Effect of using olive pulp supplemented with or without sodium bentonite supplementation on productive performance of broilers

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ABSTRACT:

A total number of 240 broiler chicks (Cobb[500]) were arranged in a factorial experiment (2x4) with 3 replicates per treatment of 10 chicks per replicate, (5 males + 5 females). Two dietary levels of Sodium Bentonite (SB) namely 0 and 2.5 %, and four dietary levels of olive pulp (OP) namely 0, 5, 10, and 15 %, and their interactions were conducted to study its effects on productive performance and carcass characteristics. The experiment lasted from hatch to 35 days of age. Results indicated that dietary SB 2.5% improved (p≤0.0001) feed conversion ratio (FCR) significantly and decreased (p≤0.0330) total feed intake (FI) significantly, gizzard weight (p≤0.0001) and increased significantly (p≤0.0008) front Parts weight compared to that of 0% level of dietary SB. Results also indicated that 10 or 15% dietary OP decreased non significantly the final body weight (BWT), total body weight gain (BWG), and total FI. The dietary group 10 or 15% dietary OP decreased significantly (p≤0.0003) the abdominal fat compared to that 0 or 5% levels of dietary OP. There were no significant effect either of OP or SB levels on weights of carcass, hind parts, heart, liver and spleen. There were also no significant interactions among all levels of SB and OP on all experiment variables. In conclusion, it could be recommended that the use of dietary SB with level of 2.5% and/or dietary OP with levels up to 15% in broiler feeds have no adverse effects.

Keywords: Sodium Bentonite, Olive pulp, Broiler chicks, Productive Performance, Carcass characteristics.

INTRODUCTION

Aluminosilicates are feed additives used in the poultry and other animal industry for a variety of objectives. Bentonites, Kaolins, and Zeolites are forms of aluminosilicate compounds that have gained popularity in recent years due to their powers as mycotoxin adsorbents and other attributes. Bentonite is an adsorbent tri-layered aluminum silicate that is primarily montmorillonite and is essentially impure clay. Depending on the major exchangeable ion, Bentonites are classed as Sodium, Calcium, or mixed kinds (Hassan and Abdel-Khalek, 1998). Sodium form is the best and mineral hydration results in a five-fold increase in weight. During this change, aluminum silicate layers become separated and water is attracted to their ionic surfaces creating a 12 to 15-fold increase in volume (Damiri *et al.*, 2010).

Many studies have shown that adding Sodium Bentonite (SB) to poultry feed improves productive performance and nutrient digestibility in broilers (Santurio, 1999and Salari *et al.*, 2006).Supplementation of diets by SB increased retention time, decreased gastrointestinal passage rate and improved productive performance (Damiri *et al.*, 2012). A number of studies confirmed clay's capability to decontaminate aflatoxin (Santurio, 1999) as SB and (Vizcarra-Olvera *et al.*, 2012) as Bentonite in broiler chickens, plant metabolites (alkaloids, tannins), diarrhea causing enterotoxins (Dominy *et al.*, 2004) an *in vitro* study and poisons (Knezević and Tadić, 1994) in pigs.

Agricultural waste disposal is becoming a public health and environmental issue. Agricultural wastes, such as waste from oil extraction (canola meal and olive meal, etc.) were used for reducing environmental pollution from agricultural wastes. Olive pressers are used to press olive fruits to extract their oil content. Crushing, pressing, and centrifugation are all steps in this process. Olive oil, olive cake (OC), and water, as well as various wastes are the end products of the total procedure. In Egypt, large amounts of OC are found without supervision in most governorates especially in the desert governorates. Smaller quantities are also regularly burned in domestic ovens or immediately after harvest, resulting in significant air pollution. By releasing harmful compounds, these uncontrolled disposal techniques pollute the environment and threaten fragile semi-arid ecosystems. The use of OC and OP as animals and poultry feeds is an excellent approach to recycle this waste product and cheap source feed. It has the potential to improve production efficiency and profitability while also allowing grains to be saved for human use.

