EFFECT OF DIETARY SUPPLEMENTATION OF OLIVE LEAF EXTRACT ON PRODUCTIVE PERFORMANCE, BLOOD PARAMETERS AND CARCASS TRAITS OF GROWING RABBITS.

G.E. Younan, Manal S. Mohamed and W. A. Morsy

Animal Production Research Institute, Agricultural Research Center, Dokki, Egypt.

SUMMARY

The present study was designed to investigate the efficacy of different dietary levels of ethanolic olive leaf extract (OLE) on growth performance, blood parameters, carcass traits, meat chemical composition and economic feed efficiency of growing rabbits. Eighty APRI line rabbits of 5 weeks of age with an average live body weight of 562 g were divided and assigned randomly into four experimental groups of 20 rabbits in each (10 males +10 females). Rabbits in the 1st group were fed basal diet without ethanolic olive leaf extract supplement (OLE1; control), while those in the 2nd (OLE2), 3rd (OLE3) and 4th (OLE4) groups were fed the same diet supplemented with OLE at levels of 0.5, 1 and 1.5 ml/kg diet, respectively. Results show that rabbits fed OLE diet (1.5 ml /kg (OLE4) had significantly (P<0.05) the highest final body weight (2143 g), followed by OLE3 (2056 g), while those in OLE1 had the lowest final body weight (1952 g) and did not differ significantly from that in OLE2 (1993 g) through the whole growing period. Daily feed intake was not significantly affect by treatment. Feed conversion ratio was significantly (P<0.05) improved with increasing OLE level in diets. Rabbits in OLE3 and OLE4 groups did not recorded mortality during the experimental period as compared to 5% in each of OLE1 and OLE2 group. Carcass percentage was significantly (P<0.05) higher in OLE3 and OLE4 than in OLE1 and OLE2. Rabbits fed OLE3 and OLE4 diet showed the best net revenue (122.9 and133.7 %) relative to control diet (100%). The current study suggested that the dietary supplementation of olive leaves extract at levels of 1 and 1.5 ml/kg diet could be successfully save and useful for growing rabbits during the growing period.

Keywords*: rabbit, olive leaves extract, growth performance, carcass, blood.*

INTRODUCTION

Olive (*Olea europaea*) leaf (OL) is one of the potent source of plant polyphenols having antioxidant, antimicrobial, antiviral properties due to its rich phenolic contents. The most phenolic component of this content is oleuropein, which gives high palatability to olive or its olive oil. In order to utilize oleuropein and other bioactive components within OL effectively enough, they should be extracted from olive leaf. Olive leaf extract (OLE) contains compounds with potent antimicrobial activities against bacteria, fungi, and mycoplasma (Huang *et al.,* 2003). Using aqueous OLE had beneficial effects in controlling the microbial infections because it is a potent source of polyphenols having antioxidant, antimicrobial, anti-inflammatory and antiviral properties (Aliabadi *et al.,* 2012). The antimicrobial activity of commercial OLE is against *campylobacter jejuni* (CJ), *helicobacter pylori* (HP) and methicillin-resistant *Staphylococcus aureus* (Sudjana *et al.,* 2009). These extracts play a role in regulating the composition of the gastric flora by selectively reducing levels of HP and CJ. The reports describing antimicrobial properties of phenolic compounds in olive products refer to compounds obtained from olive fruit, particularly hydroxyl tyrosol and oleuropein (Periera *et al.,* 2007).

At the experimental conditions, Juven *et al.* (1972) observed that oleuropein affected a significant leakage of glutamate, potassium and inorganic phosphate from *Lactobacillus plantarum.* Oleuropein had no effect on the rate of glycolysis when added to resting cells of *L. plantarum,* but it caused a decrease in the ATP content of the cells. Shafey *et al.* (2013) found that dietary addition of 50 g olive leaf/kg altered small intestine measurements and reduced live and carcass weights of broiler chickens. Cayan and Erener (2015) observed that olive leaf powder (1, 2, or 3%) can be used for reducing egg yolk cholesterol content and egg yolk coloring agent in layer diets.

In rabbits, Dub and Dugani (2013) studied the effect of ethanolic OLE at levels of 100 and 200 mg/ kg BW/ day. They found that ethanolic OLE can modify the extrinsic coagulation pathway as evidenced by the prolongation of prothrombin time and changes in thrombus morphology, enough to justify further research to evaluate its possible antithrombotic effects.

Therefore, the present study was designed to investigate the efficacy of different dietary levels of ethanolic olive leaf extract on growth performance, blood parameters, carcass traits, meat chemical composition and economic efficiency of growing rabbits.

MATERIALS AND METHODS

The present study was carried out at rabbit farm of Sakha station, belonging to Animal Production Research Institute (APRI), Agricultural Research Center, Ministry of Agriculture, Egypt.

