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ORIGINAL RESEARCH

Effect of saturated and unsaturated fat on the performance, serum and meat cholesterol level in broilers

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Abstract

Aim: A biological trial was conducted for a period of seven weeks to study the effect of graded levels of tallow (saturated) and sunflower oil (un saturated) or combination of both on the production performance, carcass characteristics, serum and meat cholesterol level in broilers.

Materials and Methods: The experimental feeds were prepared by the addition of tallow (2% and 4%) and sunflower oil (2% and 4%) either alone or in combination of both (SF oil 1% + tallow 1% and SF oil 2% + tallow 2%).

Results: Neither the fat source (sunflower oil or tallow) nor their combinations had influenced the growth rate, feed consumption, feed efficiency, livability and carcass characteristics in broilers. However, at 49 days of age, broilers fed with tallow alone had higher ($P<0.01$) abdominal fat than the rest of the treatment groups. When compared to control and tallow alone fed groups, the broilers fed with sunflower oil alone and mixture of sunflower oil and tallow had significantly ($P<0.01$) lower total serum and meat cholesterol level.

Conclusion: The data suggest that the abdominal fat yield, serum and meat total cholesterol level of commercial broilers are inversely proportional to the level of polyunsaturated fatty acids in the diet.

Keywords: broilers, carcass characters, serum and meat cholesterol, sunflower oil, tallow

Introduction

Fats and oils can be used as an alternative energy source in place of prime energy feed ingredients in broiler production. The dietary metabolizible energy (ME) increased through supplementation of fat in broiler ration had significantly increased body weight gain in broilers [1]. The cholesterol content of the food products especially from animal source becomes the prime area of consumer's concern because of the increased awareness on higher dietary cholesterol and the incidence of coronary heart diseases. Similarly, there has been growing interest over recent years in the modulation of the fatty acid composition and cholesterol content of poultry products. In poultry and other monogastric animals, the fatty acid composition of tissue lipids depends on the dietary fatty acids [2]. Accordingly, this study was formulated to know the influence of sunflower oil and tallow on the production performance, carcass yield, meat and blood cholesterol level in commercial broilers.

Materials and Methods

The biological trial was conducted for a period of seven weeks to study the effect of graded levels of sunflower oil, tallow or combination of both. Three hundred and sixty day old commercial straight run broiler chicks were randomly allotted into seven treatment groups (including control) with three replicates of twenty chicks each (Table-A). The experimental feed was formulated by following the standards prescribed in Bureau of Indian Standards [3]. Total seven isocaloric and isonitrogenous experimental feeds were prepared by adding sunflower oil, tallow or combination of both to carry out this experimental trial.

The ingredients and chemical composition of the experimental broiler starter and finisher mash are presented in Table-1 and 2 respectively. All the experimental broilers were fed with their respective experimental mash *adlibitum* throughout the study period under standard managemental conditions. Broiler starter mash was fed to broiler chicks from 0 to 25 days of age and finisher mash was fed thereafter.

At the end of 40, 43, 46, and 49 days of age, one male and one female from each replicate (total 6 per treatment) was randomly picked up and slaughtered after collecting the blood samples. The blood serum cholesterol level was estimated by one-step method [4]. The ready-to-cook yield, giblet yield and abdominal fat yields were recorded as per cent live weight. The breast and thigh meat samples were also collected from the respective samples for the estimation of total meat cholesterol level [5]. For meat quality evaluation, the collected meat samples were cut into uniform size and cooked at 15 psi for 15 minutes. The cooked meat samples were served hot to a taste panel consisting of six-members. The results were recorded on a nine point hedonic scale with ascending rate for the desired attributes of appearance, flavour, juiciness, tenderness

and overall acceptability as suggested by Lawless and Heymann [6]. For the statistical design and data analyses, complete random design was carried out. The data collected were subjected to statistical analysis as per the methods suggested by Snedecor and Cochran [7]. The percentage values were converted into Arc Sin values before statistical analysis.

