



**Full Length Article**

## Effect of Feeding Olive Leaves on the Performance, Intestinal and Carcass Characteristics of Broiler Chickens

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### Abstract

The present study was planned to investigate effects of substituting olive leaves (OL) for wheat bran (0, 15, 30, 50 g/kg diet) in broiler diets on the performance (weight gain and feed efficiency) and small intestine (SI) length/weight at 21 and 35 d of age. Carcass characteristics of broiler chickens were investigated at 35 d of age. Dietary OL of 30 g/kg and above significantly ( $P<0.01$ ) reduced performance of birds during the starter phase and OL of 50 g/kg reduced performance during the finisher phase, ( $P<0.05$ ) eviscerated carcass weight and increased SI length and weight % and ileum thickness when compared with those of the control diet. Dietary OL did not influence feed intake. Birds at 35 days of age had higher SI measurements except for duodenum length and SI segments weight % when compared with those of 21 of age. It was, therefore, concluded that replacement of 15 and 30 g wheat bran/kg with OL in the starter and finisher diets produced no significant effect on performance and carcass characteristics of chickens. Dietary 50 g OL/kg altered SI measurements and reduced live and carcass weights of broiler chickens. © 2013 Friends Science Publishers

**Keywords:** Broiler; Olive leaves; Performance; Small intestine; Carcass characteristics

### Introduction

Price fluctuation of feed ingredients is a reality of the free market. Prices for poultry feed ingredients have increased dramatically over the past decade. Much of this cost increase has resulted from the short supply as a result of industrial and human needs. With increasing prices of feed ingredients, managing the cost of poultry diets is becoming more important. Poultry diets cost is a major problem for the industry as feed cost ranges from 50 to 60% and 65 to 75% of the total cost of production in the developed and developing countries, respectively (Tackie and Flenscher, 1995; Nworgu *et al.*, 1999), but for many producers this figure is now higher. Poultry nutritionists have emphasized the need for utilizing alternative feed ingredients other than human, agriculture and industrial uses (Ravindran and Blair, 1991; 1992; 1993; Durunna *et al.*, 1999; Fanimu *et al.*, 2007; Al-Ruqaie *et al.*, 2011; Shafey *et al.*, 2011). Often these ingredients are available locally at relatively low prices. Alternative feed ingredients may offer more options for poultry nutritionists to formulate diets.

The olive, *Olea europaea*, is a small tree native to the coastal area of Mediterranean and is important oil producing crop. Olive cultivation has now spread to many new places in the world including the Kingdom of Saudi Arabia, especially in the northern region. Despite of the olive industry is being relatively new to the Kingdom, the production of olive oil has increased rapidly and olive tree gained special importance in the agriculture economy. It is

considered a healthy source of fatty acids in our diets (Harwood and Yaqoob, 2002). As with any agricultural activity, olive cultivation can have both positive and negative environmental effects. Olive leaves (OL) are considered to be an agricultural waste from the beating of olive trees for fruit harvest; however, the olive industry produces other types of wastes during harvesting and processing (Delgado Pertinez *et al.*, 1998). It has been reported that about 40 kg of leaves and 1633 of olive mill waste produced from the process of 1000 kg of fresh olives (Vlyssides *et al.*, 2004). This represents a disposal and potentially environmental pollution problem. Scientists are looking for ways to utilize and recycle agriculture waste (Sarwar *et al.*, 2002; Laufenberg *et al.*, 2003). OL and other olive by products are used as livestock feed and its twigs are reported to be very palatable to ruminants (Molina-Alcaide and Yanez-Ruiz, 2008). However, only limited information is available on the use of OL in poultry feeding. Recently, Govaris *et al.* (2010) reported that the addition of 10 g OL/kg diet did not influence body weight gain of turkey.

Introducing ingredient alternatives seems like a rational step for poultry nutritionists, however availability, cost competitiveness, handling, and accurate formulation are often obstacles that must be overcome before an alternative can be utilized successfully. This study was designed to evaluate the effects of the dietary OL on the performance, intestinal measurements and carcass characteristics of broiler chickens. In this study, OL was replaced for wheat bran in broiler diets.