Eighty APRI line rabbits (5 weeks of age and average live body weight of 562±7.82 g) were divided and assigned randomly into four experimental groups of 20 rabbits in each (10 males +10 females). Rabbits in the 1st group were fed complete diet (basal diet) without any supplements (olive leaves extract, OLE1, control). While, those in the 2nd (OLE2), 3rd (OLE3) and 4th (OLE4) groups were fed the same diet supplemented with OLE at levels of 0.5, 1.0 and 1.5 ml/kg diet, respectively. The basal diet was formulated to cover all essential nutrient requirements for growing rabbits according to De Blas and Mateos (1998). Table (1) shows the ingredients and chemical composition of the basal diet. All rabbits were kept under the same managerial conditions.

Table (1): Feed ingredients and calculated chemical analysis of the basal diet.

Ingredient	%	Calculated chemical analysis	
Berseem hay	30.05	Crude protein (%)	17.75
Barley	24.60	Digestible energy kcal/kg	2500
Wheat bran	21.50	Crude fiber (%)	12.38
Soybean meal (44% CP)	17.50	Ether extract (%)	2.27
Molasses	3.00	Calcium (%)	1.24
Di-calcium phosphate	1.60	Total phosphorus (%)	0.80
Limestone	0.95	Lysine (%)	0.98
Sodium chloride (NaCl)	0.30	Methionine (%)	0.46
Vitamin & Mineral Mixture*	0.30	Methionine + Cystine (%)	0.76
DL-Methionine	0.20	Sodium (%)	0.16

**Supplied per kilogram of diet: Vitamin A, 6000 IU; Vitamin D_3, 900 IU; Vitamin E, 40 mg; Vitamin K_3, 2 mg; Vitamin B_1, 2 mg; Vitamin B_2, 4 mg; Vitamin B_6, 2 mg; Pantothenic acid, 10 mg; Vitamin B_{12}, 0.01 mg; Niacin, 50 mg; Folic acid, 3 mg; Biotin, 0.05 mg; Choline, 250 mg; Fe, 50 mg; Mn, 8.5 mg; Cu, 5 mg; Co, 0.1 mg; Se, 0,1 mg; I, 0.2 mg and Zn, 50 mg.*

Olive leaves used in this study were collected in winter (February) from Borg El-Arab region, Alexandria governorate, Egypt. The collected olive leaves were cleaned from extraneous matter, shade-dried with passive ventilation and crushed into a fine powder. The air dried plant materials were ground in a blender with a particular size to ensure the plant powders in identical size. The powder (50 g) was macerated in 150 ml ethanol (75%) and allowed to extract for 48 h. The resultant (dark green-brown mixture) was filtered, then the crude extracts were kept in refrigerator in glass bottles until using (Dub and Dugani, 2013).

During the experimental period (5-13 wk of age), feed and water were offered *ad libitum*. Live body weight, feed intake and number of dead rabbits were recorded. Daily weight gain, feed conversion ratio and viability rate were calculated. Economic efficiency was calculated according to Raya *et al.* (1991), while relative growth rate and performance index were calculated according to North (1981).

At the end of growing period (13 weeks of age), six rabbits (3 males + 3 females) were taken randomly from each treatment, fasted for 12 h, weighed and slaughtered to estimate some of carcass traits according to Blasco *et al.* (1993). Blood samples were taken from each rabbit during slaughtering About 2 ml blood was

aspirated in EDTA vacuum tubes, centrifuged at 2500 rpm for 10 m for plasma separation (Burnett *et al.*, 2006). Plasma was stored at -20 Ċ until used for assaying. Hot carcass parts were presented as a percentage of live body weight. Blood samples were taken all rabbits in each group to determine hematological parameters and blood biochemicals in plasma. Meat samples were taken for analysis of meat from three males. Samples of meat were taken from the hind limb, dried at 60^{o}C for 2 days and grounded for analysis. Chemical analysis was carried out for meat samples according to A.O.A.C. (2005) for ash, DM, CP and EE.

For hematological parameters within 2 hrs after collection for determination of red blood cells count (RBCs), white blood cells count (WBCs), proportional of white blood cells (lymphocytes, neuterophils, monocytes, eosinophils, and basophils), hemoglobin (Hb) concentration and PCV according to Drew *et al.* (2004).

Concentrations of total proteins, triglycerides, cholesterol, high density lipoprotein (HDL) and low density lipoprotein (LDL) were calorimetrically determined by using commercial kits (Bio-Diagonosis Co., Cairo, Egypt), following the same steps as described by manufacturers. Concentration of total antioxidant capacity (TAC) and Malondialdehyde (MDA) and activity were determined calorimetrically.

Data were statistically analyzed using the General Linear Model Program of SAS (2000). Duncan's multiple range tests was performed (Duncan, 1955) to detect significant differences between means.

RESULTS AND DISCUSSION

Growth performance:

Table (2) showed that, at the end of growing period rabbits in OLE4 and OLE3 were significantly (P<0.05) heavier by 9.8 and 5.3% than in OLE1. However, LBW of rabbits in OLE2 and OLE1 was nearly similar (1993 and 1952 g). Rabbits were significantly (P<0.05) heavier in OLE4 than in OLE3. Average daily weight gain (ADWG) in the first interval (5-9 weeks of age) was significantly (P<0.05) increased only in rabbits fed OLE4 diet; however, in the second interval (9-13 weeks of age), ADWG was significantly

Table (2). Effect of dietary olive leaves extract on growth performance of growing rabbits.

