67^{b}±4.17	122.50^{ab}±11.50	153.62^{a}±7.43
Bone ash on dry fat free basis (%) **	49.67^{bc}±1.40	47.22^{c}±0.66	51.49^{ab}±0.89	51.31^{ab}±0.66	50.06^{bc}±0.99	53.32^{a}±0.88
Calcium (% bone ash)**	36.66^{b}±0.60	40.01^{a}±1.01	40.35^{a}±0.64	40.96^{a}±0.63	41.33^{a}±0.54	35.97^{b}±1.09
Phosphorus (% bone ash)**	15.95±0.42	16.60±0.11	17.04±0.17	16.65±0.05	16.88±0.14	16.12±0.71

*Mean ± SE of 8 observations; **mean ± SE of 3 observations. Mean bearing at least one common superscript within a row do not differ significantly. (P<0.05).

Table 2. Effect of feeding maize germ and maize germ oil on meat and abdominal fat characteristics and cooking loss of meat

Level of maize germ and maize germ oil	Breast meat fat characters			Abdominal fat characters		Cooking loss of meat(%)
	Acid number	Iodine number	Saponification number	Iodine number	Saponification number	
Control	32.04±4.51	94.83±10.63	196.35$^{a\pm}$14.70	61.31±2.42	179.84$^{a\pm}$6.44	23.6^{ab}±0.66
5% FFMG	27.04±4.29	86.01±10.05	205.23^{a}±8.76	63.95±1.41	171.13$^{ab\pm}$2.34	21.9$^{b\pm}$0.34
10% FFMG	36.72±1.18	88.89±9.89	247.19^{a}±20.73	70.99±1.51	177.02$^{a\pm}$0.35	23.3^{ab}±0.59
15%FFMG	27.51±1.11	98.90±6.30	207.73^{a}±20.08	61.05±3.25	162.58$^{ab\pm}$9.74	23.9$^{a\pm}$0.48
9% DFMG	40.05±1.98	100.95±3.94	203.05^{a}±9.26	70.69±4.34	175.48^{a}±4.37	22.1$^{b\pm}$0.73
MGO	38.46±0.95	95.16±5.68	104.25^{b}±9.72	61.26±1.97	156.12$^{b\pm}$4.91	19.4^{c}±0.63

Mean±SE of 4 observations. Mean bearing at least one common superscript within a column do not differ significantly (P<0.05).

Table 3. Fatty acid profile (% of total fatty acids) of thigh meat

Fatty acid	Control	FFMG-5%	FFMG–10%	FFMG–15%	DFMG-9%	MGO
Myristic acid (C14: 0)	00.68	00.68	00.56	00.61	00.54	00.49
Palmitic acid (C16: 0)	22.04	19.76	19.03	18.63	16.66	15.44
Pamitoleic acid (C16: 1)	03.86	05.78	04.16	03.51	05.38	05.53
Stearic acid (C18: 0)	06.38	02.40	05.94	04.09	04.05	04.63
Oleic acid (C18: 1)	35.23	36.64	32.10	31.65	35.09	30.17
Linoleic acid (C18: 2)	25.69	29.83	31.69	32.15	32.05	39.21
Linolenic acid (C18: 3)	00.99	00.93	00.86	01.34	00.94	01.10
EPA (C20: 5)	00.24	00.28	00.13	00.23	00.13	00.10
DHA (C22: 6)	00.92	00.93	01.20	01.24	01.29	00.76
Total saturated fatty acids	29.09	22.84	25.54	23.34	21.25	20.56
Total monoenoic fatty acids	39.09	42.42	36.26	35.16	40.47	35.70
Total PUFA	27.84	31.97	33.89	34.95	34.41	41.17
U/S	02.30	03.26	02.75	03.00	03.52	03.74

Values obtained for one pooled sample from 8 birds. U/S, Unsaturated fatty acids/ saturated fatty acids.

breast meat fat and abdominal fat of birds fed different levels of FFMG were comparable to control. The length of the fatty acids both in the abdominal fat and breast meat fat of the birds fed MGO was higher than the control (P<0.05). Saponification number was reported to be influenced by the nature of oils/fats (Valencia *et al.* 1993)

The per cent cooking loss of meat from groups fed different levels of FFMG was comparable with the control, whereas the birds fed MGO had significantly lower percentage of cooking loss (Table 2) which may be due to the presence of a tocopherol (80–100 ppm of a tocopherol) in MGO (Loliger 1989). α tocopherol is reported to maintain the integrity of cellular membranes which might have reduced the drip loss (Mitsumoto *et al.* 1995).

The per cent of linoleic acid and total PUFA content increased with increasing level of FFMG with the highest value observed in MGO fed group (Table 3). The increase in linoleic acid and total PUFA content of the meat observed in the present study might be due to an increase in the dietary intake of linoleic acid and PUFA as linoleic was the major fatty acid in MGO constituting to about 51.25% (Lasna 2006). Pinchasov and Nir (1992) also observed a linear increase in quantity of linoleic acid content and decrease in saturated and monoenoic acid quantity in tissue with an increase in dietary linoleic acid.