## Materials and Methods

OL were collected from olive trees (*Olea europaea*) and were sun dried by spreading on drying trays, and exposing directly to solar radiation and natural air circulation. Dried OL were then ground to pass a 1.4 mm steel screen using a grinder (Moline M-06, Italy). The OL powder was pelleted using a twin screw extruder (Model MPF19:25, APV-Baker UK) according to manufactory setting. The pelleting process was performed at a temperature of 60°C, and pellets were 4 mm in diameter. The pellets were then crumbled in a roller mill. Samples of the OL were analyzed for moisture, protein, crude fiber, ether extract and ash according to the American Association of Cereal Chemists (AACC, 2000). The results of proximate analysis of the OL are shown in Table 1.

A total of 200, day-old Ross male broiler chickens were individually weighed and randomly sorted into 40 replicates to minimize differences in body weight between replicates, with 5 birds each. They were housed in electrically heated battery cages. Incandescent lights were used continuously throughout the experimental period. Ten replicates were randomly assigned to either one of four starter diets to 21 days, followed by finisher diets to 35 days of age. The control diet was formulated with 50 g of wheat bran/kg. The OL was substituted for the wheat bran to produce four diets with OL levels of 0, 15, 30 and 50 g/kg diet (Table 2). The experimental diets were formulated to be isocaloric and isonitrogenous. Feed and water were available *ad libitum*.

At 21 and 35 days of age (end of the starter and experimental periods), three and four birds per diet were randomly selected, respectively and processed at King Saud University to determine small intestine (SI) measurements, processing yields and carcass quality. SI measurements were determined at 21 and 35 days of age and carcass characteristics were determined at the end of the experiment at 35 days. Birds were weighed, killed by cervical dislocation after 9 h of feed and water deprivation, bled to prevent accumulation of the blood in the skin capillaries and congealing blood vessels, scalded, defeathered in a rotary picker and eviscera and abdominal fat were removed. Body components, edible offal (liver plus heart plus gizzard) and SI were taken for measurements. The SI segments of duodenum (from the pylorus to distal point of entry of bile duct), jejunum (from entry of the bile ducts to Meckel's diverticulum) and the ileum (from Meckel's diverticulum to the ileocecal junction) were removed and then gently flushed with saline solution to remove any SI contents remained. Weight and length of each segment were recorded. Weight of SI segment was expressed on the basis of absolute value (g) or as a percentage of live weight (%). Data from carcass weight, abdominal fat and cut parts (back, breast, wings, thigh and drumstick) were recorded. Carcass weight was recorded after the removal of feathers, skin, head, viscera and abdominal fat.

**Table 1:** The nutrient composition of olive leaves (OL) and wheat bran (g/kg)<sup>1</sup>

Composition	OL	Wheat bran
Dry matter	921.5	885.0
Crude protein	85.0	150.0
Crude fat	45.0	40.0
Crude fiber	149.9	100.0
Ash	96.9	52.0
Nitrogen free extracts	545.0	543.0

<sup>1</sup>Proximate analysis according to AACC (2000)

Measurements were made of body weight gain, feed intake, and feed conversion ratio during the starter, finisher and whole experimental periods [(1 to 21, 22 to 35 and 1 to 35 days, respectively), SI segments measurements (weight, length and thickness (weight/length of duodenum, jejunum and ileum)] at 21 and 35 days of age and carcass composition at 35 days of age. Data collected were subjected to analysis of variance using GLM procedures (SAS, 1988). Where significant variance ratios were detected, differences between treatment means were tested using the least significant difference (LSD) procedures.

