

Evaluation of Olive-Derived (Powder, Extract and Oil) Supplements on Growth Dynamics, Carcass Traits and Meat's Nutritional Profile in Broilers

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Abstract

Background: The growing demand for sustainable poultry production has led to the exploration of natural feed additives that enhance growth performance and improve meat quality. Olive-derived products, known for their bioactive compounds and health benefits, have gained attention in the poultry industry. Olive leaves powder (OLP), olive leaves extract (OLE) and olive seed's oil (OSO) are rich in antioxidants, polyphenols and essential fatty acids, which may positively influence broiler growth, carcass traits and nutritional composition of meat. Understanding the effects of these supplements can contribute to developing more efficient and health-oriented poultry feeding strategies. This study evaluated the effects of olive leaf powder (OLP), olive leaf extract (OLE) and olive seed oil (OSO) on growth dynamics, carcass features and meat quality in broiler chickens. A total of 300 broilers were allocated to 4 groups: a control (basal diet) and three treatment groups receiving olive leaf powder (OLP) (0.5%) and olive seed oil (OSO) (1%) or olive leaf extract (OLE) (1.5%) with three replicates with 30 birds each for six weeks with one-way analysis of variance (ANOVA) under completely randomized design (CRD). **Findings:** Results showed that olive leaves powder (OLP), olive leaves extract (OLE) and olive seed's oil (OSO) supplementation significantly improved body weight, feed intake and feed conversion ratio compared to the control ($P < 0.05$). Additionally, olive leaf powder (OLP) and olive leaf extract (OLE) reduced abdominal fat pad (AFP) content, while olive leaf powder (OLP) increased breast meat crude protein and all treatments lowered breast meat fat content ($P < 0.05$). **Conclusion:** These findings suggest that olive-derived supplements can enhance growth, carcass characteristics and meat quality in broilers.

Keywords: day old broiler; carcass traits; growth dynamics; meat's quality; olive-derived supplements

Introduction

Recent data from the Food and Agriculture Organization (FAO) of the United Nations indicates an outstanding rise in the global production of poultry meat (Sadiq et al. 2023). Originating from wild birds of the jungle fowl, the modern broiler chicken has effectively adapted to its environment. A meat type chicken that was 5-7 weeks old was produced in the 20th century appreciations to advancements in science and technology (Hrnick et al. 1995). Over fifty years have seen the selective selection of recent broiler strains for high meat production and body weight gain (Bulfield et al. 1988). The price of feed poultry is a major issue for the industry of poultry; because it varies from 65-75% of the total cost of production in industrialized and developing nations, respectively (Thackie and

Flenscher 1995). Nutritionists that specialize in poultry raise emphasis on the necessity of alternative feed ingredients and supplements that go beyond social, agricultural and manufacturing methods (Ravindran and Blair 1991). To address waste from the manufacture of olives, nutritionists working with poultry can use olive leaves, an agricultural byproduct of fruit harvesting, as a substitute feed component (Pertinez et al. 1988). Research reveals that, the secondary metabolites found in plants not only improve physiological parameters but also improve animal yield quality, productivity and health (Surai 2014). The olive leaves herbal extract as complex mixture usually derives from the various parts of the olive tree like leaves, flowers, fruits, woods and seeds in specific conditions as important traditional medicine product (Vinatoru 2001). A

wide variety of plants, including olive leaves, have various bioactive compounds; the liquid extract from the leaves of olive is brown and tastes bitter (Simona et al. 2018). Olive fruits and leaves possess antibacterial, antioxidant, anti-inflammatory, anti-thrombotic, anti-atherogenic and anti-hypertensive properties (Obeid et al. 2005). The olive leaf extract contains many kinds of phenolic chemicals, including rutin, phenolic alcohol, phenolic acid, oleuropein and flavonoids (Rigane et al. 2012). Oleuropein is the primary class of phenolic chemicals, not any other kind. Antimicrobial, antiviral (including against HIV), anti-atherogenic, anti-hypertensive, anti-inflammatory and cardio protective properties are all existed in oleuropein (Lee-Haung et al. 2003). Additionally, olive leaves extract improves immunological function (Gonzalez et al. 1992), lowers fat (Jemai 2008) and lowers blood cholesterol values (Fki et al. 2005). Products that are considered poultry sanitary are characterized by lower levels of fat, salt and various food additives and preservatives. Due to its oxidative stability, physical, chemical and sensory qualities, olive leaf extract has previously utilized in broiler feed to preserve the frozen meat quality of the broiler (Marangoni et al. 2017). Phenolic compounds that are extracted from olive leaves function as scavengers to neutralize free radicals (Lee 2010). Additionally, olive leaves extract can enhance broiler product's quality and shelf life (Hayes et al. 2011). In Addition, OLE can utilize in treatment of the diseases such as Hypertonia, Arteriosclerosis, gout, Hyperglycemia, diabetes mellitus, arthritis, fever (Azzawie et al. 2006) and hypotensive (Khayal et al. 2002). Due to the fact that, fat oxidation and microbiological growth are the primary issues with broiler products during storage, the poultry industry has employed anti-oxidant and anti-microbial chemicals. Natural antioxidants are replacing as synthetic ones on a large scale these days, such as butyl Hydroxy anisole, butyl hydroxyl toluene and tertiary butyl hydroxyl Quinone (Botsoglou et al. 2010).

Afghanistan's intensive poultry industry is undeveloped because of dependence on foreign chicken strains and imported feed materials like soybean, maize and mineral-vitamin complexes. In fact, the country industry is threatened by the worldwide pricing instability of these feed ingredients, which also favors unofficial activities that are less regulated by public institutions. In Afghanistan, there is a growing trend of using

leftover veterinary drugs like antibiotics, anticoccidials and vaccines as growth boosters or as a prophylactic against a range of bacterial, protozoal and viral illnesses. Alternative growth promoters such as bioactive secondary metabolites are being used in place of antibiotics in animal and poultry feeding due to their prohibition (Rafiq et al. 2022). There are non-therapeutic alternatives for a wide range of medical diseases, including immune stimulants, enzymes, inorganic acids, probiotics, prebiotics, botanicals and other management techniques (Huyghebaert 2005). It is hypothesized that the OLP dietary supplementation is expected to exert beneficial effects on growing broiler. The purpose of this study was to evaluate the effects of feed supplements containing olive leaves powder (OLP), olive leaves extract (OLE) and olive seed's oil (OSO) on broiler chicken growth performance, abdominal fat pad, carcass traits and meat's nutritional composition.

