Effect of Non-oxidized and Oxidized Soybean Oil Supplemented with Two Levels of Antioxidant on Broiler Performance

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ABSTRACT : A study was designed to determine the effects on broiler performance of two levels of antioxidant (ethoxyquin) in poultry rations containing two levels of oxidized and non-oxidized soybean oil. One hundred and eighty, day old broiler chicks were randomly divided into six experimental groups comprising thirty chicks on each treatment. Six experimental rations having 2% non-oxidized soybean oil, 2% and 3% oxidized soybean oil, all three supplemented with normal (125 g/t) or higher (175 g/t) level of ethoxyquin, were formulated for both starter (0-28 days) and finisher (29-42 days) phases. These rations were randomly fed to six experimental groups having 30 birds on each ration and three replicates on each treatment. Weight gain and feed conversion ratio (FCR) of chicks fed 2% non-oxidized and 2% oxidized soybean oil were statistically non-significant. Weight gain in groups fed 3% oxidized oil was significantly lower than non-oxidized group while FCR was significantly lower than both groups. Weight gain in the higher level ethoxyquin group was significantly better than lower level, while feed intake and FCR were statistically non-significant in both levels of ethoxyquin. Acid and Thiobarbituric Acid (TBA) values in the three groups differed significantly with the lower in non-oxidized group and highest in the 3% oxidized group. Higher level of ethoxyquin significantly lower acid and TBA values compared to lower level of ethoxyquin. Thus it can be concluded that oxidation of oil reduces its feeding value and that the addition of ethoxyquin is beneficial.
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Key Words : Soybean Oil, Ethoxyquin, Acid Value, Thiobarbituric Acid, Broiler Performance

INTRODUCTION

Broiler production is one of the most efficient, economical and the quickest way of producing high quality animal protein for human consumption. More than 70% of the total cost of raising poultry is incurred on feed alone (Khan et al., 1989) and therefore, for economical poultry rearing, provision of economical and balanced feed is essential. It has become a practice to add fats or oils in poultry feeds to increase energy density, particularly in broiler feeds. Vegetable fats rich in polyunsaturated fatty acids (PUFA) are highly digestible as compared to saturated fats and represent traditional fat sources in broiler diets. However, PUFA are more sensitive towards oxidation especially when stored at high temperature and humidity. Oxidized fat has been shown to adversely affect performance and health of broilers (Engberg et al., 1996), causing encephalomalacia (Jones et al., 1986), decreased body weight and feed efficiency (Cabel and Waldroup, 1988; Asghar et al., 1989; Engberg et al., 1996). The oxidation process results in severe nutritional and economic losses. Nowadays synthetic antioxidants are used to prevent oxidation of fats, and destruction of fat soluble vitamins and xanthophyll. However, light, air, humidity and high temperature accelerate the spoilage process (Warraich, 1972). Antioxidants inhibit oxidation by reacting with free radicals, which are formed early in oxidation process, thus blocking the formation of fatty acid radicals and terminate the chain reaction. Ethoxyquin has generally been regarded as one of the most effective antioxidants used in poultry nutrition (Bartov and Bornstein, 1972; Cabel and Waldroup, 1988). Our study was conducted to determine effects of feeding oxidized vs non-oxidized soybean oil on broiler performance, and effects of adding two levels of ethoxyquin as antioxidant on nutritional quality of feed and their effect on performance.

MATERIALS AND METHODS

Birds and their management

One hundred and eighty day-old, Arbor Acre broiler chicks of mixed sexes were purchased from the local market. The chicks were weighed individually; leg banded and then randomly divided into eighteen groups of ten chicks each with three replications on each treatment. The chicks in each experimental group were kept in separate pens measuring 4 ft×3 ft×1.5 ft, which were disinfected before the start of experiment. A layer of 3-4 inch sawdust was used as litter in each pen, which was stirred regularly during the experiment to keep it dry. The ambient temperature varied from 23 to 39°C throughout the experiment. Twenty-four hour light and proper ventilation was provided in the house throughout the experimental

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period. Feed with fresh and clean water was given *ad libitum*.