## Results

The nutrient composition of dried OL is shown in Table 1. The OL had higher fiber and ash and lower protein contents when compared with those of the wheat bran. These analyses may suggest that OL is a good nutritional source of fiber in poultry diets. The effects of dietary levels of OL on the performance, SI measurements and carcass composition of broiler chickens are shown in Tables 3, 4 and 5, respectively. Increasing dietary level of OL significantly ( $P<0.01$ ) reduced body weight gain during the starter, finisher and ( $P<0.05$ ) whole experimental periods ( $0>30=50$ ,  $0=15>50$ , and  $0>30=50$  g OL/kg diet, respectively), eviscerated carcass weight when expressed on the basis of absolute value ( $0>50$  g OL/kg diet) and jejunum thickness ( $0>15$  g OL/kg diet) and increased feed conversion ratio during the starter, finisher and whole experimental periods ( $0<15=30=50$ ,  $0=15=30<50$  and  $0<50$  g OL/kg diet, respectively), thigh proportion of eviscerated carcass ( $15<30=50$  g OL/kg diet), weights of ileum and SI when expressed on the basis of absolute values ( $50>15=0$  and  $50>15$  g OL/kg diet, respectively) or as a proportion of live weight ( $50=30>15=0$  g OL/kg diet), duodenum and jejunum percentages of live weight ( $50=30>0$  and  $30>15=0$  g OL/kg diet, respectively), lengths of jejunum ( $50=15>0$  g OL/kg diet) and SI ( $50=30=15>0$  g OL/kg diet), and ileum thickness ( $50>15=0$  g OL/kg diet).

Age of bird (at 21<sup>st</sup> and 35<sup>th</sup> day) significantly ( $P<0.01$ ) increased chicken and carcass weights and all SI measurements except duodenum length and ileum weight percentage of live weight and reduced duodenum, jejunum and SI weights when expressed as percentages live weight. Dietary OL did not significantly influence weight of eviscerated carcass, neck or edible offal (liver plus heart

**Table 2:** Composition of the basal diets (g/kg)

Ingredients	Starter phase (1-21 days of age) Level of olive leaves (g/kg)				Finisher phase (21-35 days of age) Level of olive leaves (g/kg)			
	0	15	30	50	0	15	30	50
Soybean meal	376.8	378.4	380.1	382.3	303.9	305.6	307.3	309.5
Corn	258.5	256.5	254.5	251.8	329.2	327.2	325.2	322.6
Wheat	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0
Corn oil	63.3	63.5	63.7	64.0	64.0	64.2	64.4	64.6
Wheat Bran	50.0	35.0	20.0	0.0	50.0	35.0	20.0	0.0
Olive leaves	0.0	15.0	30.0	50.0	0.0	15.0	30.0	50.0
Dicalcium phosphate	16.1	16.2	16.3	16.4	16.6	16.7	16.8	16.9
Limestone	14.1	14.0	13.9	13.9	14.3	14.2	14.1	14.1
Sand	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Premix <sup>1</sup>	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Salt	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
DL-Methionine	1.5	1.6	1.6	1.7	2.3	2.4	2.4	2.5
L-Lysine	0.5	0.5	0.6	0.7	0.4	0.4	0.5	0.6
Choline	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Analysis:								
ME (kcal/g) <sup>2</sup>	2.95	2.95	2.95	2.95	3.00	3.00	3.00	3.00
CP (N% x 6.25) <sup>3</sup>	23.00	23.00	23.00	23.00	20.0	20.0	20.0	20.0
Lysine (g/kg)	12.00	12.00	12.00	12.00	11.00	11.00	11.00	11.00
Met + Cys (g/kg) <sup>4</sup>	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
Ca (g/kg)	10.00	10.00	10.00	10.00	9.00	9.00	9.00	9.00
AP (g/kg) <sup>5</sup>	5.00	5.00	5.00	5.00	4.50	4.50	4.50	4.50

<sup>1</sup>The composition of vitamins and minerals in the premix (per ton of diet): vitamin A, 6000,000 IU; vitamin D, 1500,000 IU; vitamin E, 20,000IU; vitamin K 1,000 mg; vitamin B1, 1mg; vitamin B2, 3000mg; vitamin B6, 2000mg; vitamin B12, 10mg; niacin, 20,000mg; folic acid, 500mg; pantothenic acid 5,000g; biotin, 50mg; antioxidant, 60.000mg; cobalt, 100ppm; copper, 5,000ppm; iodine, 500ppm; iron, 20,000ppm; manganese, 40,000ppm; selenium, 100 ppm; zinc, 30,000;