Parameter	OLE1	OLE2	OLE3	OLE4	SEM	P-value
No. of animals	19	19	20	20	-	-
Initial body weight (g)	562	560	561	565	7.820	0.9778
Final body weight (g)	1952^{c}	1993^{c}	2056^{b}	2143^{a}	16.67	0.0001
Daily weight gain (g):						
5-9 weeks	25.5^{b}	25.9^{b}	26.6^{b}	28.5^{a}	0.534	0.0018
9-13 weeks	24.1^{c}	25.3^{bc}	26.8^{ab}	27.9^{a}	0.498	0.0002
5-13 weeks	24.8^{c}	25.6^{c}	26.7^{b}	28.2^{a}	0.299	0.0001
Feed intake (g/ d):						
5-9 weeks	72.3	72.8	73.1	74.1	0.526	0.2223
9-13 weeks	102.7	104.0	105.2	106.1	1.145	0.3293
5-13 weeks	87.5	88.4	89.2	90.1	0.962	0.2381
Feed conversion ratio:						
5-9 weeks	2.849^{a}	2.835^{a}	2.755^{ab}	2.614^{b}	0.051	0.0315
9-13 weeks	4.279^{a}	4.128^{ab}	3.959^{b}	3.848^{b}	0.084	0.0142
5-13 weeks	3.533^{a}	3.460^{ab}	3.342^{b}	3.203^{c}	0.051	0.0001
Relative growth rate	110.5^{c}	112.3^{bc}	114.3^{ab}	116.5^{a}	0.869	0.0006
Performance index (%)	55.5^{c}	57.8c	61.7^{b}	67.2^{a}	1.122	0.0001
Viability rate	95	95	100	100	-	-

SEM = Standard error of means,
a, b, c, Means in the same row the different superscripts are significantly different (P<0.05).

(P<0.05) higher in OLE4 and OLE3 than in OLE1. During the whole experimental period (5-13 weeks of age), supplementing of olive leaves extract in diets (OLE3 and OLE4) significantly (P<0.05) increased

ADWG. The recorded insignificant changes in feed intake of all groups with significant increase in ADWG during the experimental period reflected the best feed conversion ratio of rabbit in OLE4 and OLE3 as compared to OLE1 and OLE2. Based on these findings, relative growth rate and performance index during the whole experimental period were significantly (P<0.05) the highest in OLE4 and OLE3. It is interest to observe that improving growth performance parameters in OLE4 and OLE3 was associated with increasing viability rate during the experimental period.

The obtained results are in agreement with those obtained by El-Damarawy *et al.* (2013), who revealed that olive leave powder (0.5, 1.0 and 2.0%) in Mandarah chick diet significantly increased body weight, daily weight gain and feed conversion ratio. Recently, Oke *et al.* (2017) found that OLE supplementation in the drinking water of broiler chickens significantly increased final body weight, total weight gain and feed conversion ratio. Shafey *et al.* (2013) found that dietary supplementation of OLE (0, 1.8, 3.6 and 6.25 g/kg) in broiler diets did not significantly influence feed intake. Moreover, Cayan and Erener (2015) indicated that feed intake was not affected by dietary olive leaf powder. Improving feed conversion ratio was reported by Bahsi *et al.* (2016) when oleuropein was added to mixed feed (400 ppm) of Japanese quails. Improving viability rate of rabbits in OLE4 and OLE3 may be due to that OLE is a potent source of polyphenols having antioxidant, antimicrobial, anti-inflammatory and antiviral properties. Olive leaves had the beneficial effect in controlling the microbial infections (Aliabadi *et al.*, 2012). Also, Markin *et al.* (2003) reported that aqueous OLE (0.6% (w/v) in drinking water killed *E. coli*, *P. aeruginosa*, *S. aureus* and *K. pneumonia*. In addition, ethanol extracted OLE showed the highest antimicrobial efficiency against *E. coli* and *S. enteritidis* (Korukluoglu *et al.*, 2010).

The improvement in rabbit performance observed in this study may be due to the beneficial effects of OLE on improving the nutrients digestibility and intestinal absorption. These results may be attributed to oleuropein and other phenolic compounds completely inhibit the development of *Escherichia coli* and *B. cereus* (Aziz *et al.*, 1998). Oleuropein plays a role in regulating the composition of the gastric flora by selectively reducing levels of *Campylobacter jejuni*, *Helicobacter pylori* and methicillin-resistant *Staphylococcus aureus* (Sudjana *et al.*, 2009). Also, polyphenolic compounds increase the activity of digestive enzymes by decreasing of pathogenic microorganisms that spread in these animals' digestive organs, also preventing the formation of toxins within the feed (Wenk, 2002)

Carcass, pH and meat quality traits:

Percentages of net carcass, liver, giblets and total edible parts significantly (P<0.05) increased, while abdominal fat, GIT, stomach and caecum percentages significantly (P<0.05) decreased only in OLE3 and OLE4. However, percentages of kidney, heart and small intestine were not affected by treatment (Table 3). Similar results were observed by Shafey *et al.* (2013), who showed that the addition of 6.25 g OLE/kg diet of broiler chickens significantly (P<0.05) reduced carcass abdominal fat when compared with those of the control.

