aJava

Asian Journal of Animal and Veterinary Advances

Academic
Journals Inc.

www.academicjournals.com

OPEN ACCESS Asian Journal of Animal and Veterinary Advances

ISSN 1683-9919
DOI: 10.3923/ajava.2016.158.167

Research Article
Emulsifier Effect on Fat Utilization in Broiler Chicken

[1]Muhammad Tahir Abbas, [1]Muhammad Arif, [3]Muhammad Saeed, [4]M. Reyad-ul-ferdous, [2]Muhammad Adeel Hassan, [3]M.A. Arain and [1]Abdur Rehman

[1]Department of Animal Sciences, College of Agriculture, University of Sargodha, Pakistan
[2]Graduate School of Chinese, Academy of Agricultural Sciences, Beijing, China
[3]College of Animal Sciences, Northwest A and F University, Yangling 712100, China
[4]Department of Pharmacy, Progati Medical Institute, Dhaka-1216, Bangladesh

Abstract

A trial was conducted to evaluate the effect of fat emulsifier on fat utilization in broiler chickens using 240 days old chicks which were divided into 24 replicates in a 3×2 factorial arrangement under Completely Randomized Design (CRD). Experimental diets were formulated using 1, 2 or 3% fat with or without fat emulsifier (Lecithin) at 350 mg kg^{-1}. The trial lasted for 35 days and was divided into starter and finisher phases. Statistical analysis of the data collected during the trial revealed that feed intake was not affected ($p>0.05$) by fat and fat emulsifier. Increasing fat levels resulted in a linear decrease ($p<0.05$) in starter weight gain but it didn't affect ($p>0.05$) finisher and overall weight gain. Fat emulsifier affected ($p<0.05$) finisher, final and overall weight gain but starter weight gain remained unaffected ($p>0.05$). Starter Feed Conversion Ratio (FCR) increased ($p<0.05$) with increasing fat levels but finisher and overall FCR remained unaltered ($p>0.05$). Fat emulsifier didn't affect ($p>0.05$) starter FCR but finisher FCR was improved with fat emulsifier supplementation ($p<0.05$). Dietary fat didn't affect ($p>0.05$) Dry Matter (DM) and Ether Extract (EE) digestibility but fat emulsifier significantly improved ($p<0.05$) DM and EE digestibility. The carcass composition study results revealed that fat emulsifier affected ($p<0.05$) the heart weight and linearly increasing fat levels resulted in a linear decrease ($p<0.05$) in gizzard weight. The combination of fat and fat emulsifier affected ($p<0.05$) finisher FCR, finisher weight gain, DM digestibility and EE digestibility. This investigation reveals that dietary fat should be avoided in starter diets and supplementation of fat emulsifier in broiler diets may improve DM and EE digestibility.

Key words: Broiler chickens, DM digestibility and EE digestibility, emulsifier effect, fat emulsifier, fat utilization, feed conversion ratio

Received: October 30, 2015 **Accepted:** December 21, 2015 **Published:** February 15, 2016

Editor: Dr. Kuldeep Dhama, Principal Scientist, Division of Pathology, Indian Veterinary Research Institute (IVRI), Izatnagar, Uttar Pradesh, India

Citation: Muhammad Tahir Abbas, Muhammad Arif, Muhammad Saeed, M. Reyad-ul-ferdous, Muhammad Adeel Hassan, M.A. Arain and Abdur Rehman, 2016. Emulsifier effect on fat utilization in broiler chicken. Asian J. Anim. Vet. Adv., 11: 158-167.

Corresponding Author: Muhammad Arif, Department of Animal Sciences, College of Agriculture, University of Sargodha, Pakistan

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Poultry is the most important source of animal protein that contributes significantly in maintaining the health status of an ever increasing human population. It is a cheap and main source of protein for under developed and developing countries like Pakistan. Poultry meat contributes 26.8% of total meat sources in Pakistan (Riaz *et al*., 2014). However, an alarmingly increasing human population, disease outbreaks and scarcity of quality ingredients are main obstacles in development of the poultry industry in Pakistan. Therefore, it has become mandatory to use alternate feed resources and feed additives to enhance the growth in poultry (Bhatti, 2011). Lipids (oils and fats) are energy rich components of any feed having highest number of energy yielding bonds per unit of weight (Leeson, 1993). Chemically lipids are triglycerides i.e., triesters of glycerol and fatty acids. These are needed by body to protect against shock, maintain body temperature, synthesize hormone, for proper functioning of central nervous system and muscular metabolism (Bjorntorp, 1991). Fats serve as energy reservoir for the body in the form of glycogen reservoirs. Furthermore, vitamin A, D, E and K are fat soluble which means that these vitamins are digested, transported and absorbed in the presence of fats (Leeson, 1993). Dietary fat supplementation is the key source of essential fatty acids which cannot be synthesized in birds and are therefore, necessary to be provided in feed fat supplementation in broiler feeds has been found a useful tool to improve performance and to obtain extra caloric effect to fulfill the requirements in rapidly growing chicks in a shorter time span through increased passage rate and improved digestion and absorption of nutrients in the intestinal tract (NRC., 1994).