Table 4. Lipase activity (U/ml) in the intestinal contents of 6-week-old broiler chickens fed different levels of maize germ and maize germ oil

Level of maize germ and maize germ oil	Lipase activity
Control	3.24^{c} ± 0.29
5% FFMG	2.91^{c} ± 0.31
10% FFMG	3.36^{c} ± 0.42
15% FFMG	3.95^{bc} ± 0.47
9% DFMG	5.19^{ab} ± 0.53
MGO	5.64^{a} ± 0.55

Mean ± SE of 6 observations. Means bearing at least 1 common superscript within a column do not differ significantly (P<0.05).

The lipase activity in the birds fed different levels of FFMG was not significantly different from the control group but it was higher in birds fed DFMG and MGO (Table 4). Forman and Schneeman (1980) reported that a higher level of corn oil in the diet of rats increased pancreatic lipase activity. Specific lipase activity in the pancreatic juice was reported to increase with increasing fat intake (Hulan and

Bird 1972). But in the present study there was no clear-cut trend of lipase activity with the level of ether extract.

On the basis of present results it could be concluded that, FFMG can be included up to 15% in the broiler diets without adversely affecting the carcass quality, viz. liver and meat lipid content, meat and abdominal fat characteristics, cooking loss, serum and muscle cholesterol, lipase activity and bone ash %.

REFERENCES

AOAC. 2000. *Official Methods of Analysis*. 17th edn. Association of Official Analytical Chemists, Washington, DC.

Atteh J O and Leeson S. 1983. Effect of dietary fatty acids and calcium levels on performance and mineral metabolism of broiler chickens. *Poultry Scienc*e **62** (12): 2412–19.

Atteh J O, Leeson S and Julian R J. 1983. Effects of dietary levels and types of fat on performance and mineral metabolism of broiler chicks. *Poultry Scienc*e **62** (12): 2403–11.

Boutwell Jr. J A. 1962. *Clinical Chemical Laboratory Manual Methods.* Lea and Febiger, Philadelphia.

Crespo N and Esteve-Garcia E. 2003. Polyunsaturated fatty acids reduce insulin and very low-density lipoprotein levels in broiler chickens. *Poultry Science* **82** (7): 1134–39.

Duncan D B. 1955. Multiple range and multiple 'F' test. *Biometrics* **11**: 1–42.

Folch J, Lees M and Stanley G H S. 1957. A simple method for isolation and purification of total lipids from animal tissues. *Journal of Biological Chemistry* **226**: 497–509.

Forman L P and Schneeman B O. 1980. Effects of dietary pectin and fat on the small intestinal contents and exocrine pancreas of rats. *Journal of Nutrition* **110** (10): 1992–99.

Hulan H W and Bird F H. 1972. Effect of fat level in isonitrogenous diets on the composition of avian pancreatic juice. *Journal of Nutrition* **102** (4): 459–68.

Lasna Sahib. 2006. 'Feeding value of maize germ for broilers.' M.V.Sc. Thesis. Tamil Nadu Veterinary and Animal Sciences University, Chennai, Tamil Nadu, India.

Ling W H and Jones P J. 1995. Dietary phytosterols: a review of metabolism, benefits and side effects. *Life Sciences* **57** (3): 195–206.

Loliger J. 1989. Natural Antioxidants. *Rancidity in Foods.* 2nd edn, pp. 105–123. (Eds) Allen J C and Hamilton R J. Elsevier Science Publishers Ltd., New York.

Mitsumoto M, Arnold R N, Schaefer D M and Cassens R G. 1995. Dietary vitamin E supplementation shifted weight loss from drip loss to cooking loss in fresh beef longissimus during display. *Journal of Animal Sciences* **73** (8): 2289–94.

Ostlund R E, Racette S B, Okeke A and Stenson W F. 2002. Phytosterols that are naturally present in commercial corn oil significantly reduce cholesterol absorption in humans. *American Journal of Clinical Nutrition* **75** (6): 1000–04.

Pearson A M and Dutson T R. 1994. *Quality Attributes and their Measurement in Meat, Poultry and Fish products.* Vol. 9. Blackie Academic and Professional, Glasgow, UK.

Pinchasov Y and Nir I. 1992. Effect of dietary polyunsaturated fatty acid concentration on performance, fat deposition and carcass fatty acid composition in broiler chickens. *Poultry Science* **71** (9): 1504–12.

Sanz M, Flores A and Lopez-Bote C J. 2000. The metabolic use of energy from dietary fat in broilers is affected by fatty acid saturation. *British Poultry Science* **41** (1): 61–68.

Snedecor G W and Cochran W G. 1989. *Statistical Methods*. 8th edn. Iowa State university press, Ames, USA.

Tahira R, Ata-ur-Rehman and Muhammad Anwar Butt. 2007. Characterization of rice bran oil. *Journal of Agricultural Research* **45** (3): 225–30.

Valencia M E, Watkins S E and Waldroup A L. 1993. Utilization of crude and refined palm and palm kernel oil in broiler diets. *Poultry Science* **72** (12): 2200–15.

Wang Y, Sunwoo H, Cherian G and Sim J S. 2000. Fatty acid determination in chicken egg yolk: A comparison of different methods. *Poultry Science* **79** (8): 1168–71**.**

Wybenga D R, Pileggi V J, Dirstine P H and Giorgio J D. 1970. Direct manual determination of serum total cholesterol with a single stable reagent. *Clinical Chemistry* **16** (12): 980–84.