Concerning the chemical composition of rabbit meat, results in Table (3) showed significant (P<0.05) increase in CP and significant decrease in EE by supplementing OLE at levels of 1.0 and 1.5 ml/kg. It is worthy noting that reducing EE percentage in rabbit meat as affected by OLE treatment is parallel with decreasing abdominal fat percentage in the carcass.

The pH values of stomach, small intestine and caecum contents were not significantly influenced by supplementing PLE in diets, indicating normal conditions of the digestive enzyme secretion and activity.

Blood parameters:

Plasma total proteins, HDL concentrations significantly (P<0.05) increased, while triglycerides, total cholesterol and LDL significantly (P<0.05) decreased by increasing level of OLE in the diet (Table 4). Similarly, Ahmed *et al.* (2017) found that adding oleuropein to layer hen diets (50, 100 and 150 mg/kg) resulted in significant (P<0.01) increase in plasma total proteins. Also, blood lipid profile (decreasing triglycerides, total cholesterol and LDL) significantly (P<0.01) improved compared with the unsupplied group. Moreover, Erener *et al.* (2009) observed decreases in plasma cholesterol concentration of broiler fed OLE diet. Sarica and Topbas (2014) demonstrated decrement of the concentrations of serum and hepatic triglycerides and hypo-cholesterolemic activities.

It is of interest to note that the observed reduction in abdominal fat and meat fat percentages (Table 3) may be due to improving lipid profile as affected by OLE treatment (Table 4).

Table (3). Effect of dietary olive leaves extract on carcass, pH and meat quality traits of growing rabbits.

Parameter	OLE1	OLE2	OLE3	OLE4	SEM	P-value
Net carcass weight %	48.6^{b}	49.8^{b}	51.2^{a}	51.9^{a}	0.384	0.0025
Liver weight %	2.96^{b}	3.18^{ab}	3.41^{a}	3.53^{a}	0.130	0.0251
Kidney weight %	0.51	0.53	0.56	0.57	0.039	0.6241
Heart weight %	0.36	0.37	0.37	0.39	0.014	0.3360
Giblets weight %	3.83^{c}	4.08^{bc}	4.34^{ab}	4.49^{a}	0.108	0.0032
Total edible parts weight %	52.5^{c}	53.9^{b}	55.6^{a}	56.4^{a}	0.319	0.0006
Abdominal fat weight %	1.60^{a}	1.43^{ab}	1.15^{b}	1.05^{b}	0.077	0.0309
Gastrointestinal tract weight %	24.1^{a}	22.8^{a}	20.7^{b}	19.9^{b}	0.310	0.0002
Stomach weight %	4.72^{a}	4.14^{ab}	3.89^{b}	3.63^{b}	0.205	0.0534
Small intestine weight %	3.42	3.20	3.05	2.99	0.061	0.1904
Caecum weight %	4.76^{a}	4.33^{ab}	4.16^{b}	4.09^{b}	0.147	0.0460
pH value:						
Stomach	3.20	3.17	3.23	3.63	0.219	0.7822
Small intestine	7.70	7.57	7.50	7.70	0.153	0.7206
Caecum	7.00	7.27	7.13	7.23	0.167	0.8917
Meat chemical composition (%):						
Moisture	75.2	75.0	74.4	74.3	0.322	0.1637
Ash	1.42	1.40	1.36	1.34	0.038	0.5512
CP	19.9^{b}	20.2^{ab}	21.0^{a}	21.2^{a}	0.282	0.0527
EE	3.44^{a}	3.39^{a}	3.27^{ab}	3.19^{b}	0.053	0.0302

a, b, c, Means in the same row with different superscripts are significantly different (P<0.05), SEM = Standard error of means.

Table (4). Effect of dietary olive leaves extract on some metabolites blood of growing rabbits.

Nutrient	OLE1	OLE2	OLE3	OLE4	SEM	P-value
Total protein (g/dl)	5.29^{b}	5.62^{ab}	5.86^{a}	5.96^{a}	0.117	0.0184
Triglycerides (mg/dl)	95.1^{a}	93.1^{ab}	91.4^{bc}	90.1^{c}	0.774	0.0102
Total cholesterol (mg/dl)	75.4^{a}	73.7^{a}	71.7^{b}	70.6^{b}	0.581	0.0008
HDL (mg/dl)	32.7^{b}	33.2^{b}	35.1^{a}	35.3^{a}	0.394	0.0014
LDL (mg/dl)	31.8^{a}	31.0^{ab}	30.2^{b}	29.7^{b}	0.449	0.0292
TAC (mmol/ L)$^{(1)}$	1.12^{b}	1.19^{b}	1.35^{b}	1.68^{a}	0.071	0.0024
MDA (µmol/ ml)$^{(2)}$	1.32^{a}	1.22^{ab}	1.16^{ab}	1.04^{b}	0.053	0.0480

SEM = Standard error of means,
a, b, c, Means in the same row with different superscripts are significantly different (P<0.05).
(1) TAC=total antioxidants capacity,
(2) MDA= malondialdehyde