However, there are some problems regarding fat usages, their levels and digestibility in poultry. Fat digestibility varies with age of the birds and with fat type and source being utilized (Leeson, 1993). The degree of saturation in a fatty acid is inversely proportional to the extent of its digestibility and in the same way degree of unsaturation in a fatty acid chain is responsible to enhance its digestibility (Mohammed and Horniakova, 2011). Higher levels of fats not only cause indigestion of their own but also they form insoluble calcium (Ca) soaps which cause Ca deficiency and unavailability despite the fact that how much calcium is being added in diets (Fedde *et al*., 1960; Whitehead *et al*., 1971; Whitehead and Fisher, 1975). Divalent Ca ions present in the feed bind with fatty acid molecules and result in soap formation which cannot be absorbed and digested in the digestive tract resulting in wastage of both fats and Ca (Tabeidian *et al*., 2010). Dietary fats also affect digestibility, absorption, intake and metabolism of many other feed ingredients e.g., carbohydrates, proteins and minerals (Leeson, 1993; Katongole and March, 1980). There is also a relationship between carcass composition and fat type being utilized in feed (Crespo and Esteve-Garcia, 2001). Some fats cause higher abdominal fat depositions and result in refusal of such birds on the behalf of consumers in markets. Mortality rates and Feed Conversion Ratio (FCR) are also related to fat in the diets. Excess fat in the diets causes indigestibility, lower feed intakes and lower weight gain resulting in economic losses and endangering bird life as well. So, the fats are essential and very important ingredient of feed but on the other hand their inclusion at higher levels in diet may have many bad impacts on bird performance.

From this situation there arises a need of something by which low levels of fats can be utilized efficiently and higher levels can be digested quite easily without having any bad effects performance of birds. Use of fat emulsifiers may be helpful in improving fat utilization in birds. Weight gain and FCR are improved while liver fat and fat in feces is decreased by usage of fat emulsifiers (Roy *et al*., 2010; Guerreiro Neto *et al*., 2011). It is reported that fats are a beneficial feed component but used seldom because of less digestibility and fat emulsifiers are reported to enhance the fat digestibility and improve bird performance as well. Fat emulsifiers are reported to cause a significant decrease in blood cholesterol. Phospholipid and bile acid fat emulsifiers are also reported to cause a significant increase in the serum high density lipo-proteins content which are considered as good cholesterol and are considered as a good indicator of chicken meat quality for human consumption. This phenomenon of beneficial effects have been found to be effective in poultry and at the same time they were effective in other monogastric animals like rats, monkeys and even human beings (Murata *et al*., 1983). Previous studies demonstrated that emulsifier as well as multi-enzyme in different energy density diet on growth performance, blood profiles and relative organ weight in broiler chickens, Cho *et al*. (2012). Previous study demonstrated that the improvements that can be made with lysolecithin supplementation are highly dependent on the fat incorporated in broiler feeds (Cho *et al*., 2008).

Keeping in view, the study was planned to evaluate the effects of fat emulsifier on utilization of varying levels of dietary fat in broiler chickens and resulting effects on growth performance.

MATERIALS AND METHODS

Experimental birds, housing and management: The chicks (240 male broilers) were randomly divided into 24 replicate

Table 1: Composition of experimental starter diets

	F_1		F_2		F_3	
Ingredients (%)	E_0	E_1	E_0	E_1	E_0	E_1
Corn	48.5	48.5	41	41	34	34
Rice polishing	7	7	9	9	13	13
Rice broken	4	4	7	7	10	10
Soybean meal	19	19	19	19	18	18
Sunflower meal	6.5	6.5	5.5	5.5	7	7
Corn gluten (60%)	2	2	1.5	1.5	1	1
Canola meal	7	7	9	9	10	10
Lime stone	1	1	1	1	1	1
Molasses	2	2	2	2	1	1
DCP	1	1	1		1	1
Vegetable oil	1	1	2	2	3	3
Vitamin and mineral premix	1	1	1	1	1	1
Chemical composition						
CP (%)	20	20	20	20	20	20
ME (kcal kg^{-1})	2850	280	2848	2848	2854	2854
CF (%)	3.85	3.85	3.80	3.80	3.93	3.93
Lysine (%)	1.2	1.2	1.2	1.2	1.2	1.2

F_1, F_2 and F_3 indicate added fat at the rate of 1, 2 and 3% in diets, respectively, E_0 and E_1 represent no emulsifier and 350 mg kg^{-1} fat emulsifier in the broiler diets, respectively

Table 2: Composition of experimental finisher diets

	F_1		F_2		F_3	
Ingredients (%)	E_0	E_1	E_0	E_1	E_0	E_1
Corn	54	54	51	51	47	47
Rice polishing	7	7	5	5	3	3
Rice broken	6	6	7	7	8	8
Soybean meal	18	18	15	15	15	15
Sunflower meal	6	6	6	6	8	8
Canola meal	6	6	10	10	8	8
Lime stone	2	2	2	2	1	1
Molasses	1	1	1	1	2	2
DCP	1	1	1	1	3	3
Vegetable oil	1	1	2	2	3	3
Chemical composition						
CP (%)	18	18	18	18	18	18
ME (kcal kg^{-1})	2899	2899	2900	2900	2898	2898
CF (%)	4.02	4.02	3.90	3.90	3.84	3.84
Lysine (%)	1.2	1.2	1.2	1.2	1.2	1.2
Methionine (%)	0.35	0.35	0.35	0.35	0.35	0.35
Ca (%)	1.07	1.07	1.07	1.07	1.00	1.00
P (%)	0.43	0.43	0.44	0.44	0.42	0.42

F_1, F_2 and F_3 indicate added fat at the rate of 1, 2 and 3% in diets, respectively, DCP: Dicalcium phosphate, CF: Crude fat or fiber, E_0 and E_1 represent no emulsifier and 350 mg kg^{-1} fat emulsifier in the broiler diets, respectively

lpens for 6 treatments in a 2×3 factorial arrangement under Completely Randomized Design (CRD) using 4 replicates per treatment group and 10 chicks were allotted to each replicate. Light, ventilation, relative humidity and floor space were maintained as standard. Temperature was kept at 95°F during first week and then it was decreased as 5°F per week until it was maintained at 75°F throughout the trial. This investigation approved by Department of Animal Sciences, College of Agriculture, University of Sargodha, Pakistan Ethical Committee.

