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Effect different fat sources on performance and carcass characteristics of broilers

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Abstract

An experiment was conducted to evaluate the effect of dietary fat source on broiler performance and carcass characteristics. Ninety one day-old unsexed Ross 308 broiler chicks were purchased from a commercial hatchery. Chicks used in this study had uniform initial live body weight (44.31g ±0.90). The chicks were randomly allotted to 9 pens (1mx1m) in groups of 10 chicks in a pen. The chicks were divided into three dietary treatments; each group was replicated three times. The birds were fed on starter and finisher experimental diets containing vegetable oil (A), hydrogenated vegetable oil (B) and beef tallow (C). At the end of the experiment (42 days), 2 birds per replicate were randomly selected for carcass characteristics and internal organs evaluation. The results revealed that different sources of fat had no significant ($p \geq 0.05$) effect on live performance parameters during different growth phases. However, body weight gain during starter phase (0-3 weeks), was significantly ($p \leq 0.05$) higher for birds fed dietary hydrogenated vegetable oil and beef tallow versus those fed vegetable oil. During the finisher phase (4-6 weeks), broilers fed hydrogenated vegetable oil grew faster by 13.9 and 12.0% versus those fed vegetable oil and beef tallow, respectively. In addition, FCR and PER of broilers fed dietary hydrogenated vegetable oil were improved by 12.3 and 12.4%, respectively as compared with those on dietary beef tallow.

Carcass characteristics and internal organs were not significantly (P≥0.05) influenced by dietary treatments. However birds fed hydrogenated vegetable oil had significantly (P≤0.05) higher relative weight of liver and heart compared to those on beef tallow. Moreover, relative weight of abdominal fat was numerically higher in birds fed dietary beef tallow than in those fed vegetable oil and hydrogenated vegetable oil.

Keywords: Vegetable oil, hydrogenated vegetable oil, beef tallow, broiler, performance, carcass.
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تأثير مصادر مختلفة من الدهون على آداء الدجاج اللاحم وخصائص الذبيحة

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تم اجراء هذه التجربة لتقييم مصادر مختلفة للدهون على آداء الدجاج اللاحم وخصائص الذبيحة.في هذه التجربة تم استخدام 90 كتكوت لاحم غير مجنس من سلالة الروس 308 في عمر يوم وكانت تزن 44.31±0.90 جم. تم توزيع هذه الكتاكيت عشوائياً على 9 أقفاص يحتوي كل منها على 10 كتاكيت. وقد تم تغذية الكتاكيت على 3 اغذية تجريبية تم تكرارها ثلاث مرات. اشتملت الاغذية التجريبية الابتدائية والنهائية الثلاث على الزيت النباتي كمصدر للدهون(العلف الضابط)، الزيت النباتي المهدرج والشحوم الحيوانية. وقد خلال مدة التجربة والتي استمرت 42 يوم تم تسجيل مقاييس النمو (الوزن الحي، العلف المستهلك، الوزن المكتسب، معدل التحويل الغذائي ومعدل كفاءة البروتين) اسبوعياً. وبنهاية هذه المدة تم اخذ دجاجتان من كل مكرر وذلك لدراسة خصائص الذبيحة والاحشاء الداخلية. تم تحليل البيانات احصائياً باستخدام التصميم العشوائي الكامل. اوضحت النتائج ان مصادر الدهون المختلفة لم يكن لها اي اثر معنوي على مقاييس النمو وذلك في الفترات المختلفة. غير ان الوزن المكتسب خلال للفترة الابتدائية قد تحسن بصورة معنوية في الطيور التي تم تغذيتها على الزيت النباتي المهدرج والشحوم الحيوانية مقارنة بالزيت النباتي. من ناحية اخرى وخلال الفترة النهائية فقد سجلت الطيور التي تم تغذيتها على الزيت النباتي المهدرج نمواً بمعدل 13.9 و12.0% مقارنة بتلك التي تم تغذيتها على الزيت النباتي والشحوم الحيوانية، كذلك اوضحت الدراسة أن خصائص الذبيحة والاحشاء الداخلية لم تتأثر معنوياً بالاغذية التجريبية.