Rancid or oxidized soybean oil

Soybean oil was procured from a local unit of Ghee Corporation of Pakistan. The oil was placed in a chamber for oxidation by aerating it at a temperature of 27°C for a period of 10 days (Cabel and Waldroup, 1988). Peroxide and Acid values were determined in the oil. Initially the soybean oil had peroxide value 2.98 milli-equivalent/kg and acid value 2.52 mg/g. The respective peroxide and acid values for oxidized soybean oil were 49.01 and 7.26, respectively.

Experimental rations

Three isocaloric and isonitrogenous broiler starter rations containing 2% non-oxidized soybean oil (NO) and 2% or 3% oxidized soybean oil (O) were prepared and designated as A, B and C, respectively. Each of these rations was supplemented with a normal (125 g/t) or higher (175 g/t) level of ethoxyquin (E) and called AE_1 (2% NO+125 g/t E), AE_2 (2% NO+175 g/t E), BE_1 (2% O+125 g/t E), BE_2 (2% O+175 g/t E), CE_1 (3% O+125 g/t E), and CE_2 (3% O+175 g/t E), respectively. Similarly the finisher rations were called as DE_1, DE_2, EE_1, EE_2, FE_1 and FE_2, respectively. Ingredients and chemical composition of the starter and finisher rations are given in tables 1 and 2, respectively.

Feeding

During starter phase (0-28 days) six starter rations were allotted to 18 experimental groups in such a way that each ration was fed to 30 birds in three experimental units (replicates). All the birds were weighed individually at the start and then at weekly intervals, thereafter. Weekly feed consumption of each experimental unit was recorded on per pen basis and feed conversion ratio (FCR) was calculated as kilograms of feed consumed per kilogram of live body weight gain. Therefore, feed consumption and FCR calculations were made from the average values of each pen. From 29 to 42 days finisher feed was offered in the same way as in the starter phase.

Analytical methods

I) Proximate composition (AOAC, 1990) of the starter and finisher diets is provided in tables 1 and 2, respectively.

II) For the assessment of rancidity in diets Peroxide value and Acid value were determined using AOAC (1990) methods, while TBA test was done using Pearson's (1976) method at the Animal Nutrition Laboratories, University of Agriculture, Faisalabad, Pakistan.

Statistical analysis

Data on various parameters were subjected to statistical analysis, using analysis of variance technique in completely randomized design with 3×2 factorial arrangement; Duncan's Multiple Range Test was used to compare the treatment means (Steel and Torrie, 1981).

RESULTS

Feed consumption

Feed consumption, weight gain and FCR data are given in table 3. A non-significant difference ($p>0.05$) was found among the levels of soybean oil as well as the level of ethoxyquin on feed consumption at 28 days of age. But at 42 days of age feed intake differed significantly ($p<0.05$) among levels of soybean oil (2%N, 2%O, 3%O) and linearly ($p<0.05$) decreased as the level of oxidized oil increased; however, ethoxyquin levels had no effect on feed intake (figure 1). Interaction between two factors i.e. oil and ethoxyquin were found to be statistically non-significant (table 5) in terms of feed consumption, weight gain and FCR.

Weight gain

Weight gains of birds fed 3% oxidized soybean oil in both starter and finisher phases were significantly lower ($p<0.05$) than the birds fed non-oxidized oil. In the starter phase weight gain was statistically non-significant ($p>0.05$) between 2% and 3% oxidized oil fed groups, and between non-oxidized and 2% oxidized oil fed groups. However, in the finisher phase difference in weight gain between 2% and 3% oxidized oil fed groups was statistically significant ($p<0.05$) and the difference between 2% non-oxidized and

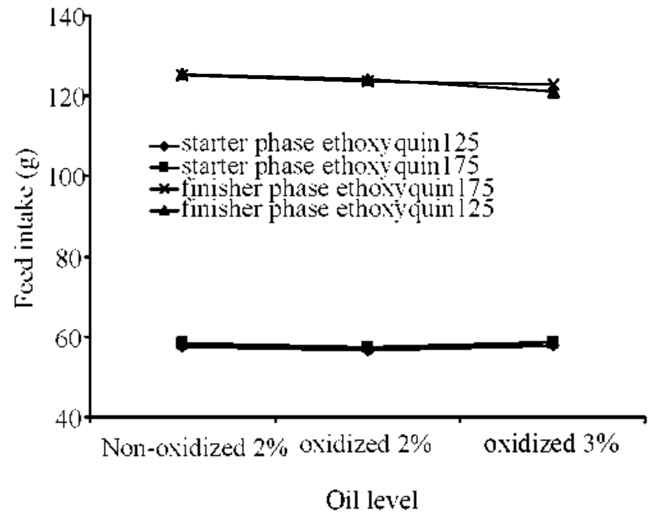

Figure 1. Effect of oxidized and non-oxidized soybean oil and ethoxyquin levels on feed intake (g) of