Materials and Method

Study Area

The experiment was conducted at the Animal Production Department's Poultry Research Farm of the Veterinary Science faculty, University of Nangarhar, Jalalabad, Afghanistan. Jalalabad is located at 34° 25' 0N (Latitude: 34.4303, and 70° 27' 10E (Longitude: 70.4528) and with an altitude of 826 m (2710 ft). This city experiences normally hot and humid tropical climate with temperature ranging from 3 °C in winter to +35 °C in summer.

Ethical approval

Entirely experimental procedures involving animals were conducted in accordance with the institutional Care strategies of Nangarhar University, Jalalabad, Afghanistan. Chickens were cared for using husbandry guidelines and standard operating procedures of broiler chickens and approved by the ethics committee of Nangarhar University, Afghanistan via letter No. 459.

Experimental birds and husbandry

A commercial broiler hatchery located in Jalalabad, Afghanistan, sold 300-day old chicks (DOC) (unsexed Ross 308, with body weight of 38.40±0.80 g). day-old chicks were divided into 3 groups (T1, T2 and T3) under completely randomized design (CRD). Each group has three replicates with 30 birds each while control fed with basal diet has 30 chicks only (Table 1). The atmospheric floor system (with a depth of 8-10 cm bedding material made of rice husk with a stocking density 2.22 m² /bird was applied to house the chickens. The first twenty-four



hours were spent completely lit, followed by an hour of darkness the next day. Feed and water were always freely available during all experiment trials. As a result, starter feed (1 – 21 days) and finisher feed (22-42 days) were created in pellet form recommended by (NRC 1994). Feed was made into mash and the chicks had free access to both water and feed at all times during the experiments Table 2. When the participants attained a body weight of 100-150 g, the light was switched off for six hours, during which time the lighting density was regulated (20-40 Lux). Temperature (°C) and humidity were managed on a weekly basis as follows: 33 °C and 40% relative humidity (RH) for the first week, 30 °C and 50% relative humidity (RH) for the second, 27 °C and 50% relative humidity (RH) for the third, 24 °C and 50% relative humidity (RH) for the fourth and 21 °C and 60% relative humidity (RH) for the fifth and sixth weeks. Vaccination against Newcastle disease virus (NDV) was done at day 6th (Lasota strain, Nobilis®ND Clone 30), against infectious bursal disease (IBD, D 78, Salvoy, USA) at day 12th and Newcastle disease (ND) live vaccine intraocular 0.3 mL each at day 20th Newcastle disease live vaccine.

Preparation of the supplements

Olive leaves were collected from olive trees (*Olea europaea*) of Batikot District olive farm, Nangarhar Province, Afghanistan. The olive oil was extracted from olive seeds at olive processing plant, Nangarhar, Afghanistan. Firstly, olive leaves (OL) were washed into clean water to remove dust. After washing washed with distal water, olive leaves (OL) were dried by spreading in clean shadow environment on drying hygienic floor and exposing directly to atmosphere and natural air circulation at 20-25 °C for ten days. After that, dried olive leaves (OL) were ground to become 1 mm olive leaves powder (OLP) by specific grinder Moline M-06, Italy (Qasem et al. 2013). Finally, The OLP 100 g was poured into 1-liter distal water then gives heat treatment to it around 90 °C for 70 minutes then olive leaves extract was immediately filtrated store at 4°C degree (Altiok et al. 2008). Samples of the OL was analyzed for moisture content and dry matter (DM) were measured by drying the sample at 105 °C to stable weight, Crude Protein (CP) content by Kjeldhal method and Fat content (EE) by Soxhlet method. While, Ash content was detected by muffle furnace at 550 °C (AOAC 2011), crude fiber (CF) was measured by drying the sample (W0) in an oven for 1 hour at 150 °C (W1) followed by putting in

muffle furnace at 550 °C about 4 hours (W2) and crude fiber (CF) was calculated as $CF = W1 - W2 \div W0 \times 100$ (AOAC 2011). $NFE = 100 - (Moisture + CP + EE + Ash + CF)$ (AOAC 2011). The nutrients composition of olive leave analyzed as percentage base by the method of (AACC 2000), moisture (9%), dry matter (91%), crude protein (8.5%), crude fat (4.5%), crude fiber (14%), crude ash (9.5%) and nitrogen free extract (54.5%).

Parameters evaluated

Growth dynamics, carcass traits and abdominal fat pad

Data were recorded for growth performance per each pen in terms of live body weight (LBW/g), body weight gain (BWG/g), feed intake (FI/g) and feed conversion ratio (FCR) were measured on weekly basis. Before the measuring of carcass traits all treatments of the experiment were hungered pre sacrificing around 10 hours. At the end of trial (42th day) 5 birds were randomly selected per replicate (having similar body weight) to sacrifice and slaughtering weight (g), dressing weight (g), carcass weight (g), breast, thigh, drumstick, back, wing, organ meats (liver, gizzard, heart) and abdominal fat pad by sensitive (1 mg) electric balance (Jones, 1984). Abdominal fat was manually cut by sharp scissors from individual carcass and weighted.

Breast meat nutritional components analysis

Breast meat sample 100 g was taken in sterile polyethylene plastic bags then store it in (10-20 °C) for the proximate analysis from 5 birds/replicate at final day of trial. Moisture content and dry matter (DM) were measured by drying the sample at 105 °C to stable weight (AOAC 2011), Crude Protein (CP) content by Kjeldhal method and Fat content (EE) by Soxhlet method (AOAC 2011), Ash content was detected by muffle furnace at 550 °C (AOAC 2011), CF was measured by drying the sample (W0) in an oven for 1 h at 150 °C (W1) followed by putting in muffle furnace at 55 °C about 4 hours (W2) and crude fiber was calculated as $CF = W1 - W2 \div W0 \times 100$ (AOAC 2011), Energy was measured as $Energy (Kcal) = 9(EE) + 4(CP) + 4(NFE)$, $NFE = 100 - (moisture + CP + EE + Ash + CF)$, pH value was measured by electric pH meter (AOAC 2011).