<sup>2</sup>Metabolizable energy was calculated from Evan (1985);

<sup>3</sup>CP = Crude protein; <sup>2,3</sup>The formulation of the diets was based on guidelines for Ross broilers (Ross Broiler Nutrition Specification 2007);

<sup>4</sup>Met + Cys = Methionine + Cysteine; <sup>5</sup>AP = Available phosphorus was calculated on the basis of 30% availability of phosphorus in plant products

**Table 3:** Body weight gain (BWG), feed intake and feed conversion ratio (FCR, feed (g)/ gain (g)) of broiler chickens fed diets containing different levels of olive leaves (OL) during the starter and finishing phases (1-21 and 22-35 days of age)

OL (g/kg)	Age (day)								
	1-21			22-35			1-35		
	BWG (g)	Feed intake (g)	FCR (Feed/gain)	BWG (g)	Feed intake (g)	FCR (Feed/gain)	BWG (g)	Feed intake (g)	FCR (Feed/gain)
0	811.0 <sup>a</sup>	1086.1	1.34 <sup>b</sup>	1356.0 <sup>a</sup>	2062.5	1.52 <sup>b</sup>	2185.7 <sup>a</sup>	3160.9	1.45 <sup>b</sup>
15	775.2 <sup>ab</sup>	1104.8	1.44 <sup>a</sup>	1330.2 <sup>a</sup>	2075.0	1.58 <sup>b</sup>	2105.3 <sup>ab</sup>	3179.8	1.53 <sup>ab</sup>
30	742.2 <sup>b</sup>	1071.5	1.44 <sup>a</sup>	1262.1 <sup>ab</sup>	2010.2	1.59 <sup>b</sup>	2004.2 <sup>b</sup>	3081.7	1.54 <sup>ab</sup>
50	748.6 <sup>b</sup>	1086.1	1.45 <sup>a</sup>	1225.9 <sup>b</sup>	2077.0	1.74 <sup>a</sup>	1974.5 <sup>b</sup>	3163.1	1.61 <sup>a</sup>
SEM <sup>1</sup>	14.8	17.1	0.03	34.7	23.6	0.04	46.8	35.6	0.03

1: Standard error of mean

a,b: Means within column followed by different superscripts are significantly different (P<0.05)

plus gizzard) as a percentage of live weight, eviscerated carcass proportion of drumsticks, wings, breast or back and intestinal thickness.

## Discussion

Results of this study showed that dietary OL of 30 g /kg and above reduced performance (body weight gain and feed efficiency) during the starter phase and OL of 50 g /kg reduced performance during the finisher phase and eviscerated carcass weight at 35 days of age. However, feed intake was not influenced by dietary level of OL during any of the experimental periods. The significant reduction in the performance of birds during the starter phase may suggest that birds cannot tolerate dietary level of 30 g OL/kg diet at

younger age. Whilst the non-significant effect of the same dietary level of OL on the performance of birds during the finisher phase may suggest an improvement in their ability to utilize OL at older age. The lower body weight gain of birds fed dietary OL levels of 30 g /kg at 35 days of age indicated carry over effects from the starter phase period. The reduction in body weight gain and feed efficiency associated with feeding higher level of OL in the diet may be attributed to the higher fiber content of OL (Summer and Leeson, 1986; Fahey *et al.*, 1992). According to Linderman *et al.* (1986) and Gous *et al.* (1990) that high fiber dietary content increases feed volume and consequently reduces nutrient density. The reduction in dietary density and the limitation of intestinal size may influence the nutrient availability for growth. Consequently, birds fed higher dietary levels of OL consumed more feed for unit weight gain when compared

**Table 4:** Small Intestine (SI) measurements at 21 and 35 days of age of broiler chickens fed diets containing different levels of olive leaves (OL)