Table-A. Experimental feed and treatment code

S.No.	Experimental feed	Treatment code
1	Control	T_1
2	Sunflower oil 2 %	T_2
3	Sunflower oil 4%	T_3
4	Tallow 2 %	T_4
5	Tallow 4%	T_5
6	Sunflower oil 1%+ Tallow 1%	T_6
7	Sunflower oil 2%+ Tallow 2%	T_7

Results and Discussion

The mean body weight (g), feed consumption (g), feed efficiency, ready to cook yield and giblet yield of broilers fed with sunflower oil, tallow either alone or in combinations are presented in Table-3. The body weight, feed consumption and feed efficiency of commercial broilers were not significantly influenced by the dietary inclusion of sunflower oil, tallow or combination of both. Similarly Sanz *et al.*[8], also recorded that dietary fats had no significant influence on the growth rate of commercial broilers. However, the broilers fed with fat based diet had comparatively better body weight gain than the non-fat based control group. However, Mohammadi *et al.*[9] reported that, Chicks fed diets supplemented with 6% of tallow or soybean oil and 3% tallow+3% soybean oil had the most body weight gain and the best value for feed conversion ratio ($P<0.01$). The better weight gain in un saturated fat based diet groups might be due to the fact that vegetable oils contained high amount of Poly Unsaturated Fatty Acids (PUFA's), which were more soluble (in to micelles) and ultimately more digestible in the intestine than the saturated fatty acids from animal fat and thereby the unsaturated fats provided the highest dietary Apparent Metabolisable Energy (AME) values in broilers. There was no mortality observed up to seven weeks of age due to the inclusion of sunflower oil, tallow or combination of both at graded levels.

Similarly there was no significant difference recorded in carcass yield due to the addition of graded levels of sunflower oil, tallow or combination of both at the age of 40, 43, 46 and 49 days in broilers. These findings are in agreement with Bilal *et al.*[10], Anjum *et* al.[11] and Habib *et* al.[12]. However, the ready-to-cook and eviscerated yields were increased as the age of the commercial broilers increased. Further when compared to the control group, all the treatment groups fed with fat based diets had better ready-to-cook and eviscerated yields. Similar findings were also observed by Hasan *et* al. [13] in broilers had significant ($P<0.01$) difference due to supplementation of 5 per cent fat in broiler diet.

Mean (S.E.) abdominal fat pad yield, serum and meat total cholesterol level in commercial broilers

Table-1. Ingredients and nutrients composition (%) of broiler starter ration

Ingredients	Experimental groups						
	T1	T2	T3	T4	T5	T6	T7
Maize	58.26	29.23	20.29	50.22	43.67	49.23	29.86
Bajra	0.00	30.00	25.60	0.00	0.00	0.00	14.80
Broken rice	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Deoiled Rice Bran	2.50	3.83	12.81	8.27	10.37	9.39	12.99
Soya meal	13.50	20.71	11.35	12.00	11.61	10.85	10.09
Deoiled Groundnut Cake	17.04	11.00	17.67	18.46	24.40	19.47	19.59
Fishmeal	5.03	0.00	4.26	5.25	2.08	5.26	4.76
Mineral Mixture	1.83	1.11	1.00	1.76	1.80	1.75	1.83
DiCalcium Phosphate	1.30	1.50	1.85	1.50	1.50	1.50	1.50
Calcite	0.22	0.17	0.85	0.23	0.00	0.24	0.27
Lysine	0.00	0.00	0.00	0.00	0.05	0.00	0.00
Methionine	0.00	0.03	0.00	0.00	0.02	0.00	0.00
Salt	0.32	0.42	0.32	0.31	0.50	0.31	0.31
Tallow	0.00	0.00	0.00	2.00	4.00	1.00	2.00
Sunflower Oil	0.00	2.00	4.00	0.00	0.00	1.00	2.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Feed supplements (g/100Kg)							
Choline chloride	50	50	50	50	50	50	50
Vitamin AB_2D_3K*	20	20	20	20	20	20	20
Minerals**	100	100	100	100	100	100	100
B Complex***	10	10	10	10	10	10	10
Liver tonic	25	25	25	25	25	25	25
Chemical composition							
Analysed CP (%)	23.02	23.03	23.09	23.06	23.08	23.04	23.03
Calculated ME (Kcal/Kg)	2804	2824	2805	2817	2798	2818	2800
Calculated Lysine (%)	1.21	1.44	1.43	1.30	1.39	1.20	1.20
Calculated Methionine (%)	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Calculated Linoleic acid (%)	1.00	1.12	1.75	0.60	1.00	1.20	1.40
Calculated Calcium (%)	1.20	1.20	1.20	1.20	1.20	1.20	1.20
Calculated Available Phosphorus(%)	0.50	0.50	0.50	0.50	0.50	0.50	0.50

* Vitamin AB_2D_3K: (supplied per Kg of feed: vitamin A-8250 IU, vitamin B_2-5mg, Vitamin D_3-1200 IU, vitamin K-1mg).