Statistical analysis

All the data were analyzed with one-way analysis of variance (ANOVA), by followed (Tukey, LSD), and homogeneity of variance test to validate the data. Using Statistical Package for the Social Sciences

(SPSS) software (IBM SPSS Statistics 23 License Authorization Wizard) (SPSS, 23 version). Probability values less than 0.05 were considered significant while using following model.

$$Y_{ij} = \mu + t_i + \Sigma_{ij}$$

Results

Growth dynamics

There was significant difference ($P < 0.05$) in live body weight (LBW/g), feed intake (FI/g), feed conversion ratio (FCR) and body weight gain (BWG/g) between the different experiments (Olive leave powder, olive leave extract and olive seed's oil) and their treatments with control as revealed (Table 3, Table 4 and Table 5). To end of the experiment olive leaves powder supplemented @ of 0.5% w/w, 1% w/w and 1.5% w/w groups, olive leaves extract supplemented @ of 0.5% v/v, 1% v/v & 1.5% v/v groups and olive seed's oil supplemented @ of 0.5% v/w, 1% v/w and 1.5% v/w groups were recorded better live body weight (LBW/g), feed intake (FI/g), feed conversion ratio (FCR) and body weight gain (BWG/g) than control group ($P < 0.05$). There were no significant differences between the treatments of olive leaves powder @ of 0.5 and 1%, olive leaves extract @ of 1 and 1.5% and olive seed's oil @ of 0.5 and 1%, respectively ($P < 0.05$).

Carcass traits

There was a significant difference ($P < 0.05$) in slaughter weight (g), dressing weight (g), carcass weight (g), carcass organs {(breast weight (g), back weight (g), thigh weight (g) and drumstick weight (g)}, gizzard and liver weights (g) between different experimental groups (OLP, OLE & OSO) (Table 6, Table 7 and Table 8). At the final day of study OLP (0.5 and 1%), OLE (1.5%) and OSO supplemented

Where; Y_{ij} = observation of dependent variable documented on i^{th} treatment

μ = Population means; t_i = Effect of i^{th} treatment i.e.

Σ_{ij} = Residual outcome of j^{th} observation in i^{th} treatment $NID \sim 0, \sigma^2$.

groups (1 and 1.5%) had better carcass traits than control group respectively ($P < 0.05$).

Abdominal fat pad

There was significant difference ($P < 0.05$) in Abdominal Fat Pad (AFP) content between the different experimental groups (OLP) and (OLE) except (OSO) with control Table 9 and Figure 1. At the final day of study OLP (0.5 and 1%), OLE (1 and 1.5%) had the lowest value of AFP content compared to OSO and control groups ($P < 0.05$). There was no significant difference between all of OSO treatments (0.5, 1 and 1.5%) and control, respectively ($P > 0.05$).

Nutritional composition of broiler breast

There was no significance difference in terms of OLP ($P > 0.05$) among the treatments (0.5, 1, and 1.5%) and control groups regarding to the moisture, dry matter, crude fiber, energy and pH content. Meanwhile there was significant difference in the value of fat, crude protein (CP) and nitrogen free extract (NFE) among the treatments (0.5, 1 and 1.5%) than control ($P < 0.05$) Table 9. The experimental treatments of OLE (0.5, 1 and 1.5%) were not significantly different than control regarding to the content of crude protein (CP), ash, crude fiber (CF), pH ($P > 0.05$). There was significantly difference was existed for moisture, dry matter (DM), nitrogen free extract (NFE) and energy compared to control ($P < 0.05$) Table 9. The result of olive seed's oil (OSO) for all treatments (0.5, 1 and 1.5%) was also significantly different ($P < 0.05$) compared to control Table 9.

Table 1. Supplementation of olive leaves powder, extract and seed's oil to broiler chicken

Groups	Treatments/birds	Diet + Supplements	Added Level %
Control	T1/30	Basal diet	Nil
Olive Leave Powder	T2/30	OLP	0.5 w/w
	T3/30	OLP	1 w/w
	T4/30	OLP	1.5 w/w
Olive Leave Extract	T5/30	OLE	0.5 v/v
	T6/30	OLE	1 v/v
	T7/30	OLE	1.5 v/v
Olive Seed Oil	T8/30	OSO	0.5 v/w
	T9/30	OSO	1 v/w
	T10/30	OSO	1.5 v/w

⁽³⁰⁾* mean number of birds per treatments. ^(c) mean no recommended supplement.

Table 2. Basal diet ingredients and nutrient levels of Ross (308) broiler chickens

Ingredients %	Starter (1 st - 21 st) day	Grower (22 nd - 42 nd) day
Maize	55%	59%
Soybean meal, *CP 48%	30.5%	28%
Canola meal	4%	3%
Rice polish	3%	3%
Sunflower meal	3%	2%
Flax seed oil	1.5%	2%
Common Salt	0.4%	0.3%
DCP	1.5%	1.5%
Sodium Carbonate	0.3%	0.2%
Mineral-vitamin premix	0.50%	0.50%
DL-methionine	0.15%	0.2%
HCL-lysine	0.15%	0.3%
Total	100%	100%
Nutrients composition		
Metabolizable Energy (kcal/kg)	2,900	3250
CP (%)	22	19.9
EE (%)	4	5
Ash (%)	4	4
CF (%)	4	4.5
Ca (%)	1	0.85

Where CP, EE and CF means crude protein, ether extract and crude fiber, respectively.