Measurement	OL (g/kg diet)				Age (day)		SEM <sup>1</sup>	Probability		
	0	15	30	50	21	35		OL	Age	OLx Age
Live weight (g)	1625.4 <sup>a</sup>	1525.6 <sup>b</sup>	1520.0 <sup>b</sup>	1566.3 <sup>b</sup>	772.4	2149.5 <sup>**</sup>	21.17	**	**	NS
Carcass weight (g)	1022.3	965.2	985.9	969.3	445.2	1390.8 <sup>**</sup>	16.59	NS	**	NS
Duodenum weight (W, g)	9.57	9.86	10.50	10.65	7.76	11.94 <sup>**</sup>	0.39	NS	**	NS
Duodenum weight (% of live weight)	0.66 <sup>b</sup>	0.73 <sup>ab</sup>	0.79 <sup>a</sup>	0.80 <sup>a</sup>	1.00	0.56 <sup>**</sup>	0.02	**	**	*
Duodenum length (L, cm)	25.1	26.9	28.3	27.6	26.2	27.5	0.73	NS	NS	NS
Duodenum thickness (W/L, gm/cm)	0.38	0.36	0.38	0.39	0.29	0.44 <sup>**</sup>	.015	NS	**	NS
Jejunum weight (W, g)	18.80	17.34	19.51	18.98	11.66	23.91 <sup>**</sup>	0.70	NS	**	NS
Jejunum weight (% of live weight)	1.22 <sup>b</sup>	1.15 <sup>b</sup>	1.41 <sup>a</sup>	1.33 <sup>ab</sup>	1.50	1.11 <sup>**</sup>	0.04	*	**	*
Jejunum length (L, cm)	61.4 <sup>b</sup>	69.6 <sup>a</sup>	65.9 <sup>ab</sup>	69.7 <sup>a</sup>	57.3	73.6 <sup>**</sup>	1.63	**	**	**
Jejunum thickness (W/L, gm/cm)	0.30 <sup>a</sup>	0.24 <sup>b</sup>	0.29 <sup>a</sup>	0.27 <sup>ab</sup>	0.21	0.32 <sup>**</sup>	0.011	*	**	NS
Ileum weight (W, g)	12.33 <sup>c</sup>	12.99 <sup>bc</sup>	15.15 <sup>ab</sup>	16.58 <sup>a</sup>	7.32	19.47 <sup>**</sup>	0.62	**	**	NS
Ileum weight (% of live weight)	0.75 <sup>b</sup>	0.78 <sup>b</sup>	1.08 <sup>a</sup>	1.08 <sup>a</sup>	0.94	0.91	0.05	**	NS	*
Ileum length (L, cm)	67.1 <sup>b</sup>	70.6 <sup>ab</sup>	74.1 <sup>a</sup>	70.9 <sup>ab</sup>	60.6	78.2 <sup>**</sup>	1.37	NS	**	NS
Ileum thickness (W/L, gm/cm)	0.17 <sup>b</sup>	0.17 <sup>b</sup>	0.20 <sup>ab</sup>	0.22 <sup>a</sup>	0.12	0.25 <sup>**</sup>	0.008	**	**	NS
SI weight (W, g)	40.70 <sup>ab</sup>	40.20 <sup>b</sup>	45.16 <sup>ab</sup>	46.21 <sup>a</sup>	26.74	55.31 <sup>**</sup>	1.42	**	**	NS
SI weight (% of live weight)	2.64 <sup>b</sup>	2.66 <sup>b</sup>	3.28 <sup>a</sup>	3.22 <sup>a</sup>	3.45	2.58 <sup>**</sup>	0.10	**	**	**
SI length (L, cm)	153.7 <sup>b</sup>	167.0 <sup>a</sup>	168.3 <sup>a</sup>	168.1 <sup>a</sup>	145.2	179.4 <sup>**</sup>	2.69	**	**	*
SI thickness (W/L, gm/cm)	0.26	0.23	0.26	0.27	0.19	0.31 <sup>**</sup>	0.007	NS	**	NS

<sup>1</sup>Standard error of mean; \*Significant difference (P<0.05); \*\*Significant difference (P<0.01); NS= Non-significant<sup>a,b,c</sup>: Means within column followed by different superscripts are significantly different (P<0.05)**Table 5:** Carcass composition of broiler chickens at 35 days of age fed diets containing different levels of olive leaves (OL) during the starter and finishing phases (1-21 and 22- 35 days of age, respectively)