Experimental design and diets: For the trial 6 iso-caloric and iso-nitrogenous broiler starter and broiler finisher diets were formulated having three fat levels 1, 2 and 3% with or without fat emulsifier at a constant level of 350 g t^{-1}. The trial lasted for 35 days and was divided into 2 phases i.e., starter and finisher phases. Description of the experimental diets is given in Table 1. The ingredients employed in feed formulation and chemical compositions of each experimental starter and finisher diet is given in Table 1 and 2, respectively. Proximate analysis of feeds is

given in Table 3. All birds and chemicals were collected from Ghazi Brothers Ltd., Pakistan as gift sample.

Vaccination: All the chicks were vaccinated against new castle disease (ND) and Infectious Bursal Disease (IBD) in this trial.

Production performance and livability: Parameters regarding body weight, Feed consumption, feed conversion ratio, mortality, all are recorded during whole experiment and also conducted digestibility trial ash as an external marker for evaluation of dry matter and ether extract digestibility described by Olukosi *et al.* (2012):

$$\text{Digestibility (\%)} = 100 - \frac{\text{marker in feed}}{\text{marker in feces}} \times \frac{\text{nutrient in feces}}{\text{nutrient in feed}}$$

Statistical data analysis: Data collected during the trial regarding initial weight, final weight, feed intake, weight gain, FCR, nutrient digestibility including dry matter and ether extract digestibility, carcass yield, breast meat yield, thigh meat yield, dressing percentage and relative organ weights of liver, heart, spleen, gizzard and abdominal fat was analyzed in 3×2 factorial arrangement under CRD and means were separated by Duncan's Multiple Range Test (Steel *et al.*, 1997).

RESULTS AND DISCUSSION

Feed intake: There was no interaction ($p>0.05$) between fat and fat emulsifier for starter, finisher and overall feed intake (Table 4). There was no individual effect ($p>0.05$) of fat emulsifier on starter, finisher and overall feed intake (Table 4). Increasing level of dietary fat supplementation did not affect ($p<0.05$) starter, finisher and overall feed (Table 4) Findings of present study are supported by Kussaibati *et al.* (1982) who reported no effect of dietary fat and exogenous fat emulsifier on feed intake during all phases of broiler life. The results might be attributed the improved nutrient digestibility with fat emulsifier supplementation which might resulted in fulfilment of the caloric requirements of the birds and hence the birds did not intake more feed (Mathlouthi *et al.*, 2002). Results of present study are contradictory to the findings of Melegy *et al.* (2010), Udomprasert and Rukkwamsuk (2006) and Tang *et al.* (2007) who reported that inclusion of various fat blends with supplementation of lysolecithin (a fat

Table 3: Proximate analysis of experimental diets

	F_1		F_2		F_3	
Ingredient (%)	Starter	Finisher	Starter	Finisher	Starter	Finisher
CP	20.08	18.02	20.01	18.09	20.08	18.04
DM	12.07	9.53	12.05	9.53	12.07	9.54
EE	2.53	2.78	3.56	3.46	4.18	4.39
Ash	4.70	4.93	5.24	4.99	4.88	4.79
Fiber	4.61	4.52	4.79	4.93	5.25	5.16

F_1, F_2 and F_3 stand for added fat at the rate 1, 2 and 3% in the diets, respectively

Table 4: Effect of fat and fat emulsifier on feed utilization in broiler

	Diets									
	F_1		F_2		F_3			Significance		
Items	E_0	E_1	E_0	E_1	E_0	E_1	SEM	Fat	Emulsifier	Fat×emulsifier
Feed intake (g)										
Starter	826.78	833.60	823.70	830	820.90	824.38	1.35	NS	NS	NS
Finisher	1404.73	1404.62	1410.31	1402.45	1407.54	1415.23	2.13	NS	NS	NS
Over all	2231.50	2238.24	2234.0	2232.42	2228.45	2239.61	2.20	NS	NS	NS
Feed conversion ratio										
Starter	1.38	1.39	1.44	1.46	1.61	1.47	0.03	*	NS	NS
Finisher	2.69	2.26	2.44	2.17	2.16	2.29	0.05	NS	*	*
Over all	1.97	1.84	1.94	1.90	1.91	1.87	0.02	NS	NS	NS
Dry matter digestibility (%)	75.47	79.88	76.02	79.70	75.87	80.09	0.17	NS	*	*
Ether extract digestibility (%)	86.22	89.67	86.53	88.76	86.47	88.94	0.09	NS	*	*

F_1, F_2 and F_3 indicate added fat at the rate of 1, 2 and 3% in diets, respectively, E_0 and E_1 indicate added fat emulsifier at the rate of 0 and 350 mg kg^{-1} in diets, respectively, NS: Non-significant ($p>0.05$), *Significant ($p<0.05$), SEM: Standard error mean

emulsifier) resulted in a significant increase in feed intake in broiler. These results might be attributed to the type of fat emulsifier used in previous studies because lysolecithin, choline and cholic acid have been reported to be more efficient fat emulsifiers as compared to bile acid which was used in present study. The results of present study are in agreement with the findings of Crespo and Esteve-Garcia (2001), Fernandez and Fraga (1996), Shahryar *et al*. (2011) and Nobakht *et al*. (2012) who found that increasing fat levels had no effect on feed intake. Some other researchers (Suksombat *et al*., 2007; Rahimi *et al*., 2011) also reported no effect of vegetable fat (oil) supplementation on average daily feed intake. It might be attributed to the lower levels of fat used in diets resulting in no effect on dustiness, palatability and intake of feed (Saleh *et al*., 2009). The results of present study are contradictory to the findings of Leeson (1993), Ghazalah *et al*. (2008), Rezaei *et al*. (2007) and Velasco *et al*. (2010) who reported that higher levels of dietary fat (up to 5%) resulted in increased feed intake in broiler. Several others have also reported that inclusion of vegetable oils in high energy diets resulted in improved feed intake (Monfaredi *et al*., 2011). The increase in feed intake might be due to higher level of dietary fat causing decreased dustiness and improved palatability (Rezaei *et al*., 2007).