Introduction

In Sudan there has been a great progress in broiler industry during the last two decades. This progress is achieved through using good quality broiler chicks. However, high quality feed with high energy is required for exploring optimum performance of commercial broilers. Nevertheless, local feed ingredients such as sorghum, groundnut cake, sesame cake and wheat bran do not meet energy requirements for the modern broiler breeds. So, animal or vegetable fat is used in broiler feed as energy source ingredient. Increasing metabolizable energy results in higher growth rates and optimum feed efficiency (Fascina *et al*., 2009). Moreover, fat improves the absorption of fat-soluble vitamins (Baião and Lara, 2005), acts as a source of the essential fatty acids, reduces the dustiness, and increases feed palatability (Balevi and Coskun, 2000 and Palmquist, 2002). Furthermore, it results in a better absorption of all nutrients (Moav, 1995 and Palmquist, 2002) and improves nutrients digestibility due to increased contact between nutrients and enzymes (Latshaw, 2008). Fats or oils as energy sources are can be obtained from animal sources such as tallow and fish oil or from plant sources such as cotton seed, groundnut, sunflower and maize oil. There has been a great use of tallow in blended oil for poultry (Balevi and Coskun, 2000 and Tabeidian *et al*., 2005). Fat digestibility is affected by fatty acid saturation degree, carbon number in the chain, free fatty acid concentration, position of the glycerol molecule, as well as the interaction between saturated and unsaturated fatty acids (Dvorin *et al*., 1998 and Leeson and Summers, 2001).

Accordingly, the current study was conducted to evaluate the effects of different dietary sources of fat on broiler performance and carcass characteristics.

Materials and methods

The site and experimental birds

This experiment was conducted at the poultry unit (open-house system) of Faculty of Agricultural Technology and Fish Sciences, University of Elneelain, Jebal-Awlia, Khartoum south. Ninety one day-old straight-run Ross 308 broiler chicks were purchased from a commercial hatchery. Chicks used in this study had uniform initial live body weight (44.31g ±0.90).

Experimental diets

The chicks were randomly allotted to 9 pens (1mx1m) in groups of 10 chicks in a pen. The chicks were divided into three dietary treatments; each group was replicated three times. The birds were fed on starter and finisher experimental diets containing vegetable oil (A), hydrogenated vegetable oil (B) and beef tallow (C). At the end of the experiment (42 days), 2 birds were randomly selected for carcass characteristics and internal organs evaluation. Starter and finisher diets were isocaloric and isonitrogenous and formulated according to nutrient specifications recommended by national research council (NRC.1994). The birds were fed on starter diets for the first 3 weeks and then after fed on finisher diets. The composition of starter and finisher diets is shown in Tables 1 and 2, respectively.

Management

Each pen was equipped with 1 metallic drinker and 1 metallic tubular feeder. Feed and water were provided *ad libitum*. Drinkers and feeders were kept clean and leveled using red brick, cuboids. The lighting schedule consisted of continuous lighting throughout the experimental period by a combination of natural and artificial light. Artificial light was (12 hours) provided by incandescent bulb lamps of 60 watts. The bulbs were hanged about one foot height from the floor during the first two weeks and then maintained to about 6 feet. Before allocation of chicks, the house was carefully cleaned and disinfected. The birds received mix vaccine (IB+ Newcastle clone) at 6 days of age, and infections bursal disease (Gumboro) vaccine at 2 weeks of age, and replicated at 4 weeks of age.

Experimental procedure

Weekly feed intake and live body weight were determined for each pen. Feed conversion ratio (FCR) was calculated as feed intake per weight gain. While protein efficiency ratio (PER) was calculated as weight gain per protein consumed. Mortality was recorded daily as it occurred. At the end of the experiment (6 weeks of age), the birds were fasted from feed for an overnight and then weighed. After fasting, 2 birds from each pen were randomly selected, manually slaughtered and carcass characteristics parameters were determined.

Statistical analyses

Data were statistically evaluated by the general linear model (GLM) procedure of SAS (SAS Institute, 2003) using complete randomized design. Moreover, Duncan's multiple range test (Steel and Torrie, 1980) was used to separate the treatment means with significant differences.