Table 1. Composition of experimental starter broiler rations (0-28 days)

Ingredients	Ingredient composition of ration (%)					
	AE_1	AE_2	BE_1	BE_2	CE_1	CE_2
Corn	29	29	29	29	24	24
Rice broken	18	18	18	18	19.7	19.7
Rice polish	7	7	7	7	7	7
Cotton seed meal	8	8	8	8	8	8
Rape seed meal	1	1	1	1	2	2
Soybean meal	13.4	13.4	13.4	13.4	14	14
Corn gluten 60%	6	6	6	6	5	5
Corn gluten 30%	3	3	3	3	4.5	4.5
Fish meal	8	8	8	8	8	8
Soybean oil	2	2	-	-	-	-
Oxidized soybean oil	-	-	2	2	3	3
Ethoxyquin	0.0125	0.0175	0.0125	0.0175	0.0125	0.0175
Molasses	2	2	2	2	2	2
Dicalcium phosphate	1	1	1	1	1	1
Limestone	1	1	1	1	1.2	1.2
Lysine	0.1	0.1	0.1	0.1	0.1	0.1
Vit. mineral premix**	0.5	0.5	0.5	0.5	0.5	0.5
Chemical analysis						
ME (kcal/kg)	3,000	3,000	3,000	3,000	3,000	3,000
Dry matter (%)*	89.51	89.31	89.22	89.55	89.16	89.11
Crude protein (%)*	21.51	21.55	21.45	21.48	21.39	21.44
Crude fiber (%)*	3.21	3.21	3.18	3.19	3.31	3.32
Crude fat (%)*	4.80	4.81	4.78	4.80	5.62	5.55
Ash (%)*	4.91	4.90	4.95	4.88	4.87	4.89
Peroxide (meq./kg)*	0.852	0.765	2.073	2.028	2.853	2.719
Calcium (%)	1.06	1.06	1.06	1.06	1.03	1.03
Phosphorus (%)	0.45	0.45	0.45	0.45	0.45	0.45
Lysine (%)	1.09	1.09	1.09	1.09	1.05	1.05
Methionine (%)	0.72	0.72	0.72	0.72	0.69	0.69

* Analyzed value.

** Provided the following per kg diet: Vit. A 8,800 IU, D_3 3,300 IU, E 6.6 IU, K_3 1.5 mg, B_1 1.5 mg, B_2 6.5 mg, B_6 2.3 mg, B_{12} 13.5 µg, pantothenic acid 12.2 mg, biotin 50 µg, niacin 35.5 mg, choline chloride 900 mg, folic acid 0.6 mg, Cu 8 mg, Mn 64 mg, Zn 65 mg, Fe 50 mg, I 1.5 mg, Co 0.25 mg, Se 0.1 mg.

2% oxidized oil fed groups was non significant ($p>0.05$). In the starter phase birds fed a higher level of ethoxyquin, weight gain was significantly higher ($p<0.05$) than the birds fed lower level of ethoxyquin; however, in the finisher phase weight gain in the two groups was statistically non-significant (figure 2).

Feed conversion ratio (FCR)

A significant ($p<0.05$) depression in feed conversion ratio was obtained at the 3% oxidized soybean oil, while chicks fed 2% non-oxidized and 2 % oxidized soybean oil showed non-significant ($p>0.05$) FCR at both phases. There was a non-significant effect between the levels of ethoxyquin on feed conversion ratio at both 28 and 42 days of age.

TBA value

TBA and acid values are given in table 4. Significant ($p<0.05$) differences were found between non-oxidized and oxidized soybean oil and two levels of antioxidant ethoxyquin on Acid and TBA values; TBA values increased significantly at both levels of ethoxyquin with increasing oxidized vegetable oil (figure 3). The two factor (O×E) interactions were non-significant ($p>0.05$) in both starter and finisher rations (table 5).