Feed conversion ratio: Starter and overall FCRs were found unaltered (p>0.05) however, finisher FCR was significantly affected (p<0.05) with combination of fat and fat emulsifier in diets (Table 4). Fat emulsifier did not affect (p>0.05) starter and overall FCR but finisher FCR was affected (p<0.05). Increasing dietary fat levels had no significant effect (p>0.05) on finisher and overall FCR however, starter FCR increased with increasing fat levels (p<0.05).Results of present study are agreed with the findings of Guerreiro Neto *et al*. (2011) who reported that there was no effect of fat and fat emulsifier interaction on overall FCR in broiler however, starter FCR was affected. Increasing FCR with increasing fat level in starter might be attributed to no lipase activity in starter phase resulting in lower absorption of fats and as a result lower energy absorption from iso-caloric (Wongsuthavas *et al*., 2007). Results of present study are contradictory to the findings of Zollitsch *et al*. (1997) who reported that there was a significant effect of fat and fat emulsifier on FCR in broilers fed diets containing a blend of different fats supplemented with choline. The difference in results might be attributed to higher emulsifying activity of choline as compared to bile acid which was used in present study.

The result of present study are in agreement with the findings of Wongsuthavas *et al*. (2007) and Nobakht *et al*. (2012) who reported that there was no effect of various fat levels on overall FCR in broiler while, starter FCR was significantly increased with increasing fat levels. The results might be attributed to lipase activity which is not found in starter phase resulting in no absorption of fats and there is more loss of energy with increasing fat level in iso-caloric diets (Gaiotto *et al*., 2001; Wongsuthavas *et al*., 2007). Results of present study are contradictory to the findings of several researchers (Crespo and Esteve-Garcia, 2001; Baiao and Lara, 2005; Fernandez and Fraga, 1996; Suksombat *et al*., 2007; Ghazalah *et al*., 2008; Velasco *et al*., 2010; Mansoub, 2011) who reported that increasing fat levels in poultry diets improved FCR throughout the broiler life span. The difference in results might be attributed to the reduced dustiness with utilization of higher fat levels in diets which might resulted in improved nutrient utilization and as a result improved FCR (Rezaei *et al*., 2007).

Nutrient digestibility: There was an interaction (p<0.05) between fat and fat emulsifier for dry matter and ether extract digestibility (Table 5). Dry matter and ether extract digestibility was affected (p<0.05) by fat emulsifier supplementation in broiler diets. Increasing dietary fat levels did not affect (p>0.05) dry matter and ether extract digestibility (Table 5).

Table 5: Effect of fat on feed utilization in broiler

	Diets				Significance	
Items	F_1	F_2	F_3	Standard error mean	Linear	Quadratic
Feed intake (g)						
Starter	829.19	829.85	822.64	0.25	NS	NS
Finisher	1405	1406	1411	3.69	NS	NS
Over all	2233	2234	2234	3.82	NS	NS
Feed conversion ratio						
Starter	1.39	1.46	1.54	0.05	*	NS
Finisher	2.48	2.31	2.22	0.09	NS	NS
Over all	1.91	1.92	1.89	0.04	NS	NS
Dry matter digestibility (%)	79.35	80.04	79.68	0.31	NS	NS
Ether extract digestibility (%)	87.95	88.02	87.89	0.25	NS	NS

F_1, F_2 and F_3 indicate added fat at the rate of 1, 2 and 3% in diets, respectively, NS: Non-significant (p>0.05), *Significant effect (p<0.05)

Table 6: Effect of fat and fat emulsifier on growth performance of broiler

	Diets									
	F_1		F_2		F_3			Significance		
Items (g)	E_0	E_1	E_0	E_1	E_0	E_1	Standard error mean	Fat	Emulsifier	Fat×emulsifier
Initial weight	42.3	41.67	42.03	41.3	41.25	41.85	0.25	NS	NS	NS
Final weight	1133.80	1225.51	1154.71	1170.0	1169.40	1196.73	11.09	NS	*	NS
Weight gain										
Starter	602.75	601.82	575.25	567.92	512.18	567.58	12.27	NS	NS	NS
Finisher	531.02	623.27	579.44	650.08	657.18	629.08	13.37	NS	*	*
Overall weight gain	1091.50	1183.40	1112.70	1131.70	1128.10	1154.80	12.82	NS	*	NS
Average daily gain	31.18	33.81	31.79	32.33	32.23	32.99	0.37	NS	NS	NS

F_1, F_2 and F_3 indicate added fat at the rate of 1, 2 and 3% in diets, respectively, E_0 and E_1 indicate added fat emulsifier at the rate of 0 and 350 mg kg^{-1} in diets, respectively, NS: Non-significant ($p>0.05$), *Significant effect ($p<0.05$)

Table 7: Effect of fat on growth performance of broilers

	Diets				Significance	
Items (g)	F_1	F_2	F_3	Standard error mean	Linear	Quadratic
Initial Weight	41.99	41.66	41.55	0.43	NS	NS
Final Weight	1179	1164	1183	22.38	NS	NS
Weight gain						
Starter	602.28	571.55	539.88	21.25	*	NS
Finisher	577.15	616.76	643.14	23.16	NS	NS
Overall weight gain	1137	1122	1141	22.19	NS	NS
Average daily gain	32.49	32.06	32.62	0.64	NS	NS