OL (g/kg)	Body composition										
	Live body Weight (g)	Eviscerated Carcass (g)	g/kg live body weight				g/kg eviscerated carcass				
			Abdominal fat	Neck	Edible offal <sup>1</sup>	Eviscerated carcass	Thigh	Drums	Wings	Breast	Back
0	2247.5 <sup>a</sup>	1451.7 <sup>a</sup>	16.1	24.5	56.1	646.0	184.5 <sup>ab</sup>	135.4	41.3	344.5	230.6
15	2100.5 <sup>b</sup>	1379.5 <sup>ab</sup>	16.4	26.2	56.6	656.8	168.0 <sup>b</sup>	133.2	39.6	358.2	236.3
30	2112.5 <sup>b</sup>	1380.7 <sup>ab</sup>	16.1	24.8	53.0	653.2	186.3 <sup>a</sup>	140.3	36.4	345.7	231.1
50	2137.5 <sup>b</sup>	1351.2 <sup>b</sup>	21.7	20.5	3.1	632.2	191.2 <sup>a</sup>	141.0	35.7	340.5	224.9
SEM <sup>2</sup>	27.7	28.8	2.2	1.7	2.3	9.4	7.6	5.5	2.6	12.9	6.1

<sup>1</sup>: Edible offal= Liver weight + heart weight +gizzard weight; <sup>2</sup>: Standard error of mean;<sup>a,b</sup>: Means within column followed by different superscripts are significantly different (P<0.05)

with those fed the control or low OL diet. In addition, high fiber diet increases digesta passage rate and reduces retention time of feed in chickens and rabbits (De Blas *et al.*, 1989; Ibrahim and El-Zubeir, 1991). The reduction in performance of birds fed high dietary levels of OL may be attributed to these factors, albeit the non-significant difference in feed intake. However, the addition of moderate level of insoluble fiber (7.5 g /kg diet) improved performance of broiler chickens at marketing age of 42 d without influencing feed intake (Sarikhani *et al.*, 2010).

The non-significant effects of OL on feed intake of birds suggested that OL did not adversely affect the palatability of the diet. It appears that the preparation of OL contributed to the acceptability of birds to OL. OL was prepared by grinding then pelleting and crumbling before incorporating it into the experimental diets. In addition, experimental diets were formulated to be isocaloric, isonitrogenous and balanced for nutrients to meet nutrient recommendation (NRC, 1994). According to Adebawale *et al.* (1991), fiber content and physical texture of the diet affect the performance of birds. In growing pigs, the

addition of OL to the diets reduced feed intake and body weight gain and consequently increased feed to gain ratio (Paiva-Martins *et al.*, 2009). According to the above researchers, the lower feed intake of pigs is induced by a reduction in palatability. This was due to the presence of oleuropein in OL, which is a bitter glycoside. Results from intestinal measurements indicated that higher dietary levels of OL increased the weights of duodenum, ileum and the whole SI as proportions of body weight (50=30>0, 30>0=15, 50=30>0=15 g/kg diet, respectively). Similar finding was reported by (Pond *et al.*, 1989). The increase in SI length and weight (50=30=15>0) of birds fed high OL diets appeared to be a way of physical adaptation for the SI to deal with high fiber diets. This adaptation may allow the birds to consume higher amounts of feed so that required nutrients may be obtained. In several species, weight, volume, and capacity of the gastrointestinal tract (GIT) have been shown to increase with increasing dietary fiber (Coey and Robinson, 1954; Hansen *et al.*, 1992).

It is concluded that OL does have a potential for replacing the expensive wheat bran as a fiber source for

broiler diets. Replacement of 15 and 30 g wheat bran/kg with OL in starter and finisher broiler diets, respectively produces no significant effect on the performance and carcass of broiler chickens. The replacement of higher levels of OL reduced body weight gain, feed efficiency, carcass eviscerated weight and increased intestinal weight and length.

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