Most of the phenolic compounds (oleuropein, verbascoside, flavones flavones, flavonols, flavan-3-ols and substitued phenols) in OLE have been shown to possess hypo-cholesterolaemic activities due to lowering the concentrations of blood and hepatic triglyceride and altering the metabolism of cholesterol (Romani *et al.,* 1999). The mechanism of this hypo-cholesterolaemic action may be due to the inhibition of dietary cholesterol absorption in the small intestine or its production by liver and/or stimulation of the biliary secretion of cholesterol and cholesterol excretion in the feces (Rezar *et al.,* 2015). Oleuropein in OLE contain phenolic compounds, which have been shown to possess hypo-cholesterolaemic activities (Sarica and Topbas, 2014). These compounds are known to provide a protective effect against the oxidation of low-density lipoproteins (LDL), which are involved in the development of atherosclerosis. The hydroxytyrosol and oleuropein found in olive leaves are known to prevent LDL oxidation and to inhibit 3-hydroxy-3-methyglutaryl coenzyme A – an enzyme that plays an important role in cholesterol synthesis. These properties of hydroxytyrosol and oleuropein might have contributed to the decreases in plasma cholesterol levels (Patrick and Uzick, 2001). These compounds are known to provide a protective effect against the oxidation of low-density lipoproteins (LDL), which are involved in the development of atherosclerosis and cardiovascular diseases. The hydroxytyrosol and oleuropein found in olive leaves are known to prevent LDL

oxidation and to inhibit 3-hydroxy-3-methyglutaryl coenzyme A – an enzyme that plays an important role in cholesterol synthesis (Cayan and Erener, 2015).

Regard to antioxidant system (Table 4), total antioxidant capacity significantly (P<0.05) increased, while malondialdehyde (MDA) significantly (P<0.05) decreased by increasing OLE level in diet up to 1.5 ml/kg (OLE4).In agreement with the obtained results, Ahmed *et al.* (2017) found that adding oleuropein to layer hen diets (50, 100 and 150 mg/kg) resulted in significant (P<0.01) improvement in superoxide dismutase (SOD) and total antioxidant capacity (TAC), while MDA concentration significantly decreased. Also, Jemai *et al.* (2008) reported that olive leaf or OLE are a source of many phytochemicals that are considered as potential sources of antioxidant. According to Hayes *et al.* (2011), phenolic compounds in the OLE are considered as a free radical scavenger by breaking the free radical chain reaction.

Blood hematological values:

Hematological parameters, including hemoglobin (Hb) concentration, package cell volume (PCV) and count of platelets significantly (P<0.05) increased, while WBCs count and percentages of neutrophils and lymphocytes significantly (P<0.05) decreased in OLE 3 and OLE4 as compared to control (OLE1). However, count of red blood cells (RBCs) and white blood cells (WBCs),and percentages of monocytes, basophils and eosinophils were not influenced by the different dietary OLE (Table 5).

Table (5). Effect of dietary olive leaves extract on some blood hematology traits of growing rabbits.

Parameter	OLE1	OLE2	OLE3	OLE4	SEM	P-value
Hemoglobin (g/ dl)	11.2^{b}	11.9^{ab}	12.7^{a}	12.9^{a}	0.296	0.0364
PCV (%)	35.7^{b}	36.9^{ab}	37.8^{a}	37.9^{a}	0.404	0.0521
RBCs ($x10^{6}$/ µl)	5.61	5.60	6.19	6.15	0.257	0.2755
Platelets ($x10^{3}$/ µl)	318.7^{b}	356.3^{b}	418.3^{a}	422.0^{a}	15.59	0.0112
WBCs ($x10^{3}$/ µl)	8.37^{a}	7.23^{ab}	6.37^{b}	6.35^{b}	0.524	0.0508
Neutrophils (%)	34.3^{a}	33.7^{a}	32.3^{b}	31.5^{b}	0.333	0.0010
Lymphocytes (%)	59.7^{a}	59.0^{ab}	57.7^{bc}	56.5^{c}	0.577	0.0081
Monocytes (%)	3.33	3.33	5.00	5.33	0.881	0.2421
Basophils (%)	1.67	2.67	3.33	4.33	0.667	0.1062
Eosinophils (%)	1.00	1.33	1.67	2.33	0.333	0.2011

SEM = Standard error of means,
a, b, c, Means in the same row with different superscripts are significantly different (P<0.05).

Concentration of Hb obtained were generally fall within normal range (9.4 -17.4) for rabbits (Ross *et al.*, 1979; Mitruka and Rawnsley, 1997). The PCV is an index of toxicity and its distribution vary with breeds. Reduction in the concentration of PCV in the blood may suggest the presence of a toxic factor (e.g. haemagglutinin) which had adverse effect on blood formation (Oyawole and Ogunkunle, 1998).

High WBCs count is usually associated with microbial infection, the presence of foreign body or antigen (Ahamefule *et al.*, 2008). The total may be increased by 15 to 30% in rabbits under stress conditions (Campbell *et al.*, 2004; Poljičak-Milas *et al.*, 2009).