F_1, F_2 and F_3 indicate added fat at the rate of 1, 2 and 3% in diets, respectively, NS: Non-significant effect ($p>0.05$), *Significant effect ($p<0.05$)

Findings of present study are supported by the results obtained by Adrizal *et al*. (2002), Maisonnier *et al*. (2003), Parsaie *et al*. (2007), Firman *et al*. (2008), Kil *et al*. (2010) and Cho *et al*. (2012) who reported that there was a significant increase in DM and EE digestibility in broiler fed iso-caloric diets containing fat emulsifier and dietary fats at low level. The results might be attributed to the action of fat emulsifier as an emulsifying agent for dietary fat and a stabilizer for other feed ingredients along with higher degree of lipolysis of triglycerides resulting in more micelle formation, digestion and absorption of fats (Cho *et al*., 2012). Results of present study are not in line with the findings of several researchers (Danicke *et al*., 2000; Sanz *et al*., 2000; Hertrampf, 2001; Andreotti *et al*., 2004; Ferreira *et al*., 2005; Guerreiro Neto *et al*., 2011) who reported that that there was no effect of low level of fat emulsifier supplementation in iso-caloric diets containing higher fat levels (5-6%) from various sources. The differences in the results might be attributed to improper concentration of fat emulsifier supplemented in the diets containing higher levels of fat. This might resulted in decreased uptake and utilization of feed ingredients including dietary fat and other feed ingredients (De Los Santos *et al*., 2008).

Weight gain: No interaction was found between fat and fat emulsifier for starter, final and overall weight gain ($p>0.05$) however, finisher weight gain was improved ($p<0.05$) (Table 6). Dietary fat did not affect starter, finisher, final and overall weight gain (Table 7). Increasing level of dietary fat in starter feed resulted in a linear decrease in weight gain ($p<0.05$) while, there was no effect ($p>0.05$) on finisher, final and overall weight gain. Results of this study are in line with the findings of Roy *et al*. (2010), Guerreiro Neto *et al*. (2011) and Luc *et al*. (2013) who reported that addition of fat emulsifier in vegetable oil based broiler diets resulted in an improved weight gain during finisher phase however, no effect was found on starter weight gain. These results might be attributed to no activity of lipase in starter phase while increased weight gain in finisher phase might be attributed to increased lipase activity resulting in higher fat digestibility along with emulsification (Gaiotto *et al*., 2001; Wongsuthavas *et al*., 2007; Guerreiro Neto *et al*., 2011).

Andreotti *et al*. (2004) and Ferreira *et al*. (2005) who reported that there was no interaction between fat emulsifier and higher levels of dietary fat in broiler diets with regard to weight gain. The results might be attributed to use of higher concentration of dietary fats with an improper concentration of fat emulsifier (Andreotti *et al*., 2004).

The result of present study are in agreement with the findings of several researchers (Sanz *et al*., 2000; Crespo and Esteve-Garcia, 2001; Suksombat *et al*., 2007; Wongsuthavas *et al*., 2007; Ghazalah *et al*., 2008;

Table 8: Effect of fat and fat emulsifier on organ weight of broiler

	Diets									
	F_1		F_2		F_3			Significance		
Items (g)	E_0	E_1	E_0	E_1	E_0	E_1	Standard error mean	Fat	Emulsifier	Fat×emulsifier
Liver weight	28	31	31	28	30	27.75	0.65	NS	NS	NS
Heart weight	7.51	8	7.54	8.52	6	9	0.32	NS	*	NS
Spleen weight	1.75	2	2	1.75	1.62	1.75	0.08	NS	NS	NS
Gizzard weight	25.50	29.51	23.55	22.25	20.25	19	0.68	*	NS	NS

F_1, F_2 and F_3 indicate added fat at the rate of 1, 2 and 3% in diets, respectively, E_0 and E_1 indicate added fat emulsifier at the rate of 0 and 350 mg kg^{-1} in diets, respectively, NS: Non-significant ($p>0.05$), *Significant ($p<0.05$)

Tabeidian *et al*., 2010; Velasco *et al*., 2010; Nobakht, 2011) who reported that there was no effect of graded fat levels on weight gain in broiler. Gaiotto *et al*. (2001) and Guerreiro Neto *et al*. (2011) reported that fat supplementation in broiler resulted in a linear decrease in weight gain during starter phase. The decrease in weight gain during starter phase might be attributed to no or limited lipase activity which might result in poor fat utilization (Gaiotto *et al*., 2001; Wongsuthavas *et al*., 2007). The results of present study are contradictory to the findings of a number of researchers (Adrizal *et al*., 2002; Baiao and Lara, 2005; Rezaei *et al*., 2007; Monfaredi *et al*., 2011; Shahryar *et al*., 2011) who reported that weight gain in broiler was affected by varying levels and higher proportion of dietary fat as compared to other feed ingredients. The difference in the results might be attributed to the decreased dustiness with usage of higher fat levels resulting in more palatability, increased feed intake and higher weight gain as a result (Rezaei *et al*., 2007).