Acid value

Acid value increased significantly ($p<0.05$) as the level of oxidized oil increased in both starter and finisher phase; the higher level of ethoxyquin significantly ($p<0.05$) reduced the acid value in both phases (figure 4). The

Table 2. Composition of experimental finisher broiler rations (29-42 days)

Ingredients	Ingredient composition of ration (%)					
	AE_1	AE_2	BE_1	BE_2	CE_1	CE_2
Corn	29.4	29.4	29.4	29.4	25	25
Rice broken	21	21	21	21	22.50	22.50
Rice polish	7	7	7	7	7	7
Cotton seed meal	8	8	8	8	8	8
Rape seed meal	3.75	3.75	3.75	3.75	4.25	4.25
Soybean meal	8	8	8	8	9.50	9.50
Corn gluten 60%	4	4	4	4	2.75	2.75
Corn gluten 30%	4.5	4.5	4.5	4.5	5.40	5.40
Fish meal	8	8	8	8	8	8
Soybean oil	2	2	-	-	-	-
Oxidized soybean oil	-	-	2	2	3	3
Ethoxyquin	0.0125	0.0175	0.0125	0.0175	0.0125	0.0175
Molasses	2	2	2	2	2	2
Dicalcium phosphate	1	1	1	1	1	1
Limestone	0.8	0.8	0.8	0.8	1	1
Lysine	0.10	0.10	0.10	0.10	0.10	0.10
Vit. mineral premix**	0.5	0.5	0.5	0.5	0.5	0.5
Chemical analysis						
ME (kcal/kg)	3,000	3,000	3,000	3,000	3,000	3,000
Dry matter (%)*	88.75	88.71	88.90	88.51	89.01	88.91
Crude protein (%)*	19.85	19.73	19.50	19.55	19.77	19.75
Crude fiber (%)*	3.11	3.02	3.15	3.18	3.31	3.29
Crude fat (%)*	4.61	4.55	4.58	4.53	5.71	5.77
Ash (%)*	4.55	4.81	4.85	4.89	4.75	4.53
Peroxide (meq./kg)*	0.896	0.875	2.210	2.157	2.868	2.652
Calcium (%)	1.056	1.056	1.056	1.056	1.118	1.118
Phosphorus (%)	0.421	0.421	0.421	0.421	0.425	0.425
Lysine (%)	1.01	1.01	1.01	1.01	1.03	1.03
Methionine (%)	0.606	0.606	0.606	0.606	0.607	0.607

* Analyzed value.

** Provided the following per kg diet: Vit. A 8,800 IU, D_3 3,300 IU, E 6.6 IU, K_3 1.5 mg, B_1 1.5 mg, B_2 6.5 mg, B_6 2.3 mg, B_{12} 13.5 µg, pantothenic acid 12.2 mg, biotin 50 µg, niacin 35.5 mg, choline chloride 900 mg, folic acid 0.6 mg, Cu 8 mg, Mn 64 mg, Zn 65 mg, Fe 50 mg, I 1.5 mg, Co 0.25 mg, Se 0.1 mg.

interaction between levels of oxidized oil and ethoxyquin was also found to be statistically ($p<0.05$) significant (table 5).

DISCUSSION

Feed consumption

The results obtained in the present study showed that the oxidized oil had no effect on feed intake during the starter phase, but that during the finisher phase it did have a significant effect ($p<0.05$). The explanation for the difference between phases could be that feeding oxidized soybean oil had such an effect only in the longer term. Diaz (1977) reported a non-significant difference in feed intake among broiler chicks fed rations containing oxidized fat/oils with or without added antioxidant, which supports our findings during the starter phase. Hussain and Kratzer (1982), Award et al. (1983). Cabel and Waldroup (1988), however, reported reduced feed intake ($p<0.05$) in birds fed on rations having rancid feed with high peroxide values which is in line with our findings in the finisher phase.