These results may indicate positive effects of OLE treatment on hematological parameters and the impact on liver and spleen function, as well as, other tissues like bone marrow, where RBCs are synthesized (Feldman *et al.*, 2000).

Economic efficiency:

Data in Table (6) Revealed that total feed cost increased by supplementing OLE in diets, as a result of increasing of average feed intake and OLE cost. Also, net selling price increased in OLE3 and OLE4 due to increasing weight gain and viability rate as compared to OLE1 and OLE2. The same trend was found in the net revenue and relative revenue. The best value of relative revenue was found in the rabbits fed diet supplemented with 1.5 ml OLE/kg (133.7%), followed by those in OLE3 (122.9%), but the poorest value was recorded in control (100%).

Table (6). Effect of dietary olive leaves extract on economical study.

Parameter	OLE1	OLE2	OLE3	OLE4
Average feed intake (kg /head)	4.898	4.951	4.995	5.044
Price /kg diet (L.E.)	4.65	4.68	4.71	4.74
Total feed cost (L.E.)	22.78	23.17	23.53	23.91
Average weight gain (kg/head)	1.390	1.433	1.495	1.578
Selling price (L.E.)(1)	48.65	50.16	52.33	55.23
Viability rate	95	95	100	100
Net selling price (L.E.)	46.21	47.65	52.33	55.23
Net revenue (L.E.)(2)	23.43	24.49	28.80	31.32
Relative revenue (%)	100	104.5	122.9	133.7

Other conditions like management are fixed.
- Ingredients price (L.E. per ton) at 2019 were: 4500 barley; 2700 berseem hay; 4000 wheat bran; 8000 soybean meal (44%); 500 limestone; 12000 premix; 60000 methionine; 1000 di-calcium phosphate; 3000 molasses; 1000 salt.
- Adding 200 L.E. /ton for pelliting.
(1) Price of kg live body weight was 35 L.E.
(2) Net revenue = Selling price – total feed cost

Therefore, based on the foregoing results, olive leaves extract could be successfully incorporated into the diet of growing rabbits up to 1.5 ml/ kg diet, in terms of improved production performance alleviation of post-weaning stress with high profitability, under Egyptian environmental conditions.

REFERENCES

Ahamefule, F.O.; Obua, B.E.; Ukweni, I.A.; Oguike, M.A. and Amaka, R.A. (2008). Haematological and biochemical profile of weaning rabbits fed raw or processed pigeon pea seed meal based diets. African J. Agricul. Res., 3(4): 315-319.

Ahmed, M.M.; El-Saadany, A.S.; Shreif, E.Y. and El-Barbary A.M. (2017). Effect of dietary olive leaves extract (oleuropein) supplementation on productive, physiological and immunological parameters in bandarah chickens 2- during production period. Egypt. Poult. Sci., 37(I): 277-292.

Aliabadi, M.A.; Darsanaki, R.K.; Rokhi, M.L.; Nourbakhsh, M. and Raeisi, G, (2012). Antimicrobial activity of olive leaf aqueous extract. Annals of Biological Research, 3(8): 4189-4191.

A.O.A.C. (2005). Association of Official Analytical Chemists. Official methods of analysis. 18th Ed. Published by the AOAC, Washington, D. C., USA.

Aziz, N.H.; Farag, S.F.; Mousa, L.A. and Abo-Zaid, M.A. (1998). Comparative antibacterial and antifungal effects of some phenolic compounds. Microbios., 93: 43–54.

Bahsi, M.; Çiftci, M.; Şimsek, Ü.G.; Azman, M.A., Özdemir, G.; Yilmaz, Ö. and Dalkilic, B. (2016). Effects of olive leaf extract (oleuropein) on performance, fatty acid levels of breast muscle and some blood parameters in Japanese quail (Coturnix coturnix Japonica) reared in different stocking densities. Ankara. Üniv. Vet. Fak. Derg., 63: 61-68.

Blasco, A.; Ouhayoun, J. and Masoero, G. (1993). Hormonization of criteria and terminology in rabbit meat research. World Rabbit Sci., 1(1): 1-10.

Burnett, N.; Mathura, K.; Metivier, K.S.; Holder, R.B.; Brown, G. and Campbell, M. (2006). An investigation into haematological and serum chemistry parameters of rabbits in Trinidad. World Rabbit Sci., 14: 175 – 187.

Campbell, T.W. (2004). Mammalian hematology: Laboratory animals and miscellaneous species. *In:* Thrall MA: Veterinary Hematology and Clinical Chemistry, 1st ed, Lippincott Williams and Wilkins, pp. 211-224.

Cayan, H. and Erener, G. (2015). Effect of olive leaf (*Olea europaea*) powder on laying hens performance, egg quality and egg yolk cholesterol levels. Asian Australas. J. Anim. Sci., 28: 538-543.

De Blas, J.C. and Mateos, G.G. (1998). Feed Formulation. In: De Blas C., Wiseman J. (Eds). The Nutrition of the Rabbit. CABI Publishing. CAB International, Wallingford Oxon, UK, 241-253.

Drew, P.; Harles, C.R.J.S.; Trevor, B. and John, L. (2004). Oxford Handbook of Clinical Haematology. 2th Edition, Oxford University Press, USA.