** Minerals: (supplied per Kg of feed: manganese-54mg, zinc-54mg, Iron-2mg, iodine-0.2mg, copper-0.2mg, cobalt-0.1mg)

*** Vitamin B complex: (supplied per Kg of feed: thiamine-1mg, pyridoxine-2mg, Cyanocobalamine-15mcg, vitamin E-10mg, niacin-15mg, calcium D pantathonate-10mg, folic acid-1mg)

Table-2. Ingredients and nutrients composition (%) of broiler finisher ration

Ingredients	Experimental groups						
	T1	T2	T3	T4	T5	T6	T7
Maize	58.26	29.23	20.29	50.22	43.67	49.23	29.86
Bajra	0.00	30.00	25.60	0.00	0.00	0.00	14.80
Broken rice	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Deoiled Rice Bran	2.50	3.83	12.81	8.27	10.37	9.39	12.99
Soya meal	13.50	20.71	11.35	12.00	11.61	10.85	10.09
Deoiled Groundnut Cake	17.04	11.00	17.67	18.46	24.40	19.47	19.59
Fishmeal	5.03	0.00	4.26	5.25	2.08	5.26	4.76
Mineral Mixture	1.83	1.11	1.00	1.76	1.80	1.75	1.83
DiCalcium Phosphate	1.30	1.50	1.85	1.50	1.50	1.50	1.50
Calcite	0.22	0.17	0.85	0.23	0.00	0.24	0.27
Lysine	0.00	0.00	0.00	0.00	0.05	0.00	0.00
Methionine	0.00	0.03	0.00	0.00	0.02	0.00	0.00
Salt	0.32	0.42	0.32	0.31	0.50	0.31	0.31
Tallow	0.00	0.00	0.00	2.00	4.00	1.00	2.00
Sunflower Oil	0.00	2.00	4.00	0.00	0.00	1.00	2.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Feed supplements (g/100Kg)							
Choline chloride	50	50	50	50	50	50	50
Vitamin AB_2D_3K*	20	20	20	20	20	20	20
Minerals**	100	100	100	100	100	100	100
B Complex***	10	10	10	10	10	10	10
Liver tonic	25	25	25	25	25	25	25
Chemical composition							
Analysed CP (%)	20.05	20.12	20.15	19.98	20.40	20.40	20.08
Calculated ME (Kcal/Kg)	2935	2905	2899	2920	2912	2928	2892
Calculated Lysine (%)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Calculated Methionine (%)	0.4	0.35	0.35	0.35	0.35	0.35	0.35
Calculated Linoleic acid (%)	1.2	1.76	2.36	1.08	1.00	1.44	1.67
Calculated Calcium (%)	1.20	1.20	1.20	1.20	1.20	1.20	1.20
Calculated Available Phosphorus (%)	0.50	0.50	0.50	0.50	0.50	0.50	0.50

* **Vitamin AB_2D_3K:** (supplied per Kg of feed: vitamin A-8250 IU, vitamin B_2-5mg, Vitamin D_3-1200 IU, vitamin K-1mg).
** **Minerals:** (supplied per Kg of feed: manganese-54mg, zinc-54mg, Iron-2mg, iodine-0.2mg, copper-0.2mg, cobalt-0.1mg)
*** **Vitamin B complex:** (supplied per Kg of feed: thiamine-1mg, pyridoxine-2mg, Cyanocobalamine-15mcg, vitamin E-10mg, niacin-15mg, calcium D pantathonate-10mg, folic acid-1mg)

Table-3. Effect of sunflower oil, tallow or combination of both on mean (± S.E.) body weight (g), cumulative feed consumption (g), feed efficiency, ready to cook yield and giblet yield of commercial broilers

Treatment	Body weight NS (g)	Feed consumption NS (g)	Feed Efficiency NS	Ready to cook NS yield (per cent live weight)	Giblet yield NS (per cent live weight)
Control	1826.6 ± 13.76	3833.32 ± 63.70	2.10 ±0.08	75.35±0.13	4.93±0.12
SF oil 2%	1980.00 ± 82.60	3636.17 ± 59.25	1.84±0.13	75.95±0.19	4.90±0.23
SF oil 4%	2001.24± 38.41	3606.90 ± 75.05	1.80±0.08	76.02±0.59	4.85±0.03
Tallow 2%	1909.78± 34.45	3708.34 ± 76.71	1.94±0.08	75.68±0.22	5.02±0.07
Tallow 4%	1898.40± 20.15	3370.80 ± 4.39	1.78±0.04	75.47±0.11	5.08±0.12
SF oil 1% + Tallow 1%	1916.68± 37.50	3364.92 ± 6.81	1.76±0.04	75.88±0.54	4.95±0.22
SF oil 2% + Tallow 2%	1913.11± 4.51	3365.00 ± 5.58	1.76±0.15	75.87±0.28	5.00±0.19