Weight gain

A significant reduction in weight gain was observed in birds fed diets containing oxidized oil. Oxidized oil in the diet may have raised the levels of aldehydes and other metabolites that are toxic to the animals. Ethoxyquin supplementation had partial effect on weight gain i.e. it had a significant effect in the starter phase but a non-significant effect in the finisher phase. These results are in line with Chrapa (1968), Bratov and Bornstein (1972), Award et al. (1983), Takigawa and Ohyama (1983), Miyazawa and

Table 3. Effect of oxidized and non-oxidized soybean oil and ethoxyquin levels on broiler performance

Treatments	Starter phase (0-28 days)			Finisher phase (29-42) days		
	Weight gain (g/bird/day)	Feed intake (g/bird/day)	FCR	Weight gain (g/bird/day)	Feed intake (g/bird/day)	FCR
Oil level						
Non-oxidized (2%)	37.48[a]±0.54	58.07±0.12	1.54[b]±0.01	51.60[a]±0.36	125.42[a]±0.33	2.43[b]±0.01
Oxidized (2%)	36.35[ab]±0.54	57.50±0.38	1.58[b]±0.01	50.50[a]±0.42	123.85[b]±0.59	2.45[b]±0.02
Oxidized (3%)	35.21[b]±0.556	58.28±0.34	1.65[a]±0.01	48.21[b]±0.35	121.92[c]±0.47	2.52[a]±0.01
Ethoxyquin						
125 g/t	35.67[c]±0.43	57.42±0.30	1.61±0.01	50.21±0.54	123.64±0.76	2.46±0.01
175 g/t	37.03[d]±0.53	58.14±0.26	1.57±0.02	50.00±0.60	123.78±0.47	2.47±0.02

[a,b,c,d] Means±SEM in a column with different superscripts differ significantly (p<0.05).
Means±SEM in a column without superscripts do not differ significantly (p>0.05).
Values of each parameter are means of 3 observations.

Table 4. Effect of oxidized and non-oxidized soybean oil and ethoxyquin levels on TBA and Acid values of diets

Treatments	Starter phase (0-28 days)		Finisher phase (29-42 days)	
	TBA value (mg/kg)	Acid value (mg/g)	TBA value (mg/kg)	Acid value (mg/g)
Oil level				
Non-oxidized (2%)	2.74[c] ±0.04	5.95[c] ±0.02	2.55[c] ±0.08	5.59[c] ±0.15
Oxidized (2%)	3.47[b] ±0.13	10.80[b] ±0.07	4.04[b] ±0.02	10.94[b] ±0.09
Oxidized (3%)	4.89[a] ±0.13	13.38[a] ±0.10	5.05[a] ±0.16	13.41[a] ±0.02
Ethoxyquin				
125 g/t	3.85[d] ±0.31	10.34[d] ±1.04	3.88[d] ±0.39	10.23[d] ±1.14
175 g/t	3.54[e] ±0.32	9.75[e] ±1.13	3.78[e] ±0.34	9.72[e] ±1.22

[a,b,c,d,e] Means±SEM in a column with different superscripts differ significantly (p<0.05).
Means±SEM in a column without superscripts do not differ significantly (p>0.05).
Values of each parameter are means of 3 observations.

Knobba (1986) who observed reduced weight gain when oxidized oil or fat were added in the rations for broilers and guinea pigs.

Reduced weight gain in oxidized oil fed birds was clearly shown by Cabel and Waldroup (1988) who fed 4 or 7 meq peroxide/kg feed and reported lower body weights than control fed 0 meq peroxide and demonstrated that weight gain was unaffected when broilers were fed diet containing a peroxide level of 4 meq or less/kg of diet. Lin et al. (1989) observed significantly (p<0.05) lower weight gain in broilers fed diets containing oxidized sunflower oil whereas antioxidant supplementation improved growth. Results of the present study also agree with the findings reported by Engberg et al. (1996) and Wang et al. (1997) who studied that there was growth depression or lowered weight gain in broilers, when fed oxidized oil with or without antioxidant as compared to normal oil.

Feed conversion ratio (FCR)

A significant (p<0.05) depression in FCR was obtained from birds fed diets containing the higher level of oil at any age. Ethoxyquin supplementation resulted in a non-significant effect on FCR. The findings of the present study agree with Eschenbach and Hartfiel (1985) who noted that oxidized oil caused poorer FCR than fresh oil. Cabel and Waldroup (1988) observed feed conversion ratio at 21 and 42 days of age to be significantly lower in birds fed diet containing 4 or 7 meq peroxide/kg feed. The present results are also supported by findings of Wang et al. (1997) who reported greater feed efficiency of chicks fed rations containing normal fat with or without ethoxyquin than chicks fed rations containing oxidized fat with or without ethoxyquin.