Dub, A.M. and Dugani, A.M. (2013). Antithrombotic effect of repeated doses of the ethanolic extract of local olive (Olea europaea L.) leaves in rabbits. Libyan J. Med., 8: 1-6.

Duncan, D.B. (1955). Multiple range and multiple F-Test, Biometrics, 11: 1-42.

El-Damrawy, S.Z.; Khalifah, M.M.; and Fares, W.A. (2013). Dietary olive leaf and antioxidant status in chickens performance, some physiological treats and immunological response of Mandarah chicks supplemented olive leaves powder in their diets. Egypt. Poult. Sci., 33: 279-287.

Erener, G.; Ocak, N.; Oztürk, E.; Cankaya, S. and Özkanca, R. (2009). The Effects of olive leaf extract on performance, some blood parameters and cecal microflora of broilers.Food Chemistry, 93: 197–204.

Feldman, B.F., Zinkl, J.G. and Jain, N.C. (2000). Schalm's Veterinary Hematology. Lippincott Williams and Wilkins, Philadelphia, USA.

Hayes, J.E.; Allen, P.; Brunton, N.; O'Grady, M.N. and Kerry, J.P. (2011). Phenolic composition and in vitro antioxidant capacity of four commercial phytochemical products: olive leaf extract (*Olea europaea* L.) lutein, sesamol and ellagic acid. Food Chemistry, 126: 948–955.

Huang, S.L.; Zhang, L.; Huang, P.L.; Chang, Y.T. and Huang, P.L. (2003). Anti-HIV activity of olive leaf extract (OLE) and modulation of host cell gene expression by HIV-1 infection and OLE treatment. Biochemical and Biophysical Research Communications, 307(4): 1029-1037.

Jemai, H.; Bouaziz, M.; Fki, I.; El Feki, A. and Sayadi, S. (2008). Hypolipidimic and antioxidant activities of oleuropein and its hydrolysis derivative-rich extracts from Chemlali olive leaves. Chemico-Biological Interaction, 176: 88–98.

Juven, B.; Henis, Y. and Jacoby, B. (1972). Studies on the mechanism of the antimicrobial action of oleuropein. Journal of Applied Bacteriology, 35(4): 559–567.

Korukluoglu, M.; Sahan, Y.; Yigit, A.; Ozer, E.T. and Gucer, S. (2010). Antibacterial activity and chemical constitutions of Oleaeuropaea L. leaf extracts. Journal of Food Processing and Preservation, 34: 383-396.

Markin, D.; Duek, L. and Berdicevsky, I. (2003). *In vitro* antimicrobial activity of olive leaves. Mycoses, 46: 132–136.

Mitruka, B.M.; Rawsley, H.M. (1997). Clinical, biochemical and haematological reference value in normal experimental animal. Mason publishing company New York, pp. 35 – 50.

North, M.O. (1981). Commercial Chicken. Production Annual. 2nd Edition, Production 6th Ed. Interstate Printers and Publishers. INC., USA.

Oke, O.E.; Emeshili, U.K.; Iyasere, O.S.; Abioja, M.O.; Daramola, J.O.; Ladokun, A.O.; Abiona, J.A.; Williams, T.J.; Rahman, S.A.; Rotimi, S.O.; Balogun, S.I. and Adejuyigbe, A.E. (2017). Physiological responses and performance of broiler chickens offered olive leaf extract under a hot humid tropical climate. J. Appl. Poult. Res., 26: 376-382.

Oyawoye, E.O. and Ogunkunle, M. (1998). Physiological and biochemical effects of raw jack beans on broilers. Proceedings of annual Conference of Nigerian Society Anim. Prod., 23: 141-142.

Patrick, L. and Uzick., M. (2001). Cardiovascular disease: C-reactive protein and the inflammatory disease paradigm: HMG-CoA reductase inhibitors, alpha-tocopherol, red yeast rice, and olive oil polyphenols. A review of the literature. Altern. Med. Rev., 6: 248-271.

Periera, A.P.; Ferreira, I.C.; Marcelino, F.; Valentao, P.; Andrade, P.B.; Seabra, R.; Estevinho, L.; Bento, A. and Pereira, J.A. (2007). Phenolic compounds and antimicrobial activity of olive (Olea europaea L. Cv. Cobrancosa) leaves. Molecules, 12(5): 1153-1162.

Poljičak-Milas, N.; Kardum-Skelin, I.; Vuđan, M.; Silvija Marenjak, T.; Ballarin-Perharić, A. and Milas, Z. (2009). Blood cell count analyses and erythrocyte morphometry in New Zealand white rabbits. Veterinarski arhi., 79(6): 561-571.

Raya, A.H.; Abbas, A.M. and Hussein, M.A.A. (1991). Comparative studies on the efficiency of some plant protein sources to replace soybean meal in rations for broiler chicks performance and economic efficiency. J. Agric. Sci., Mansoura Univ., 16: 2514-2527.

Rezar, V.; Levart, A. and Salobir, J. (2015). The effect of olive by products and their extracts on antioxidative status of laying hens and oxidative stability of eggs enriched with n-3 fatty acids. Poljoprivreda, 21: 216-219.