Results and discussion

Table 3. presents live performance as influenced by different sources of fat. Generally, dietary treatments had no significant ($p\geq0.05$) effect on live performance parameters during different growth phases. However, body weight gain during starter phase (0-3 weeks), was significantly ($p\leq0.05$) higher for birds fed dietary hydrogenated vegetable oil and beef tallow compared to those fed vegetable oil. This increase in body weight gain may due to higher feed consumed during this period. During the finisher phase (4-6 weeks), broilers fed hydrogenated vegetable oil grew faster by 13.9 and 12.0% versus those fed vegetable oil and beef tallow, respectively. 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 (Duraisamy *et al*., 2013). In addition, FCR and PER of broilers fed dietary hydrogenated vegetable oil were improved by 12.3 and 12.4%, respectively as compared with those on dietary beef tallow. On the other hand, broilers fed hydrogenated vegetable oil showed higher final body weight by13.1 and 7.5% versus those fed vegetable oil and beef tallow, respectively. Feeding dietary vegetable oil caused a decrease in overall feed intake by 9.5 and 9.3% when compared with broilers fed hydrogenated vegetable oil and beef tallow, respectively. However, Sanz *et al*. (2000) evaluated the effect of diets containing sunflower oil and a mixture of bovine tallow/swine fat in broilers and did not observe any effect of the lipid sources on feed intake. These results are disagreed with studies that showed a decrease in feed intakes when UFA were fed (Sklan and Ayal, 1989 and Huang *et al*., 1990). These latter authors owed the

lower feed intakes observed when diets containing UFA are fed to the higher digestibility and metabolizable energy of UFA and thus reducing the energy requirement of the birds. Furthermore overall body weight gain of birds fed vegetable oil decreased by 13.4% compared with hydrogenated vegetable oil-fed broilers. Crespo and Esteve-Garcia (2001) reported that feed intake and feed efficiency were affected by the different fats. Sunflower and linseed oil showed better feed efficiency. Females fed olive oil had better feed efficiency than those fed tallow. The effect of type of fat on feed efficiency could be related to degree of unsaturation, since Su and Jones (1993) and Zollitsch *et al*. (1997) have reported that digestibility of fat increases as the degree of unsaturation increases. Nevertheless, sunflower oil or tallow had no effects on the growth rate, feed consumption, feed efficiency, livability and carcass characteristics in broilers (Duraisamy *et al*., 2013). Likewise Sanz *et al*. (1999) also recorded that dietary fats had no significant influence on the growth rate of commercial broilers. On the other hand, the broilers fed with fat based diet had comparatively better body weight gain than the non-fat based control group.

Table 4. and Table 5. Show the influence of different sources of fat on carcass characteristics and internal organs, respectively. Dietary treatments had no significant ($P \geq 0.05$) effect on carcass characteristics and internal organs. These results are coincided with Crespo and Esteve-Garcia (2001) who claimed that dressing percentage was not affected by the different types of fat. However birds fed hydrogenated vegetable oil had significantly ($P \leq 0.05$) higher relative weight of liver and heart compared to those on beef tallow. On the other hand relative weight of abdominal fat was numerically higher in birds fed dietary beef tallow than in

those fed vegetable oil and hydrogenated vegetable oil. This agreed with Crespo and Esteve-Garcia (2001) who reported less abdominal fat in birds fed sunflower and linseed oils compared to those fed tallow. Similarly, Vila and Esteve-Garcia (1996) found that sunflower oil produced less abdominal fat deposition in broilers than tallow at different levels of fat inclusion. Diets rich in UFA have been found to reduce fat deposition in broiler chicks when compared to diets supplemented with the same amount of fats rich in SFA (Sanz *et al*., 1999). At 49 days of age, broilers fed with tallow alone had higher ($P<0.01$) abdominal fat than the rest of the treatment groups (Duraisamy *et al*., 2013). 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*. (2002) and Monfaredi *et al*. (2011) 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 (Sanz *et al*., 1999). 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.

Conclusion

It could be concluded that broilers fed dietary hydrogenated vegetable oil perform better than either those fed on dietary vegetable oil or animal tallow. In addition, abdominal fat obviously reduced in birds fed dietary vegetable oil or hydrogenated vegetable oil versus animal tallow.

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Table 1. Composition and calculated analysis of broiler starter diets containing different sources of fat.