Table 3 Broiler's growth performance supplemented with olive leaves powder (1-6 weeks)

Weeks	Parameters	Mean \pm SE (OLP%)			
		Control	0.5%	1%	1.5%
First	LBW (g)	170.66 \pm 0.66 ^a	157 \pm 1.154 ^b	175 \pm 7.637 ^a	145 \pm 2.886 ^b
	FI (g)	163.47 \pm 0.64 ^a	141.54 \pm 1.041 ^b	142.48 \pm 6.21 ^b	139.5 \pm 2.77 ^b
	FCR	0.96 \pm 0.000 ^b	0.90 \pm 0.005 ^c	0.81 \pm 0.000 ^d	0.962 \pm 0.00 ^a
	BWG (g)	114.5 \pm 2.309 ^b	113 \pm 1.154 ^b	127 \pm 1.154 ^a	101 \pm 7.732 ^c
Second	LBW (g)	353.33 \pm 14.52 ^c	419.5 \pm 2.309 ^a	400.3 \pm 2.886 ^a	399.5 \pm 3.464 ^b
	FI (g)	500 \pm 17.32 ^a	503.4 \pm 4.041 ^a	497.6 \pm 1.732 ^a	463.1 \pm 3.983 ^b
	FCR	1.415 \pm 0.010 ^c	1.200 \pm 1.016 ^a	1.243 \pm 0.013 ^a	1.159 \pm 0.000 ^b
	BWG (g)	180 \pm 11.54 ^c	261.85 \pm 5.196 ^a	228 \pm 4.014 ^b	254.5 \pm 2.304 ^a ^b
Third	LBW (g)	750 \pm 11.54 ^b	767.7 \pm 1.732 ^b	883.3 \pm 4.041 ^a	765.75 \pm 2.886 ^b
	FI (g)	1109.33 \pm 11.56 ^b	1147.45 \pm 4.647 ^a	1108.65 \pm 6.841 ^b	1051.15 \pm 5.196 ^c
	FCR	1.479 \pm 0.007 ^a	1.494 \pm 0.002 ^a	1.255 \pm 0.002 ^c	1.372 \pm 0.001 ^b
	BWG (g)	328 \pm 6.928 ^c	348.15 \pm 5.398 ^{bc}	437 \pm 7.505 ^a	366.15 \pm 8.082 ^b
Fourth	LBW (g)	1256 \pm 28.86 ^c	1312 \pm 10.39 ^b	1339 \pm 9.23 ^a	1319.10 \pm 12.6 ^b
	FI (g)	1906 \pm 26.00 ^b	1974.85 \pm 8.74 ^a	1964.3 \pm 14.2 ^a	1904.4 \pm 23.44 ^b
	FCR	1.525 \pm 0.014 ^a	1.505 \pm 0.005 ^a	1.466 \pm 0.000 ^b	1.443 \pm 0.004 ^b
	BWG (g)	500 \pm 23.09 ^b	544.2 \pm 9.122 ^a	501.55 \pm 13.5 ^b	553.35 \pm 10.76 ^a
Fifth	LBW (g)	1750 \pm 28.86 ^c	1912.15 \pm 21.65 ^a	1930 \pm 11.547 ^a	1854 \pm 26.558 ^b
	FI (g)	2711 \pm 22.51 ^b	2979.8 \pm 11.08 ^a	2966.16 \pm 16.47 ^a	2904.9 \pm 7.37 ^a
	FCR	1.549 \pm 0.012 ^a	1.558 \pm 0.011 ^a	1.536 \pm 0.000 ^a	1.567 \pm 0.013 ^a
	BWG (g)	431 \pm 10.96 ^c	600.6 \pm 5.715 ^a	588.65 \pm 6.552 ^a	535 \pm 5.773 ^b
Sixth	LBW (g)	2120 \pm 17.320 ^c	2281 \pm 10.969 ^b	2506.5 \pm 7.794 ^a	2323.5 \pm 9.56 ^b
	FI (g)	40150 \pm 20.207 ^{ab}	4092.66 \pm 10.41 ^b	4177 \pm 7.505 ^a	4175 \pm 11.57 ^a
	FCR	1.957 \pm 0.006 ^a	1.794 \pm 0.004 ^b	1.666 \pm 0.002 ^a	1.796 \pm 0.002 ^b
	BWG (g)	490 \pm 2.886 ^c	579 \pm 3.464 ^a	560 \pm 8.660 ^a ^b	540 \pm 8.660 ^b

^{a, d} Different values in the same row are significantly different (P<0.05).

Where, SE: standard error; OLP: olive leaves powder; LBW: live body weight; FI: feed intake; FCR: feed conversion ratio; feed conversion; and BWG: body weight gain.

Table 4 Broiler, s growth performance supplemented with olive leaves extract (1-6th weeks)

Weeks	Parameters	Mean ± SE (OLE%)			
		Control	0.5%	1%	1.5%
First	LBW (g)	170.66±0.66 ^b	144±3.055 ^c	176.66±6.00 ^b	190±2.886 ^a
	FI (g)	163.47±0.640 ^a	142.6±3.025 ^a	153.22±5.21 ^{ab}	162±2.464 ^a
	FCR	0.96±0.000 ^a	0.990±0.000 ^b	0.990±0.00 ^b	0.871±0.00 ^c
	BWG (g)	114.5±2.309 ^b	100±2.886 ^c	134±2.886 ^a	140±2.886 ^a
Second	LBW (g)	353.33±14.52 ^b	420±1.732 ^a	437±1.732 ^a	435.95±2.886 ^{ab}
	FI (g)	500±17.32 ^b	499±0.585 ^b	530.66±2.603 ^a	533.33±3.756 ^a
	FCR	1.415±0.010 ^a	1.238±0.003 ^b	1.213±0.001 ^b	1.223±0.000 ^b
	BWG (g)	180±11.54 ^b	258.7±1.154 ^a	257.7±1.732 ^a	250.45±2.886 ^a
Third	LBW (g)	750±11.54 ^c	787±4.618 ^b	845±4.04 ^a	842.45±3.521 ^a
	FI (g)	1109.33±11 ^b	1074.35±3.55 ^c	1143.31±5.37 ^a	1147.75±4.474 ^a
	FCR	1.479±0.00 ^a	1.365±0.003 ^b	1.353±0.002 ^b	1.362±0.000 ^b
	BWG (g)	328±6.928 ^c	344.15±3.897 ^b	407.8±7.332 ^a	406.5±13.56 ^a
Fourth	LBW (g)	1256±28.86 ^c	1325.1±11.25 ^b	1388±15.87 ^a	1350.5±20.64 ^a
	FI (g)	1906±26 ^c	1925±17.55 ^b	2002.5±12.70 ^a	2004.5±18.76 ^a
	FCR	1.525±0.014 ^a	1.453±0.010 ^b	1.496±0.002 ^a	1.485±0.005 ^{ab}
	BWG (g)	500±23.09 ^b	536±9.699 ^a	492.7±10.669 ^b	498±13.567 ^b
Fifth	LBW (g)	1750±28.86 ^c	1892±21.939 ^b	1930±17.320 ^a	1890±17.320 ^b
	FI (g)	2711±22.51 ^c	2931±13.85 ^b	3004±9.23 ^a	3010±5.77 ^a
	FCR	1.549±0.012 ^a	1.549±0.010 ^a	1.556±0.009 ^a	1.592±0.011 ^a
	BWG (g)	431±10.96 ^c	566.4±4.965 ^{ab}	584.5±3.175 ^a	549.5±2.020 ^b
Sixth	LBW (g)	2120±17.320 ^c	2281±10.969 ^b	2402.5±15.877 ^a	2421±10.96 ^a
	FI (g)	4015±20.207 ^a	4073.75±14.57 ^a	4016.5±7.621 ^a	4083.9±9.2 ^a
	FCR	1.957±0.006 ^a	1.785±0.002 ^b	1.713±0.008 ^c	1.686±0.00 ^d
	BWG (g)	490±2.886 ^c	555±8.660 ^b	590±5.773 ^a	600±5.773 ^a