from 40 to 49 days of age are presented in Table 4. There was a significant ($P<0.01$) difference noticed in abdominal fat yield of commercial broilers fed with graded levels of tallow than the other treatment groups. Similarly Bilal *et al.* [10], Hasan *et al.*[13] and Monfaredi *et al.*[14] also observed a significant increase in abdominal fat yield of commercial broilers fed with saturated fats. The higher abdominal fat yield recorded in groups of broilers fed with tallow based diet might be due to the fact that saturated fats tend to deposit more fat in abdominal area also supported by Sanz *et al*. The lowest abdominal fat yield recorded in broilers fed with sunflower oil based diet might be due to the fact that vegetable oils inhibits the lipogenesis by inhibiting 9-desaturase complex and thereby reduces the fat deposition.

The serum, breast and thigh muscle total cholesterol level was also significantly influenced by the different dietary treatments from 40 to 49 days of age with an increasing muscle cholesterol level with the age of the broilers. This was in accordance with the findings of Hasan *et al.*[13] and Qureshi *et al.*[15] who recorded similar correlation between the age of the broiler and the muscle total cholesterol level in broilers. When compared to the control group, the broilers fed with sunflower oil alone or combination of sunflower oil and tallow based diet had reduced serum and breast muscle total cholesterol level. Whereas, the groups of broilers fed with tallow based diet had 16 - 20 per cent higher serum and muscle total cholesterol level. The higher level of total cholesterol level in groups of broilers fed with tallow based diet might be due to the reason that tallow is composed essentially of saturated fatty acids that increase the fat deposition Azman *et al.*[16] in the muscle and ultimately the total cholesterol was also increased. The highest level of meat cholesterol recorded in group of broilers fed with tallow based diet might be due to the fact that saturated fats such as tallow tend to deposit more fat in body when compared

Table-4. Effect of sunflower oil, tallow or combination of both on mean (S.E.) serum and meat total cholesterol level from 40 to 49 days of age in commercial broilers

Treatment	Abdominal fat yield** (per cent live weight)	Serum cholesterol** (mg per cent)	Breast muscle cholesterol** (mg per cent)	Thigh muscle cholesterol** (mg per cent)
Control	1.68^{a} ± 0.07	137.83^{abc} ± 5.33	77.33^{a} ± 2.93	95.43^{a}± 2.62
SF oil 2%	1.54^{a} ± 0.13	128.40^{ab} ± 4.58	72.80^{a} ± 2.64	92.45^{a}± 3.38
SF oil 4%	1.46^{a} ± 0.06	121.97^{a} ± 4.85	69.43^{a} ± 0.78	90.00^{a}± 2.61
Tallow 2%	1.87^{a}± 0.12	140.87^{bc} ± 2.37	90.28^{b} ± 2.91	112.67^{b}± 3.06
Tallow 4%	1.93^{b} ± 0.06	152.70^{c} ± 7.65	93.17^{b} ± 1.26	117.41^{b}± 4.64
SF oil 1% + Tallow 1%	1.54^{a} ± 0.12	119.50^{a} ± 4.49	76.50^{a} ± 2.93	95.18^{a}± 1.99
SF oil 2% + Tallow 2%	1.53^{a} ± 0.09	119.37^{a} ± 1.38	74.97^{a} ± 2.53	94.07^{a}± 3.02

Each value is the mean of 24 observations, ** Mean values (in column) bearing at least one common superscript do not differ significantly (*P>0.01*)

to the vegetable fats containing more amount of unsaturated fats also reported by Sanz *et al*.

Conclusion

1. Broilers fed with diet containing sunflower oil alone (2 or 4 per cent) and in combination with tallow (each at 1 per cent) had better body weight gain and feed efficiency.
2. The abdominal fat deposition, serum and meat total cholesterol levels were significantly reduced in commercial broilers fed with either sunflower oil alone or combination of sunflower oil and tallow based diet than those fed with tallow alone based diet or control diet.
3. It was recorded that irrespective of the dietary treatments, there was a linear increase in abdominal fat deposition, serum and meat total cholesterol level with the increase in age of the commercial broilers.
4. It was observed that the abdominal fat yield, serum and meat total cholesterol level of commercial broilers are inversely proportional to the level of polyunsaturated fatty acids in the diet. Whereas, the same parameters are directly proportional to the level of saturated fatty acids in their diet.

Author's contribution

This work was carried under the valuable advice and guidance of KM. MSK had carried out the biological research work and carcass characteristics study and KD compiled the data and carried out the statistical analysis, drafted and revised the manuscript. All authors read and approved the final manuscript.

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Competing interests

Authors declares that they have no competing interest.

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