Olive pulp (OP) is the remainder of OC after the removal of most seeds fractions (Sadeghi *et al.*, 2009 and Abd El-Ghani, 2000). This can be achieved by sieving the dry OC to separate most of the endocarp, which leads to improvement in the chemical composition and nutritional value. It should be noted here that in many studies there is confusion between the terms (OP, OC, olive cake meal (OCM) or olive meal waste (OMW)). In fact, all terms user in animal and poultry production means dry waste after olive press operation, and referred to separating of the endocarp or not separating, but mostly the OP is referred to as separating of the endocarp.

Dietary SB supplementation may counteract some of OP problems, for example SB uptakes tannins intake, ameliorate the negative effect of aflatoxins**,** increase retention time, allowing dietary ingredients to be digested and utilized more efficiently.

The objective of this research work is using olive pulp supplemented with Sodium Bentonite on productive performance of broilers.

MATERIALS AND METHODS

The study was conducted at South Sinai Research Station, (Ras - Sedr) belonging to Desert Research Center, Cairo, Egypt, to investigate the effect of using olive pulp with or without Sodium Bentonite on productive performance and carcass characteristics of broilers.

Preparation of olive pulp:

During the olive pressing season, the material was collected and brought to the test location. Olive cake (OC) was put on a plastic sheath for sun drying and mixed every several hours to ensure that the material dried efficiently. To avoid moisture, the OC was covered overnight. After the material had been air dried for four days, the endocarp began to separate. The most of the endocarps were removed using a 2-mm sieve in this operation.

Chemical analysis:

The proximate chemical analyses for OC, OP and all diets were determined according to the Association of Official Analytical Chemists (AOAC, 1984). Dry basis samples of OC and OP were used to determine the following: Moisture, ash, crude protein (CP), ether extract (EE) and crude fiber (CF)) contents. Screening of some mycotoxin's concentrations in OP, starter diet and all diet ingredients namely Aflatoxins (AFB1, AFB2, AFG1 and AFG2) and OchratoxinA (OTA) were measured by high-performance liquid chromatography (HPLC) methods.

Digestion trial of olive pulp (OP):

The trial was done on Matroh roosters in the same experiment site. Ten roosters within direct method of digestion experiment; olive pulp was used alone in this method without any additives (100 % OP). The roosters were housed individually in metabolic cages equipped with trays to receive excreta. The roosters were fed with the OP for 3 days to ensure that there are no other feed residues in their alimentary canal. Five days after feeding, the tested feed and excreta collection had begun. The quantities of daily feed intake and excreta voided by each rooster were recorded for three days. The amount of dry excreta for each rooster was determined by weighting the fresh collection from each cage after drying at 60 ºC for 24 h in an electrical oven. It was ground and kept for chemical analysis. The experiment was conducted to determine the metabolizable Energy (ME) of OP calculated according to Zarei (2006)**.** The gross energy (GE) content in OP was measured by a Bomb Calorimeter IKA C 200 (IKA, Germany) standardized with benzoic acid. Finally, the equations used for calculation of Apparent Metabolizable Energy (AME) are as follow:

$$AME = [(Fi \times GEf) - (E \times GEe)] / Fi$$

AME/g of feed = Apparent Metabolizable Energy (kcal/g)

Fi = Feed intake (g)

E = Excreta (g)

GEf = Gross Energy of feed sample (kcal/g)

GEe = Gross Energy of excreta (kcal/g)

Experimental design:

The experiment was applied on broiler chicks aged 1 day and it was terminated when birds were 35 day of age. A total number of 240 broiler chicks (Cobb[500]) were distributed into 8 treatments of 30 chickens each, in each three replicates n=10 (5 male + 5 female). The treatments represented two dietary SB levels being 0 and 2.5 %, and four dietary OP levels namely 0, 5, 10 and 15 % in 2x4 factorial design (Table 1) to investigate the effect of dietary SB, OP and their interactions on productive performance and carcass characteristics.