a, b different values in the same row are significantly different (P<0.05)

Where; SE: standard error; OLE: olive leaves extract; LBW: live body weight; FI: feed intake; FCR: feed conversion; BWG: body weight gain.

Table 5 Broiler's growth performance supplemented with olive seed's oil (1-6th weeks)

Weeks	Parameters	Mean ± SE (OSO%)			
		Control	0.5%	1%	1.5%
First	LBW (g)	170.66±0.66 ^a	172.66±5.174 ^a	180±2.886 ^a	144.66±3.179 ^b
	FI (g)	163.47±0.640 ^a	144.69±4.336 ^{bc}	153.33±2.459 ^{ab}	136.62±3.003 ^c
	FCR	0.96±0.000 ^a	0.837±0.000 ^c	0.851±0.000 ^c	0.944±0.000 ^b
	BWG (g)	114.5±2.309 ^c	126.5±1.732 ^a	130.5±2.309 ^a	100±2.309 ^d
Second	LBW (g)	353.33±14.52 ^b	418.4±2.309 ^a	414.5±3.464 ^a	381±4.041 ^b
	FI (g)	500±17.32 ^a	486.7±2.309 ^a	500.5±3.214 ^a	471.16±2.603 ^a
	FCR	1.415±0.010 ^a	1.163±0.000 ^d	1.207±0.002 ^c	1.243±0.000 ^b
	BWG (g)	180±11.54 ^b	247.45±1.732 ^a	242.4±1.732 ^a	236±2.309 ^a
Third	LBW (g)	750±11.54 ^b	841.85±4.994 ^a	812.95±4.474 ^a	775.8±2.713 ^b
	FI (g)	1109.33±11.56 ^a	1071.65±5.109 ^b	1104±3.464 ^a	10644±3.521 ^b
	FCR	1.479±0.007 ^a	1.272±0.001 ^c	1.358±0.003 ^b	1.772±0.000 ^b
	BWG (g)	328±6.928 ^c	423.45±15.61 ^a	400.2±12.58 ^{ab}	394.8±9.064 ^b
Fourth	LBW (g)	1256±28.8 ^b	1316±8.08 ^{ab}	1343.4±16.5 ^a	1326.5±19.3 ^{ab}
	FI (g)	1906±21.881 ^a	1914±21.88 ^a	1957±21.881 ^a	1918±21.881 ^a
	FCR	1.525±0.014 ^a	1.454±0.00 ^b	1.457±0.012 ^b	1.446±0.012 ^b
	BWG (g)	500±23.09 ^b	540±14.43 ^a	530.2±14.43 ^a	484.7±8.54 ^c
Fifth	LBW (g)	1750±28.86 ^c	1870±14.433 ^{ab}	1900±11.547 ^a	1804.6±14.664 ^{bc}
	FI (g)	2711±22.5 ^b	2918.45±5.513 ^a	2960±11.54 ^a	2906±10.96 ^a
	FCR	1.549±0.012 ^b	1.560±0.009 ^b	1.557±0.003 ^b	1.610±0.007 ^a
	BWG (g)	431±10.96 ^c	543.5±3.752 ^a	544.15±3.377 ^a	489±3.464 ^b
Sixth	LBW (g)	2120±17.320 ^b	2522.5±15.877 ^a	2255.5±25.69 ^{ab}	2200±11.547 ^b
	FI (g)	40150±20.207 ^a	4095±5.716 ^a	4099±9.23 ^a	4025.55±14.11 ^b
	FCR	1.957±0.006 ^a	1.626±0.007 ^d	1.817±0.016 ^b	1.684±0.002 ^c
	BWG (g)	490±2.886 ^c	650±5.773 ^a	570±2.886 ^b	550±5.773 ^b

^{a, b, c, d} different values in the same row are significantly different (P<0.05)

Where, SE: standard error; OSO: olive seed's oil; LBW: live body weight, FI: feed intake; FCR: feed conversion ratio; and BWG: body weight gain.

Table 6. Carcass traits of broiler with supplementation OLP at the final day 42th of the trail.