Carcass characteristics: Fat emulsifier supplementation did not affect ($p>0.05$) liver, spleen and gizzard weight however, heart weight was affected ($p<0.05$) and gizzard weight decreased ($p<0.05$) linearly with increasing fat level (Table 8). The result of present study are in agreement with the findings of Crespo and Esteve-Garcia (2001), Ghazalah *et al*. (2008) and Nobakht *et al*. (2012) reported that dietary vegetable fat supplementation in broiler had no effect on the dressing percentage of broiler. Several other researchers (Peebles *et al*., 1997; Lara *et al*., 2006; Suksombat *et al*., 2007; Roy *et al*., 2010; Guerreiro Neto *et al*., 2011; Shahryar *et al*., 2011) also found that there was no effect of dietary oils on dressing percentage and carcass characteristics including abdominal fat, live weight, liver weight, dressing percentage, thigh weight, breast weight, heart weight, spleen weight and gizzard weight. The results might be attributed to the source of fat utilized in all the studies because vegetable fats might not affect carcass characteristics of broiler (Lara *et al*., 2006). The results of present study are contradictory to the findings of several researchers (An *et al*., 1997; Tabeidian *et al*., 2010; Velasco *et al*., 2010; Nobakht *et al*., 2012; Kabir and Ide, 1995) reported that supplementation of fat in poultry had a significant effect on dressing percentage, liver, gizzard and breast and thigh weights. The higher carcass and organ weights obtained in birds consuming dietary fat might be as a result of fat which might gave higher metabolizable energy values as compared to other energy sources (Saleh *et al*., 2009). Results of present study are not in line with the findings reported that inclusion of fat in broiler diets reduced the relative weight of liver which might be attributed to the presence of inositol which is involved in the movement of fats from liver to other body parts in broilers (Schaible, 2000). The differences in results might be attributed to increased utilization of fat as a source of energy in broilers when the diets contained fat (Nobakht, 2011).

Present study is in line with the findings of Andreotti *et al*. (2004), Ferreira *et al*. (2005), Lara *et al*. (2006), Roy *et al*. (2010), Guerreiro Neto *et al*. (2011), Cho *et al*. (2012) and Luc *et al*. (2013) who reported that there was no effect of fat emulsifier supplementation on the internal organ weights of broiler. The results might be attributed to increased utilization of fat as a source of energy when the diets contain fat and fat emulsifier (Nobakht, 2011). Results of present study are not in line with the findings of Praharaj *et al*. (1997) reported that relative weights of liver, heart, spleen and gizzard were affected significantly in broiler by supplementation of fat emulsifier in the diets. The difference in results might be attributed to the presence of lecithin in commercial emulsifier preparations which might enhance the activity of emulsification (Schaible, 2000).

CONCLUSION

This investigation reveals that dietary fat should be avoided in starter diets and supplementation of fat emulsifier in broiler diets may improve DM and EE digestibility. It can also be concluded that supplementation of fat emulsifier in broiler rations may improve dry matter and ether extract digestibility.

Further investigation entails to identification of mechanisms of action as well as other effective or toxic effect on animal.

ACKNOWLEDGMENTS

Authors acknowledge to Dr. Muhammad Arif and Mr. Abdur Rehman, Department of Animal Sciences, College of Agriculture, University of Sargodha, Pakistan as well as Graduate School of Chinese, Academy of Agricultural Sciences, Beijing (100081), China, College of Animal Sciences, Northwest A and F University, Yangling, 712100, China, Progati Medical Institute, Department of Pharmacy, Dhaka-1216. Bangladesh for their collaborated support.

REFERENCES

Adrizal, S. Ohtani and M. Yayota, 2002. Dietary energy source and supplements in broiler diets containing defatted rice bran. J. Applied Poult. Res., 11: 410-417.

An, B.K., H. Nishiyama, K. Tanaka, S. Ohtani, T. Iwata, K. Tsutsumi and M. Ksaai, 1997. Dietary safflower phospholipid reduces liver lipids in laying hens. Poult. Sci., 76: 689-695.

Andreotti, M.O., O.M. Junqueira, M.J.B. Barbosa, L.C. Cancherini, L.F. Araujo and E.A. Rodrigues, 2004. [Intestinal transit time, performance, carcass characteristics and body composition in broilers fed isoenergy diets formulated with different levels of soybean oil]. Revista Brasileira Zootecnia, 33: 870-879, (In Portuguese).

Baiao, N.C. and L.J.C. Lara, 2005. Oil and fat in broiler nutrition. Braz. J. Poult. Sci., 7: 129-141.

Bhatti, M.Y., 2011. Emerging prospects of poultry production in Pakistan at the dawn of 21st century. Vet. News Views, 6: 24-30.

Bjorntorp, P., 1991. Importance of fat as a support nutrient for energy: Metabolism of athletes. J. Sports Sci., 9: 71-76.

Cho, J.H., P.Y. Zhao and I.H. Kim, 2012. Effects of emulsifier and multi-enzyme in different energy densitydiet on growth performance, blood profiles and relative organ weight in broiler chickens. J. Agric. Sci., 10.5539/jas.v4n10p161

Cho, J.H., Y.G. Chen, J.S. Yoo, W.T. Kim, I.B. Chung and I.H. Kim, 2008. Evaluation of fat sources (lecithin, mono-glyceride and mono-diglyceride) in weaned pigs: Apparent total tract and ileal nutrient digestibilities. Nutr. Res. Pract., 2: 130-133.

Crespo, N. and E. Esteve-Garcia, 2001. Dietary fatty acid profile modifies abdominal fat deposition in broiler chickens. Poult. Sci., 80: 71-78.

Danicke, S., H. Jeroch, W. Bottcher and O. Simon, 2000. Interactions between dietary fat type and enzyme supplementation in broiler diets with high pentosan contents: Effects on precaecal and total tract digestibility of fatty acids, metabolizability of gross energy, digesta viscosity and weights of small intestine. Anim. Feed Sci. Technol., 84: 279-294.

De Los Santos, F.S., A.M. Donoghue, K. Venkitanarayanan, M.L. Dirain, I. Reyes-Herrera, P.J. Blore and D.J. Donoghue, 2008. Caprylic acid supplemented in feed reduces enteric *Campylobacter jejuni* colonization in ten-day-old broiler chickens. Poult. Sci., 87: 800-804.