Romani, A.; Mulinacci, N.; Pinelli, P.; Vincieri, F.F. and Cimato, A. (1999). Polyphenolic Olea europaea L. Journal of Agriculture and Food Chemistry, 47: 964–967.

Ross, J.G.; Christies, G., Halliday, W.G.; Jones R.M. (1979). Haematological and blood chemistry comparison values for clinical pathology in poultry. Vet. Record., 102: 29 -31.

Sarica, S. and Toptas, S. (2014). Effects of dietary oleuropein supplementation on growth performance, serum lipid concentrations and lipid oxidation of Japanese quails. J. Anim. Physiol. Anim. Nutr., 98(6): 1176-1186.

SAS Institute, Inc. (2000). SAS User's guide: Statistics. SAS Inst. Inc., Cary, NC, USA.

Shafey, T.M.; Al-Ruqaei, I.M. and Almufarij, S.I. (2013). Effect of feeding olive leaves extract (Oleuropein) on the performance, nutrient utilization, small intestine and carcass characteristics of broiler chickens. Journal of Animal and Veterinary Advances, 12(6): 740-746.

Sudjana, A.N.; D'Orazio, C.; Ryan, V.; Rasool, N.; Ng, J.; Islam, N.; Riley, T.V.; and Hammer, K.A. (2009). Antimicrobial activity of commercial Olea europaea (olive) leaf extract. Int J Antimicrob Agents. 33: 461–463.

Wenk, C. (2002). Herbs, botanicals and other related substances. WPSA-Bremen. Germany.

تأثير اضافة مستخلص أوراق الزيتون الى علائق الأرانب النامية على الاداء الانتاجى وقياسات الدم وصفات الذبيحة.

جورج عزت يونان و منال سعود محمد و وائل عوض محمود مرسى

معهد بحوث الإنتاج الحيواني- مركز البحوث الزراعية- الدقي- مصر.

تهدف الدراسة الحالية الي تقييم اضافة مستويات مختلفة من المستخلص الكحولى لأوراق الزيتون (ايثانول) فى العليقه على الاداء الانتاجى وقياسات الدم وصفات الذبيحة والتركيب الكيماوى للحم والكفاءة الاقتصادية للارانب النامية، تم تقسيم عدد 80 من الأرانب الأبرى عمر خمسة أسابيع إلى أربعة مجاميع متماثلة، 20 أرنب في كل منها بمتوسط وزن 7.82±562 جرام. تم تغذيه المجموعة الاولي على عليقه متكامله (17,75٪ بروتين خام و 2500 كيلو كالوري طاقة مهضومة /كجم علف) دون أي اضافات، في حين تم تغذية المجموعات الثانية والثالثة والرابعة على نفس العليقه للمجموعه الأولى مضافا إليها مستخلص أوراق الزيتون على مستويات 0.5 ، 1.0 ، 1.5 مل/كجم عليقه على التوالي. أظهرت الدراسه النتائج الأتيه:

1- الارانب المغذاه على 1.5 مل مستخلص أوراق الزيتون لكل كيلوجرام علف سجلت معنويا أعلى وزن جسم نهائى (2143 جرام) يليها تلك المغذاه على 1 مل مستخلص أوراق الزيتون لكل كيلوجرام علف (2056 جرام) بينما تلك المغذاه على العليقة الكنترول سجلت معنويا أقل وزن جسم نهائى (1952 جرام) والتى لم تختلف معنويا عن تلك المغذاه على 0.5 مل مستخلص أوراق الزيتون لكل كيلوجرام علف (1993 جرام).

2- عدم وجود اختلافات معنوية فى العلف المستهلك (جرام/ يوم/ أرنب) نتيجة استخدام مستخلص أوراق الزيتون فى العليقة.

3- لوحظ تحسن معنوى فى معدل التحويل الغذائى بزيادة مستوى مستخلص أوراق الزيتون فى العلائق.

4- لم تسجل الأرانب المغذاة على المستويات المرتفعة من مستخلص أوراق الزيتون (1.5 و 1.0 مل لكل كيلوجرام علف) اى نفوق مقارنة بتلك المغذاة على العليقة الكنترول أو المضاف اليها 0.5 مل لكل كيلوجرام علف (5%).

5- تحسنت بشكل معنوى نسبة تصافى الذبيحة بزيادة مستوى مستخلص أوراق الزيتون فى العليقة.

6- سجلت الأرانب المغذاة على 1.5 مل مستخلص أوراق الزيتون لكل كيوجرام علف أعلى عائد اقتصادى نسبى (133.7%) يليها تلك المغذاة على 1.0 مل مستخلص أوراق الزيتون لكل كيوجرام علف (122.9%) بينما سجلت الارانب المغذاة على العليقة الكنترول أقل عائد اقتصادى نسبى (100%).

خلصت الدراسه المقدمه الى أن اضافة مستخلص أوراق الزيتون الى عليقة الأرانب النامية بمعدل 1 و 1.5 مل لكل كيلوجرام علف يحسن من الاداء الانتاجى خلال فترة النمو.