Parameters (gr)	Control	Mean \pm SE OLP		
		0.5 %	1 %	1.5 %
Live Body weight	2057.5 \pm 82.7 ^c	2514.50 \pm 34.92 ^a	2606.5 \pm 77.07 ^a	2281.00 \pm 5.196 ^b
Slaughter/weight	1945 \pm 48.89 ^b	2386 \pm 8.082 ^a	2414 \pm 94.979 ^a	2195 \pm 28.86 ^{ab}
Dressing weight	1775 \pm 101.03 ^c	1920 \pm 75.05 ^b	2075 \pm 43.301 ^a	1905 \pm 2.886 ^b
carcass weight	1285 \pm 31.754 ^c	1445 \pm 83.715 ^a	1455 \pm 37.527 ^a	1355 \pm 25.980 ^b
Breast weight	570 \pm 0.577 ^b	781 \pm 0.866 ^a	782.5 \pm 1.443 ^a	592 \pm 1.443 ^b
Back weight	159.5 \pm 1.080 ^b	192.5 \pm 1.080 ^a	189.5 \pm 1.080 ^a	160 \pm 1.080 ^b
Thigh weight	96 \pm 1.914 ^b	121 \pm 1.914 ^a	117 \pm 1.914 ^a	99 \pm 1.914 ^b
Drumstick w	88.5 \pm 1.399 ^b	140 \pm 1.399 ^a	146 \pm 1.399 ^a	86.5 \pm 1.399 ^b
Leg weight	83.5 \pm 2.835 ^a	84 \pm 2.835 ^a	90 \pm 2.835 ^a	85 \pm 2.835 ^a
Gizzard weight	47. \pm 1.136 ^b	65.5 \pm 1.136 ^a	63.5 \pm 1.136 ^a	50 \pm 1.136 ^b
Liver weight	36 \pm 2.327 ^c	44.5 \pm 2.327 ^b	54 \pm 2.327 ^a	38 \pm 2.327 ^c
Head weight	47 \pm 0.978 ^a	46.5 \pm 0.978 ^a	50.5 \pm 0.978 ^a	49.5 \pm 0.978 ^a
Heart Weight	9.5 \pm 1.90 ^a	10.5 \pm 1.190 ^a	11.5 \pm 1.190 ^a	10 \pm 1.190 ^a
wing weight	51.5 \pm 0.866 ^b	51 \pm 0.866 ^b	61 \pm 0.866 ^a	55.5 \pm 0.866 ^b

^{a, b} different values in the same row are significantly different (P < 0.05). where, OLP means olive leaves powder.

Table 7. Carcass traits of broiler with supplementation OLE at the final day 42nd of the trail.

Parameters(gr)	Control	Mean + SE OLE		
		0.5%	1%	1.5%
Live Body weight	2057±82.7 ^c	2281±10.969 ^b	2427.5±102 ^a	2421.5±46.765 ^a
Slaughter/ weight	1945±4889 ^b	2150±28.86 ^{ab}	2210±57.73 ^{ab}	2350±28.860 ^a
Dressing weight	1775±101.03 ^c	1850±28.86 ^{ab}	1990±51.96 ^b	2180±11.54 ^a
carcass weight	1285±31.754 ^c	1405±8.660 ^b	1405±8.660 ^b	1735±31.74 ^a
Breast weight	570±0.577 ^c	645±2.686 ^b	621±12.124 ^b	788±4.041 ^a
Back weight	159.5±1.080 ^b	180±0.288 ^b	181.5±0.288 ^b	195±0.577 ^a
Thigh weight	96±1.914 ^c	100.5±0.288 ^c	113.5±0.288 ^b	120±4.041 ^a
Drumstick weight	88.5±1.399 ^b	90.5±0.288 ^b	92.5±0.288 ^b	113.5±0.288 ^a
Leg weight	83.5±2.835 ^{ab}	91.5±0.288 ^a	88.5±0.288 ^a	86.5±4.562 ^a
Gizzard weight	47.±1.136 ^b	45±0.577 ^b	47±0.577 ^b	56±3.464 ^a
Liver weight	36±2.327 ^b	40.5±0.288 ^b	41.5±0.288 ^{ab}	44.5±2.020 ^a
Head weight	47±0.978 ^a	50.5±0.288 ^{ab}	52±1.154 ^a	52±0.577 ^a
Heart Weight	9.5±1.90 ^a	10.5±0.288 ^a	10.5±0.288 ^a	11.5±1.443 ^a
wing weight	51.5±0.866 ^b	55.5±1.443 ^{ab}	69.5±2.598 ^a	70±4.04 ^a

^{a, b} different values in the same row are significantly different ($P < 0.05$). where, OLE means olive leave extract.

Table 8. Carcass traits of broiler with supplementation OSO at the final day 42nd of the trail

Parameters (gr)	Control	Mean \pm SE OSO		
		0.5 %	1 %	1.5 %
Live Body Weight	2120 \pm 17.320 ^b	2155.5 \pm 25.69 ^b	2522.5 \pm 15.877 ^a	2640 \pm 11.547 ^a
Slaughter/weight	1945 \pm 4889 ^c	2008 \pm 33.484 ^b	2350 \pm 28.867 ^a ^b	2475 \pm 43.301 ^a
Dressing weight	1775 \pm 101.03 ^b	2001.5 \pm 56.869 ^b	1862 \pm 50.680 ^{ab}	2140 \pm 23.094 ^a
Carcass weight	1285 \pm 31.754 ^b	1445 \pm 83.710 ^b	1510 \pm 34.641 ^a	1683.5 \pm 3.752 ^a
Breast weight	570 \pm 0.577 ^b	574 \pm 2.309 ^b	685 \pm 2.868 ^a	630 \pm 5.484 ^a
Back weight	159.5 \pm 1.080 ^d	220 \pm 0.288 ^c	275.5 \pm 0.288 ^a	252.5 \pm 1.443 ^b
Thigh weight	96 \pm 1.914 ^b	131.5 \pm 0.866 ^a	135.5 \pm 0.288 ^a	140.5 \pm 4.330 ^a
Drumstick	88.5 \pm 1.399 ^b	88 \pm 0.577 ^b	101.5 \pm 0.288 ^a	105.5 \pm 2.886 ^a
Leg weight	83.5 \pm 2.835 ^a	90 \pm 0.573 ^a	90.5 \pm 0.577 ^a	91 \pm 1.732 ^a
Gizzard weight	47. \pm 1.136 ^a	52.5 \pm 0.866 ^a	51 \pm 0.288 ^a	50 \pm 3.464 ^a
Liver weight	36 \pm 2.327 ^b	38 \pm 0.577 ^b	40.5 \pm 0.2884 ^{ab}	45 \pm 1.732 ^a
Head weight	47 \pm 0.978 ^a	50 \pm 0.577 ^a	50.6 \pm 0.577 ^a	56.5 \pm 0.288 ^a
Heart Weight	9.5 \pm 1.90 ^a	11.5 \pm 0.288 ^a	10.5 \pm 0.288 ^{ab}	10.4 \pm 0.866 ^a
wing weight	51.5 \pm 0.866 ^c	72 \pm 1.154 ^a	61.5 \pm 0.866 ^b	69.5 \pm 0.288 ^a

^{a, b} different values in the same row are significantly different ($P < 0.05$). where, OSO means olive seed's oil.

Table 9. Breast meat proximate composition with Supplementation OLP, OLE & OSO at final day.