Ingredients, %	Different fat sources		
	Vegetable oil	Hydrogenated vegetable oil	Beef tallow
Sorghum	64.00	64.00	64.23
groundnut cake	24.00	24.00	24.00
Wheat bran	1.19	1.19	1.00
Broiler Super concentrates*	5.00	5.00	5.00
Lime stone	1.25	1.25	1.25
Dicalcium phosphate	0.12	0.12	0.12
Vegetable oil	3.25	0.00	0.00
Hydrogenated vegetable oil	0.00	3.25	0.00
Beef tallow	0.00	0.00	3.25
Salt	0.30	0.30	0.30
Lysine	0.13	0.13	0.10
Methionine	0.16	0.16	0.15
Choline	0.20	0.20	0.20
Enzymes	0.20	0.20	0.20
Mycotoxin binder	0.20	0.20	0.20
Calculated analysis			
ME (kcal/kg)	3172	3172	3165
CP%	22.9	22.9	22.9
Crude fiber%	4.22	4.22	4.21

Ether extract%	6.93	6.93	6.93
Ca%	1.00	1.00	1.00
Available phosphorous%	0.45	0.45	0.45
Lysine%	1.10	1.10	1.08
Methionine%	0.58	0.58	0.57
Methionine + Cystine%	0.79	0.79	0.78

*Cp 35%, ME 1900 kcal/kg, C.fiber 3.0%, EE 3.0%, Ash 33%, Ca 6.5%, Av. P 6.5%, Lysine 11%, Methionine 4.2%, Methionine+Cystine 4.5%. Vitamin A 250000 IU/Kg, Vitamin D3 50000 IU/Kg, Vitamin E 500Mg/Kg, Vitamin K3 40 Mg/Kg, Vitamin B1/ Thiamin 20 Mg/Kg, Vitamin B2/ Riboflavin 100 Mg/Kg, Niacin Vitamin PP 600 Mg/Kg, Pantothenic acid/ Vitamin B3 160 Mg/Kg,Vitamin B6/ Pyridoxine 30 Mg/Kg, Vitamin B12 300 Mcg/Kg, Biotin/Vitamin H 1000 Mcg/Kg, Choline 7000 Mg/Kg, Folic Acid 15 Mg/Kg. Copper 300 mg/Kg, Zinc 1.100 mg/Kg, Iron 600 mg/Kg, Manganese 1.200 mg/Kg, Cobalt 4.0 mg/Kg, Iodine 20.0 mg/Kg, Selenium 4.0 mg/Kg, Anti-oxidant Added, Phytase Added, Mould inhibitor Added, Salinomycin 1200 mg/kg.

Table 2. Composition and calculated analysis of broiler finisher diets containing different sources of fat.

	Different fat sources		
Ingredients, %	Vegetable oil	Hydrogenated vegetable oil	Beef tallow
Sorghum	70	70	70
groundnut cake	16.5	16.5	16.5
Wheat bran	3	3	3
Broiler Super concentrates*	5	5	5
Lime stone	1.17	1.17	1.17
Vegetable oil	3.29	0.00	0.00
Hydrogenated vegetable oil	0.00	3.29	0.00
Beef tallow	0.00	0.00	3.29
Salt	0.30	0.30	0.30
Lysine	0.10	0.10	0.10
Methionine	0.04	0.04	0.04
Choline	0.20	0.20	0.20
Enzymes	0.20	0.20	0.20
Mycotoxin binder	0.20	0.20	0.20
Calculated analysis			
ME (kcal/kg)	3193	3193	3183
CP%	20.07	20.07	20.07
Crude fiber%	3.88	3.88	3.88
Ether extract%	6.58	6.58	6.58

Ca%	0.90	0.90	0.90
Available phosphorous%	0.42	0.42	0.42
Lysine%	1.01	1.01	1.01
Methionine%	0.44	0.44	0.44
Methionine + Cystine%	0.62	0.62	0.62

*As shown in Table 1.