Fedde, M.R., P.E. Waibel and R.E. Burger, 1960. Factors affecting the absorbability of certain dietary fats in the chick. J. Nutr., 70: 447-452.

Fernandez, C. and M.J. Fraga, 1996. The effect of dietary fat inclusion on growth, carcass characteristics and chemical composition of rabbits. J. Anim. Sci., 74: 2088-2094.

Ferreira, A.F., M.O. Andreotti, A.S. Carrijo, K.M.R. de Souza, V.B. Fascina and E.A. Rodrigues, 2005. [Nutritional value of soybean oil, beef tallow and their blends of diets for broilers]. Acta Scientiarum-Anim. Sci., 27: 213-219, (In Portuguese).

Firman, J.D., A. Kamyab and H. Leigh, 2008. Comparison of fat sources in rations of broilers from hatch to market. Int. J. Poult. Sci., 7: 1152-1155.

Gaiotto, J.B., J.F.M. Menten, A.M.C. Racanicci and M.C. Iafigliola, 2001. [Soybean oil, acidulated soapstock, beef tallow and mixtures of fat sources in broilers diets]. Revista Brasileira Ciencia Avicola, 2: 219-227, (In Portuguese).

Ghazalah, A.A., M.O. Abd-Elsamee and A.M. Ali, 2008. Influence of dietary energy and poultry fat on the response of broiler chicks to heat therm. Int. J. Poult. Sci., 7: 355-359.

Guerreiro Neto, A.C., A.C. Pezzato, J.R. Sartori, C. Mori and V.C. Cruz *et al*., 2011. Emulsifier in broiler diets containing different fat sources. Revista Brasileira Ciencia Avicola, 13: 119-125.

Hertrampf, J., 2001. Features-lecithin improves poultry performance-a performance enhancer derived from soya improves growth in broilers and turkeys and egg production in layers. Poult. Int., 40: 26-29.

Kabir, T. and T. Ide, 1995. Effect of dietary soybean phospholipid and fats differing in the degree of unsaturation on fatty acid synthesis and oxidation in rat liver. J. Nutr. Sci. Vitaminol., 41: 635-645.

Katongole, J.B.D. and B.E. March, 1980. Fat utilization in relation to intestinal fatty acid binding protein and bile salts in chicks of different ages and different genetic sources. Poult. Sci., 59: 819-827.

Kil, D.Y., T.E. Sauber, B.D. Jones and H.H. Stein, 2010. Effect of the form of dietary fat and the concentration of dietary neutral detergent fiber on ileal and total tract endogenous losses and apparent and true digestibility of fat by growing pigs. J. Anim. Sci., 88: 2959-2967.

Kussaibati, R., L. Guillaume and B. Leclercq, 1982. The effects of age, dietary fat and bile salts and feeding rate on apparent and true metabolisable energy values in chickens. Br. Poult. Sci., 23: 393-403.

Lara, L.J.C., N.C. Baiao, C.A.L. Aguilar, S.V. Cancado, M.A. Fiuza and B.R.C. Ribeiro, 2006. [Carcass yield, composition and fat acid percentage of carcass for broiler fed on different lipid source diets]. Arquivo Brasileiro Medicina Veterinaria Zootecnia, 58: 108-115, (In Portuguese).

Leeson, S., 1993. Recent Advances in fat Utilization by Poultry. In: Recent Advance in Animal Nutrition in Australia, Farrell, D.J. (Ed.). University of New England, Armidale, Australia, pp: 170-181.

Luc, M., S. Ludo, R. Marc, A. Arno, L. Saskia and A. van der Aa, 2013. The effect of different emulsifiers on fat and energy digestibility in broilers. Proceedings of the 19th European Symposium on Poultry Nutrition, August 26-29, 2013, Potsdam, Germany, pp: 1-4.

Maisonnier, S., J. Gomez, A. Bree, C. Berri, E. Baeza and B. Carre, 2003. Effects of microflora status, dietary bile salts and guar gum on lipid digestibility, intestinal bile salts and histomorphology in broiler chickens. Poult. Sci., 82: 805-814.

Mansoub, N.H., 2011. Effect of fish oil fed a low-protein diet on performance, carcass characterizes and blood indices in broiler chicks. Ann. Biol. Res., 2: 113-120.

Mathlouthi, N., J.P. Lalles, P. Lepercq, C. Juste and M. Larbier, 2002. Xylanase and β-glucanase supplementation improve conjugated bile acid fraction in intestinal contents and increase villus size of small intestine wall in broiler chickens fed a rye-based diet. J. Anim. Sci., 80: 2773-2779.

Melegy, T., N. Khaled, R. El-Bana and H. Abdellatif, 2010. Dietary fortification of a natural biosurfactant, lysolecithin in broiler. Afr. J. Agric. Res., 5: 2886-2892.

Mohammed, H.A. and E. Horniakova, 2011. Effect of using saturated and unsaturated fat with mixing them in broiler diet on blood parameter. J. Microbiol. Biotechnol. Food Sci., 1: 309-322.

Monfaredi, A., M. Rezaei and H. Sayyahzadeh, 2011. Effect of supplemental fat in low energy diets on some blood parameters and carcass characteristics of broiler chicks. South Afr. J. Anim. Sci., 41: 24-32.

Murata, M., K. Imaizumi and M. Sugano, 1983. Hepatic secretion of lipids and apolipoproteins in rats fed soybean phospholipid and soybean oil. J. Nutr., 113: 1708-1716.

NRC., 1994. Nutrient Requirements of Poultry. 9th Edn., National Academy Press, Washington, DC., USA., ISBN-13: 9780309048927, Pages: 155.