Experimental diets and management:

Birds had free access to feed and water. Electric heaters used to provide the chicks with heat needed for brooding. The house temperature was kept at 33°C for the first three days, and then decreased gradually until it reached 28 °C from the second week until the end of the experiment with natural temperature. The birds were housed in pyramid battery. Composition, chemical analysis, and calculated analysis of the experimental diets (starter, grower and finisher) are shown in Tables (2, 3 and 4), respectively. The experimental diets were formulated to cover the nutrient requirement of broiler chicks from 1 to 35 days according to guidelines of (Cobb[500] broiler performance and nutrition supplement 2012) and (NRC 1994). The birds fed starter diet from 1 to 10 day of age, grower diet from 11 to 21 days of age and finisher diet from 22 to 35 day of age.

Productive performance:

Live body weight (BWT), body weight gain (BWG), feed intake (FI) and feed conversion ratio (FCR) for each replicate were totaled and divided on the number of chicks to obtain the averages.

Carcass characteristics:

At the end of experimental period (35 d of age) birds were deprived from the feed for 12 hours and individually weighed, slaughtered (by severing the jugular vein), defeathered and eviscerated. A carcass trial was performed on 48 birds including (1 male and 1 female) from each replicate to determine carcass variables namely, carcass, front parts, hind parts, gizzard, heart, liver, spleen and abdominal fat weights (g).

Statistical analysis:

The main effects of dietary levels of OP and SB and their interactions were statistically tested by two-way analysis of variance according to Winer, (1971). Statistical analysis was performed using GLM procedure of statistical analysis system package (SAS, 1988).

RESULTS AND DISCUSSION

Proximate chemical analysis of olive pulp (OP) and olive cake (OC):

Removing the most of endocarps process in OP increased crude protein (CP), nitrogen free extract (NFE) and ether extract (EE) and decreased crude fiber (CF) and ash compared to OC. Chemical compositions of OP and OC for dry matter (DM), CP, CF, EE, NFE and ash were (93.90, 8.00, 23.82, 44.23, 12.44 and 5.41%) and (95.05, 6.10, 34.44, 38.2, 10.00 and 6.31%) for the OP and OC, respectively (Table 5). In general, the compositions of OP or OC in present study are acceptable source of CP, EE and CF but poor in AME (2000 kcal/kg) compared to many several reports as shown in (Table 5). The composition of OP or OC varies depending on the type of olive trees, how the fruits are handled before pressing, and the type of olive presser used (Kiritsakis, 1990 and Abo Omar, 2005). It is possible that the difference in the chemical compositions may be due to the drying, grinding, and removing the nucleolus process.

Mycotoxin concentrations in all diet ingredients (yellow corn, soybean meal and concentrate) was not detected as shown in (Table 6). Screening mycotoxins concentrations in OP revealed that the mycotoxin concentrations were (0.9, 0.6, 1.5, 3.0and 8.4 ppb) for (AFB1, AFG1, total AFs and OTA), respectively. In general, the concentrations of total AFs in OP were lower than 20 ppb according to the action of FDA, (2011). Previous studies showed the presence of spores of toxicogenic moulds (Aspergillus) in olives (Leontopoulos *et al.*, 2003). Indeed, the presence of OTA has been reported by (Tantaoui-Elaraki *et al.*, 1983 and Belaiche, 2001). In present study, fresh OP used in same season of harvesting was dried well and not stored which may be reason of the lower mycotoxins contamination in the OP used in the present study.