Results of the present study, however, did not agree with the findings reported by Oertel and Hartfiel (1982) who found no influence on feed conversion efficiency in broilers fed rations containing oxidized fat. The probable explanation could be the lower level of rancidity; in the present study oxidized soybean oil having 49.01 meq/kg peroxide value and 7.52 mg/g acid value was used.

TBA value

Squires et al. (1991) reported the utility of thiobarbituric acid test (TBA) in the determination of the quality of fats and oils in the feeds. The TBA test is a rapid and simple method for determining the extent that a fat has degraded to non-metabolizable aldehydes, such as melonaldehydes. A fat that has a high peroxide number or high value in TBA test would not be suitable for use in feeds because it would

Table 5. Interaction of oxidized and non-oxidized soybean oil with two levels of ethoxyquin on different parameters

Ethoxyquin	Starter phase (0-28 days)			Finisher phase (29-42 days)		
	Oil level			Oil level		
	Non-oxidized (2%)	Oxidized (2%)	Oxidized (3%)	Non-oxidized (2%)	Oxidized (2%)	Oxidized (3%)
	Weight gain (g/bird/day)					
125 g/t	36.75±0.49	35.82±0.78	34.46±0.56	51.97±0.55	50.57±0.72	48.50±0.63
175 g/t	38.21±0.83	36.89±0.77	35.96±0.75	51.64±0.59	50.42±0.62	47.92±0.54
	Feed intake (g/bird/day)					
125 g/t	57.75±0.12	56.71±0.27	57.85±0.36	125.64±0.13	124.14±0.65	121.14±0.69
175 g/t	58.39±0.20	57.35±0.30	58.67±0.55	125.21±0.69	123.57±0.31	122.71±0.36
	Feed/gain (FCR)					
125 g/t	1.57±0.01	1.58±0.01	1.68±0.02	2.44±0.25	2.45±0.05	2.50±0.06
175 g/t	1.52±0.03	1.55±0.02	1.63±0.02	2.42±0.08	2.45±0.02	2.52±0.05
	TBA value (mg/kg)					
125 g/t	2.85±0.01	3.72±0.03	5.00±0.12	2.50±0.18	4.04±0.05	5.11±0.34
175 g/t	2.63±0.01	3.22±0.15	4.78±0.25	2.60±0.01	4.04±0.01	5.00±0.01
	Acid value (mg/g)					
125 g/t	6.45^c±0.16	10.97^b±0.08	13.61^a±0.08	5.89^c±0.16	11.16^b±0.03	13.66^a±0.04
175 g/t	5.47^c±0.15	10.07^b±0.01	13.15^a±0.01	5.30^c±0.01	10.79^b±0.08	13.16^a±0.01

^{a,b,c} Means±SEM in a rows with different superscripts differ significantly ($p<0.05$).
Means±SEM in a rows without superscripts do not differ significantly ($p>0.05$).
Values of each parameter are means of 3 observations.

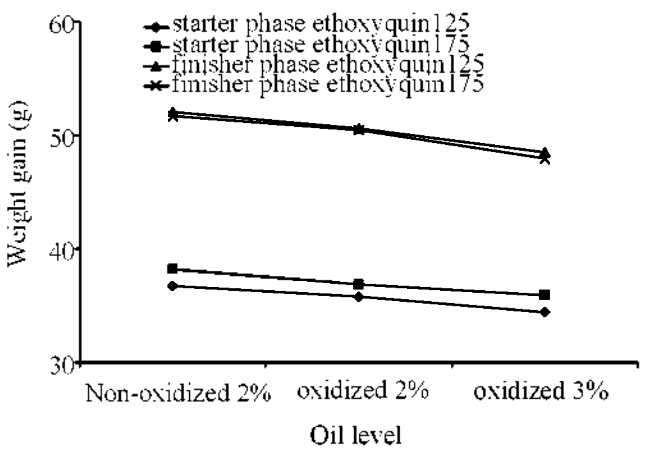

Figure 2. Effect of oxidized and non-oxidized soybean oil and ethoxyquin levels on weight gain (g) of broilers.