Nobakht, A., 2011. Effects of graded levels of poultry fat on performance and carcass traits in broilers. Adv. Environ. Biol., 5: 2676-2679.

Nobakht, A., A. Ariyana and F. Mazlum, 2012. Effect of different levels of canola oil with vitamin E on performance and carcass traits of broilers. Int. Res. J. Applied Basic Sci., 3: 1059-1064.

Olukosi, O.A., O.A. Bolarinwa, A.J. Cowieson and O. Adeola, 2012. Marker type but not concentration influenced apparent ileal amino acid digestibility in phytase-supplemented diets for broiler chickens and pigs. J. Anim. Sci., 90: 4414-4420.

Parsaie, S., F. Shariatmadari, M.J. Zamiri and K. Khajeh, 2007. Influence of wheat-based diets supplemented with xylanase, bile acid and antibiotics on performance, digestive tract measurements and gut morphology of broilers compared with a maize-based diet. Br. Poult. Sci., 48: 594-600.

Peebles, E.D., I.D. Brake and M.A. Latour, 1997. Broiler performance, yield and bone characteristics as affected by starter diet fat level. J. Applied Poult. Res., 6: 325-330.

Praharaj, N.K., E.A. Dunnington, W.B. Gross and P.B. Siegel, 1997. Dietary effects on immune response of fast-growing chicks to inoculation of sheep erythrocytes and *Escherichia coli*. Poult. Sci., 76: 244-247.

Rahimi, S., S.K. Azad and M.A.K. Torshizi, 2011. Omega-3 enrichment of broiler meat by using two oil seeds. J. Agri. Sci. Tech., 13: 353-365.

Rezaei, M., A. Attar, A. Ghodratnama and H. Kermanshahi, 2007. Study the effects of different levels of fat and L-carnitine on performance, carcass characteristics and serum composition of broiler chicks. Pak. J. Biol. Sci., 10: 1970-1976.

Riaz, H., A. Jabbar, M.H. Rashid, S. Riaz and F. Latif, 2014. Endoglucanase production by *Humicola insolens*: Effect of physiochemical factors on growth kinetics and thermodynamics. Int. J. Agric. Biol., 16: 1141-1146.

Roy, A., S. Haldar, S. Mondal and T.K. Ghosh, 2010. Effects of supplemental exogenous emulsifier on performance, nutrient metabolism and serum lipid profile in broiler chickens. Vet. Med. Int. 10.4061/2010/262604

Saleh, H., S. Rahimi and M.A.K. Torshizi, 2009. The effect of diet that contained fish oil on performance, serum parameters, the immune system and the fatty acid composition of meat in broilers. Int. J. Vet. Res., 3: 69-75.

Sanz, M., A. Flores and C.J. Lopez-Bote, 2000. The metabolic use of energy from dietary fat in broilers is affected by fatty acid saturation. Br. Poult. Sci., 41: 61-68.

Schaible, P.J., 2000. Poultry Feeds and Nutrition. 2nd Edn., AVI Publishing Co. Inc., USA.

Shahryar, H.A., R. Salamatdoust-Nobar, A. Lak and A.R. Lotfi, 2011. Effect of dietary supplemented canola oil and poultry fat on the performance and carcass characterizes of broiler chickens. Curr. Res. J. Biol. Sci., 3: 388-392.

Steel, R.G.D., J.H. Torrie and D.A. Dickey, 1997. Principles and Procedures of Statistics: A Biometrical Approach. 3rd Edn., McGraw-Hill Co., New York, USA., ISBN: 9780070610286, Pages: 666.

Suksombat, W., T. Boonmee and P. Lounglawan, 2007. Effects of various levels of conjugated linoleic acid supplementation on fatty acid content and carcass composition of broilers. Poult. Sci., 86: 318-324.

Tabeidian, S.A., M. Ghafoori, Y. Bahrami, S. Chekani-Azar and M. Toghyani, 2010. Effect of different levels of dietary fat on broiler performance and production cost with emphasis on calcium and phosphorus absorption. Global Veterinaria, 5: 54-60.

Tang, M.Y., Q.G. Ma, X.D. Chen and C. Ji, 2007. Effects of dietary metabolizable energy and lysine on carcass characteristics and meat quality in arbor acres broilers. Asian-Australasian J. Anim. Sci., 20: 1865-1873.

Udomprasert, P. and T. Rukkwamsuk, 2006. Effect of an exogenous emulsifier on growth performance in weanling pigs. Kasetysart J. (Nat. Sci.), 40: 652-656.

Velasco, S., L.T. Ortiz, C. Alzueta, A. Rebole, J. Trevino and M.L. Rodriguez, 2010. Effect of inulin supplementation and dietary fat source on performance, blood serum metabolites, liver lipids, abdominal fat deposition and tissue fatty acid composition in broiler chickens. Poult. Sci., 89: 1651-1662.

Whitehead, C.C., W.A. Dewar and J.N. Downie, 1971. Effect of dietary fat on mineral retention in the chick. Br. Poult. Sci., 12: 249-254.

Whitehead, C.C. and C. Fisher, 1975. The utilisation of various fats by turkeys of different ages. Br. Poult. Sci., 16: 481-485.

Wongsuthavas, S., C. Yuangklang, S. Wittayakun, K. Vasupen, J. Mitchaothai, P. Srenanual and A.C. Beynen, 2007. Dietary soybean oil, but not krabok oil, diminishes abdominal fat deposition in broiler chickens. Int. J. Poult. Sci., 6: 792-795.

Zollitsch, W., W. Knaus, F. Aichinger and F. Lettner, 1997. Effects of different dietary fat sources on performance and carcass characteristics of broilers. Anim. Feed Sci. Technol., 66: 63-73.