Groups	Parameters	Control %	Mean \pm SE		
			0.5%	1%	1.5%
OLP	MO	69.46 \pm 0.06 ^a	69.1 \pm 0.20 ^a	68.1 \pm 0.20 ^a	67.9 \pm 0.36 ^a
	DM	30.64 \pm 0.06 ^b	30.90 \pm 0.20 ^{ab}	31.99 \pm 0.20 ^a	32.06 \pm 0.36 ^a
	CP	23.55 \pm 0.15 ^b	23.65 \pm 0.64 ^b	24.65 \pm 0.05 ^a	24.12 \pm 0.47 ^a
	EE	2.47 \pm 0.29 ^a	1.45 \pm 0.050 ^b	1.25 \pm 0.05 ^b	1.15 \pm 0.05 ^b
	Ash	0.95 \pm 0.0 ^a	0.87 \pm 0.075 ^a	0.92 \pm 0.02 ^a	1.04 \pm 0.0 ^a
	CF	1.07 \pm 0.08 ^a	1.09 \pm 0.09 ^a	1.06 \pm 0.08 ^a	1.10 \pm 0.0 ^a
	NFE	2.57 \pm 0.09 ^b	3.84 \pm 0.0 ^a	4.11 \pm 0.10 ^a	4.65 \pm 0.1 ^a
	Energy	126.98 \pm 0.15 ^a	123.01 \pm 0.16 ^a	126.29 \pm 0.13 ^a	125.43 \pm 0.08 ^a
	PH	6 \pm 0.10 ^a	5.45 \pm 0.15 ^a	5.20 \pm 0.20 ^a	5.75 \pm 0.15 ^a
OLE	MO	69.64 \pm 0.06 ^b	64.27 \pm 2.23 ^b	65.1 \pm 0.20 ^b	66.85 \pm 0.45 ^b
	DM	30.64 \pm 0.06 ^b	35.03 \pm 2.23 ^a	34.9 \pm 0.20 ^a	33.15 \pm 0.45 ^a
	CP	23.55 \pm 0.15 ^a	23.88 \pm 0.31 ^a	23.68 \pm 0.11 ^a	23.25 \pm 0.65 ^a
	EE	2.47 \pm 0.29 ^a	2.06 \pm 0.07 ^a	0.88 \pm 0.01 ^b	0.70 \pm 0.10 ^b
	Ash	0.95 \pm 0.0 ^a	1.09 \pm 0.10 ^a	0.30 \pm 0.10 ^b	0.30 \pm 0.05 ^a
	CF	1.07 \pm 0.08 ^a	1.01 \pm 0.09 ^a	1.03 \pm 0.08 ^a	1.15 \pm 0.01 ^a
	NFE	2.57 \pm 0.09 ^b	6.99 \pm 0.07 ^a	9.01 \pm 0.08 ^a	7.87 \pm 0.04 ^a
	Energy	126.98 \pm 0.15 ^b	142.02 \pm 0.06 ^a	138.68 \pm 0.03 ^a	130.78 \pm 0.02 ^b
	PH	6 \pm 0.10 ^a	6.30 \pm 0.20 ^a	5.65 \pm 0.05 ^a	5.35 \pm 0.25 ^a
OSO	MO	69.46 \pm 0.06 ^a	64.23 \pm 0.23 ^b	65.20 \pm 0.70 ^b	67.0 \pm 0.53 ^b
	DM	30.64 \pm 0.06 ^c	35.77 \pm 0.23 ^a	34.80 \pm 0.70 ^a	32.97 \pm 0.53 ^b
	CP	23.55 \pm 0.15 ^a	23.56 \pm 1.16 ^a	23.03 \pm 1.05 ^a	23.30 \pm 0.09 ^a
	EE	2.50 \pm 0.29 ^a	2.20 \pm 0.50 ^a	2.10 \pm 0.60 ^b	1.95 \pm 0.26 ^b
	Ash	0.95 \pm 0.0 ^b	2.17 \pm 0.07 ^a	2.20 \pm 0.10 ^a	1.10 \pm 0.05 ^b
	CF	1.07 \pm 0.05 ^a	1.02 \pm 0.07 ^a	1.1 \pm 0.04 ^a	1.0.1 \pm 0.06 ^a
	NFE	2.57 \pm 0.09 ^b	6.82 \pm 0.85 ^a	6.37 \pm 0.10 ^a	6.61 \pm 0.09 ^a
	Energy	126.98 \pm 0.15 ^b	141.32 \pm 0.25 ^a	136.5 \pm 0.19 ^a	137.19 \pm 0.23 ^a
	PH	6 \pm 0.10 ^a	6 \pm 0.10 ^a	6.25 \pm 0.15 ^a	5.7 \pm 0.20 ^a

^{a, b} different values in the same row are significantly different (P <0.05). where, (OLP) olive leaves powder, (OLE) olive leaf extract, (OSO) olive seed's oil, DM (dry matter), CP (crude protein), EE (ether extract), Ash (crude ash), CF (crude fiber), NFE (nitrogen free extract), Energy = (kcal/100 gr), PH (power of hydrogen).

Figure1. A, B & C indicates the figures of OLP, OLE & OSO with control in terms of AFP.