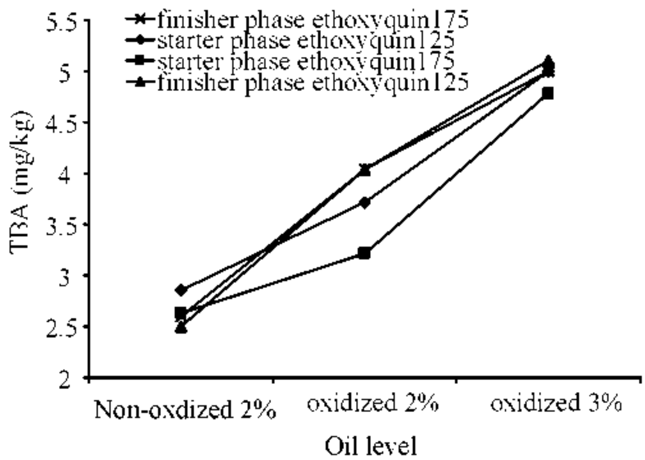

Figure 3. Effect of oxidized and non-oxidized soybean oil and ethoxyquin levels on TBA (mg/kg) of broilers

contain a high peroxide or aldehydde content. Increased TBA value in feed in the present study is in line with the results of Franic (1983) who concluded that TBA value of fish meal stored at high temperature increased significantly due to excessive moisture and prolonged storage.

The results also reveal that ethoxyquin level had significant effect on vegetable oil stability in terms of TBA test. Villwock and Hartfiel (1982) also reported that with increasing amount of antioxidants the fat oxidation was less intensive in the mixed feed. Bartov and Bornstein. 1972; Cabel and Waldroup 1989. reported that rancidity development in stored rice bran could be slowed by the addition of ethoxyquin or EDTA or both. In the present study soybean oil was used which has lower TBA values compared to other sources. Squires et al. (1990) reported that the corn oil had lower value TBA test compared to poultry fat and commercial animal fat and vegetable fat blend.

Acid value

Acid value is the test that indicates the quality of free fatty acids which are present in one gram of fat/oil or

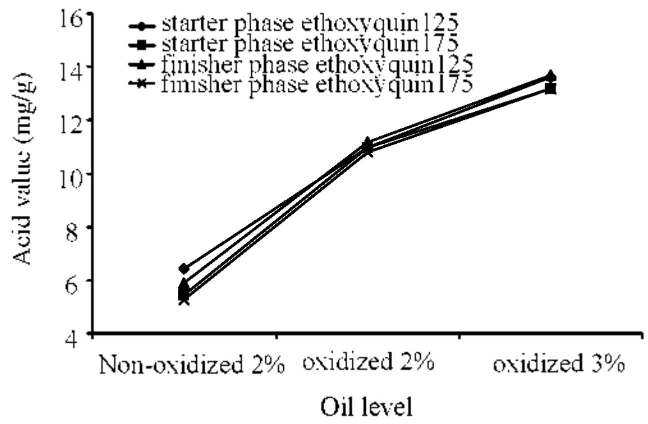

Figure 4. Effect of oxidized and non-oxidized soybean oil and ethoxyquin levels on acid value (mg/g) of broilers

product. As the level of oxidation increases the acid value also increases which adversely affects the feed quality. However, antioxidants supplementation alleviates oxidation and thus also reduces acid value and thus improves feed quality (Waheed. 1998). The results of present study are in agreement with the results of Waheed (1998) who concluded that there was a significant effect of antioxidants on rancidity (Acid value) developed in feeds containing higher levels of fat. Similar results were observed by Ramzan (1993) who found that acid value increased significantly with increasing fat percentage and storage time. In his study acid value increased at 2% fat level from 8.33 to 11.12, while at 4% fat acid value increased from 8.5 to 12.11 in starter rations. Shemet and Martinenko (1983) reported that antioxident santoquin at 150 gm/ton prevented rancidity during long-term storage. Pelvin and Novicov (1989) reported that santoquin significantly delayed destruction of unsaturated fatty acids and formation of secondary oxidation products. From this study it can be concluded that in broiler rations oxidation/rancidity can have deleterious effects on broiler performance and supplementation with ethoxyquin can alleviate these effects. In feeds having 3% oxidized soybean oil, addition of 125 g/t ethoxyquin is beneficial in terms of broiler performance as well as in terms of acid value and TBA value.

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