Table 3. Live performance of broilers fed diets with different sources of fat

Parameter	Dietary treatments			
	Vegetable oil	Hydrogenated vegetable oil	Beef tallow	± SEM
0-3 wk				
Feed intake	913.79+51.44	999.33+42.23	988.16+120.89	46.00
Body weight gain	657.49 [b]+48.28	739.65 [a]+19.88	735.79 [a]+43.00	22.54
FCR	1.39 +0.04	1.35 +0.07	1.34+0.09	0.04
PER	3.14 +0.08	3.24 +0.16	3.27 ±0.23	0.10
4-6 wk				
Feed intake	2480.30+146.82	2716.40+186.37	2720.10+234.91	111.29
Body weight gain	1172.90+132.38	1336.50+142.95	1192.80+152.88	82.55
FCR	2.13 +0.22	2.04 +0.17	2.29+0.23	0.12
PER	2.35 +0.23	2.45 +0.22	2.18 ±0.21	0.13
0-6 wk				
Live body W. (g/bird)	1874.50+179.88	2120.80+142.46	1972.50+186.86	98.64

Feed intake (g/bird)	3394.10+183.29	3715.70+164.73	3708.30+355.78	144.26
Body weight gain (g/bird)	1830.40+180.10	2076.20+143.59	1928.60+186.93	98.88
FCR (g feed /g Bwt gain)	1.86 +0.15	1.79 +0.11	1.93 +0.14	0.08
PER (Bwt gain/protein consumed)	2.58 +0.19	2.68 +0.17	2.50 ±0.17	0.10

Values are means of 3 replicates per treatment (10 bird\replicate).

[ab]Means ± SD with different superscripts in the same row are significantly different (P≤ 0.05).

SEM: Standard error of the means from ANOVA d.f 6.

Table 4. Carcass characteristics of broilers fed diets with different sources of fat

Parameter	Dietary treatments: Vegetable oil	Hydrogenated vegetable oil	Beef tallow	± SEM
Live body weight	1775.00	2076.00	2354.67	
Dressing % on hot base	71.32 ± 2.20	73.80 ±1.61	71.52 ±2.64	1.26
Absolute wt of Abdominal fat	28.00 ± 9.54	38.33 ± 3.21	47.67 ± 20.21	7.53
Relative wt of Abdominal fat	2.16 ±0.41	2.51 ±0.32	2.74 ±0.77	0.31
Absolute wt of breast	429.33 ±128.26	510.00 ±17.44	525.33 ±134.94	63.33
Relative wt of breast	33.34 ±3.20	33.39 ±2.66	30.79 ±3.67	1.85
Meat bone ratio of breast	7.77 ±2.15	9.45 ±3.75	7.82 ±5.79	2.41
Absolute wt of thigh	248.00±53.70	221.33±22.48	300.67±35.23	22.68
Relative wt of thighs	19.54±1.63	14.52±2.15	18.20±4.21	1.67
Meat bone ratio of thigh	4.80±2.56	5.09±0.91	5.24±3.08	1.37
Absolute wt of drumsticks	161.33 ^{b}±45.49	186.00 ^{ab}±25.00	237.33 ^{a}±6.43	20.96
Relative wt of drumsticks	12.62±1.24	12.14±1.83	14.13±0.85	0.79
Meat bone ratio of drumsticks	2.87 ±0.22	4.33 ±1.38	2.90 ±0.25	0.47

Values are means of 3 replicates per treatment.

[ab]Means ± SD with different superscripts in the same row are significantly different ($P \leq 0.05$).
SEM: Standard error of the means from ANOVA d.f 6.

Table 5. Internal organs of broilers fed diets with different sources of fat

Parameter	Dietary treatments			± SEM
	Vegetable oil	Hydrogenated vegetable oil	Beef tallow	
Absolute wt of liver	31.67 ^{b}±5.51	47.67 ^{a}±10.26	38.67 ^{ab}±3.21	4.03
Relative wt of liver	2.51 ^{ab}±0.12	3.10 ^{a}±0.52	2.31 ^{b}±0.18	0.19
Absolute wt of gizzard	23.33 ^{b}±3.51	25.33 ^{ab}±5.03	31.00 ^{a}±1.73	2.13
Relative wt of gizzard	1.87±0.32	1.65±0.30	1.87±0.33	0.18
Absolute wt of heart	9.33±2.08	12.00±0.00	10.00±2.00	0.96
Relative wt of heart	0.74 ^{a}±0.03	0.78 ^{a}±0.04	0.60 ^{b}±0.10	0.04
Length of Intestine	175.67 ±21.83	181.00 ±18.08	177.67 ±18.08	12.56

Values are means of 3 replicates per treatment.

[ab]Means ± SD with different superscripts in the same row are significantly ($P \leq 0.05$) different.

SEM: Standard error of the means from ANOVA d.f 6.