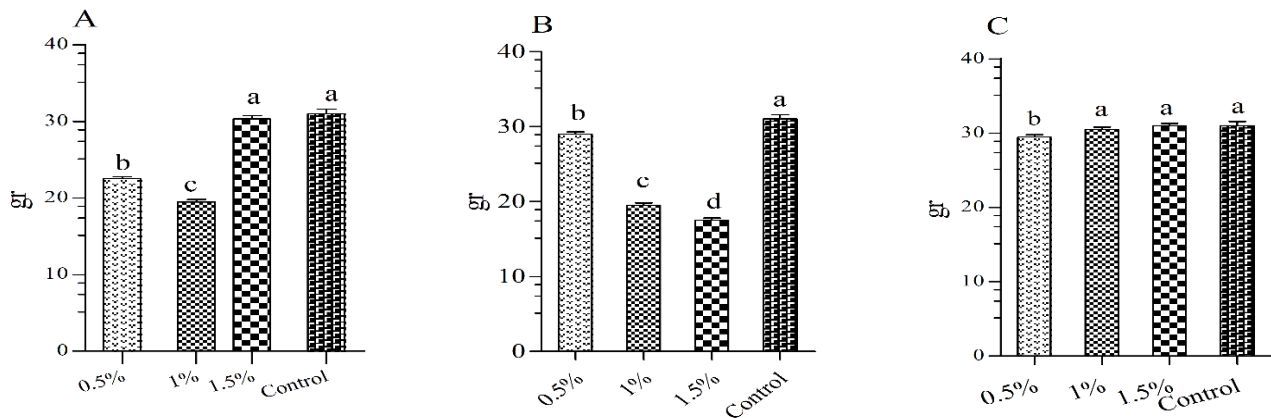


Figure -1: A, B & C indicates the figures of OLP, OLE & OSO with control in terms of AFP. Bar graph & Error bar indicates the mean of parameter and Standard deviation of the mean, respectively. On the bases of the results OLP, OLE & OSO had significantly impact on AFP of the broiler ($P < 0.05$).

Discussion

Previous studies have reported that, inclusion of olive leaves powder to the diets of broiler (20 or 25 g/kg) resulted in a significant increase in the body weight gain (BWG/g) and enhanced feed conversion ratio (FCR) (Amini et al. 2019; Erener et al. 2020). This variation might be due to bioactive compounds, antioxidant properties and antimicrobial effects. In contrast, Pečjak et al. (2020) reported that olive leaves powder had no significant effect on body weight gain (BWG/g) and feed conversion ratio (FCR). Similarly, Zbigniew et al. (2014) showed that, adding olive leaves (5 and 10 g/kg) diet significantly increase feed intake (FI/g). This variation might attribute that olive leaves harbor many phenolic compounds (Agah et al. 2019; Bilal et al. 2021). Our results are similar in terms of the addition of olive leaves extract (10 mL/liter and 20 mL/liter) into drinking water had the significant effect on growth performance of broiler chicks (El-Damrawy 2011). The extracted of Oleuropein compound from the olive leaves can improve growth of the broiler chicken (Jabri et al. 2017). This variation might be due to various reasons e.g. antioxidant activity, antimicrobial properties and anti-inflammatory effects. Conversely, research reported that addition of olive leaf extract into drinking water under heat stress did not improve growth performance of the broiler (Agah et al. 2019). The inclusion of olive seed's oil to broiler diet had significantly improved the growth rate of broiler (Al-Shanti et al. 2003). Oke et al. (2017) showed that, OLE significantly enhanced the carcass

characteristics of broiler. Meanwhile Erener et al. (2020) mentioned that, OLE did not have significant effects on the carcass traits of broiler. The findings of present study of OSO were different with Zhang et al. (2013) adding of OSO to diet of broiler was significantly reduced the AFP content. This reduction attributes might be due to the presence of some phenolic compounds in olive leaves (Bilal et al. 2021). The results of present study approved by the findings of (Mahmod 2013) that olive oil had a significant reduction in the fat content of the breast and thighs as well as a positive effect on crude protein. This variation might due to the mono saturated fats, antioxidant properties and improved lipid metabolism. A study found that combining the broiler breast meat with olive oil in an in vitro method improved broilers' breast chemical and sensory quality parameters (Bahsi et al. 2016). This reduction attributes, due to the presence of some phenolic compounds in olive leaves (Bilal et al. 2021). There was significantly difference was existed for moisture, dry matter (DM), nitrogen free extract (NFE) and energy compared to control. This variation might be due to nutritional content of olive oil, olive leaves powder and olive extract. Similarly, it might be due to increased digestibility and metabolism rate. A study on the effect of OLE in water revealed that OLE did not significantly enhance the bone ash content (Bakhsh et al. 2013). This variation occurred due to Catechin-rich oil olive leaf extract enhances bone calcium content of estrogen-deficiency. In another study the impact of OLE on Japanese quails found an increase in poly

unsaturated, omega 3 and omega 6 fatty acids in breast muscles, while a significant decrease in saturated fatty acids (Jones 1984). OLP supplementation to broiler diet decreased pH and increased monounsaturated fatty acids in their breast muscle (Papadomichelakis et al. 2018). This pH decrease in broiler breast muscle might be attributed to several factors e.g. antioxidant properties, fatty acid composition, microbial activity and enhanced glycolysis rate. In contrast, it was found that, there was no significant impact on broiler breast's meat pH and other physical quality parameters (Yavuz 2020).

Conclusion

It can be concluded that addition of OLP, OLE and OSO to the diet of broiler from the 2nd week until 42nd day age at the percentage of 1, 1.5 and 0.5% had high growth performance and excellent carcass characteristics among the experimental treatments. The reduction of Abdominal Fat pad was reduced by OLP 1% and OLE 1.5% among the all-experimental treatments. The inclusion of OLP (1.5%), OLE (1.5%) and OSO (1.5%) to diet of broiler is advised for the reduction of fat content of breast meat. While, 1% of OLP addition to the broiler is increased the crude protein (CP) content. This variation might be due to alteration of fatty acid composition, because olive oil is rich in monounsaturated fats, particularly oleic acid, which can alter the fatty acid composition of the meat. When broilers consume olive oil, it influences the types of fats deposited in their tissues, often leading to a higher proportion of healthier unsaturated fats and a reduction in saturated fats. There is need of further study to examine the respective feed supplements to broiler about the evaluation of gut morphology, nutrient digestibility and gut microbiota.

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Author Contributions

Sameen Sargand and Rozi Khan Sadiq conceived and planned the experiments. Sameen Sargand and Rashid Ahmad Ahmadi carried out the experiments. Sameen Sargand, Rozi Khan Sadiq and Sayed Attaulhaq Banuree planned and carried out the

simulations. Fazal Raziq contributed to manuscript preparation. Sameen Sargand, Rozi Khan Sadiq, Fazal Raziq and Rashid Ahmad Ahmadi contributed to the interpretation of the results. Sameen Sargand took the lead in writing the manuscript. All authors provided critical feedback and helped shape the research, analysis and manuscript. All authors contributed to the study conception, design, material preparation, data collection, analysis and drafting of the manuscript.

Data Availability Statement

The data supporting this study findings are available from the corresponding author upon reasonable request.

Conflict of Interest

No potential conflict of interest was found by the authors.

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