Productive performance:

No significant interaction effects were found among all levels of SB and OP on productive performance (Table 7). Similar results were obtained by Salama, (2013) who compared effects of OC and clay on 0, 10 or 15 % dietary OC each with 0, 2 or 3 % dietary clay fed to laying hens. He did not find significant interactions between dietary OC and clay levels in final BWT, BWG, FI and FCR in laying hens. However, the present results are in disagreement with Salama *et al.*, (2016) who compared effects of OC and Bentonite on 30 or

60 % dietary OC instead of dietary clover hay each with 0, 0.5 or 1% dietary SB and control without OC in growing rabbit. They found that rabbits fed on diets with 30% OC plus 1% Bentonite significantly resulted in the best final BWT, BWG and FCR. However, they did not find significant interactions between dietary OC and Bentonite levels in FI,

Table (7) shows no significant effects of dietary SB that had been observed on final body weight (BWT) and total body weight gain (BWG) at total experimental period namely at (1-35 day of age), and regardless of dietary OP levels. dietary SB improved significantly ($p \leq 0.0001$) feed conversion ratio (FCR) and decreased significantly ($p \leq 0.033$) feed intake (FI) at dietary SB levels 2.5 compared to that of 0 level of dietary SB and regardless of dietary OP levels at total experimental period as shown in Table (7), where FCR were 1.758 and 1.703 g feed /g BWG, and FI were 3131.24 and 3022.45 g/bird for the two dietary SB levels (0 and 2.5%), respectively (Table 7).

Similar results were obtained by Tauqir and Nawaz, (2001) who reported that SB supplementation at 1% level significantly improved FCR than those fed 0, 2, 3 or 4% SB levels in the mixed sexes Hubbard broiler chicks from 1 to 42 days of age. Also,Khanedar *et al.*, (2012) reported that dietary SB 1% significantly improved FCR and decreased FI than those fed 0 or 1.5% dietary SB in male Ross^{308} strain broiler chickens. Also, Besseboua *et al.*, (2018) compared the effect of six diets containing dietary SB as (0, 1, 2, 3, 4 or 5 %) on FI and FCR of Arbor Acre broiler chicks. They found that non supplemented SB significantly increased FI compared with other groups. Also, FCR was improved by adding4%. of SB to diet

Table (7) shows that no significant effect of dietary OP was observed on total FI, final BWT, BWG and FCR. The lack of significance of dietary OP was regardless of dietary SB levels. Similar results were obtained by Al-Harthi, (2017) who found insignificant effect on BWT, BWG and FCR of Ross^{308} male broiler chicks fed 0, 5 or 10 % dietary OC. Also, Sateri *et al.*, (2017) stated that there wewr no significant differences by dietary level of Olive meal (OM) 0, 2, 4, 6 or 8 % in BWT, BWG and FCR values of male Ross^{308} broiler chickens. Also, Similar results were obtained by Pečjak *et al.*, (2020) who found that there were no significant differences between (0 or 10 %) dietary OC levels on BWT, FI and FCR of male Ross^{308} broilers.

Similar results were obtained by Pečjak *et al.*, (2020) who found that there were no significant differences between (0 or 10 %) dietary OC levels on BWT, FI and FCR of male Ross^{308} broilers.

Total FI, final BWT and BWG showed non-significant decrease in birds fed 10 or 15% dietary OP compared to those fed 0 or 5% dietary OP (Table 7). The negative effect of high levels dietary OP on FI and FCR was noticed before by several authors as was found by ELbaz *et al.*, (2020) who found that high levels of OP (10 and 15%) declined significantly the FCR compared with the control or 5% groups fed to Ross^{308} broilers from 1 to 35 days of age. Moreover, FI decreased in group by 15%of OP compared to (0 or 5%) OP levels.

The FI decrease occurred in the present study by dietary SB may be attributed to viscose nature of Bentonite which absorbs much water and decreased passage rate of digesta more than normal, which may affect feed intake and other characteristics negatively (Damiri *et al.*, 2012).

The improvement of FCR that were noticed due to SB supplementation could be attributed to reduction in the rate of feed passage in the gastrointestinal tract as an effect of water absorption of food, which led to subjecting of nutrients to enzymatic action for quite a long time, or could have been due to the action of Bentonite on the enhanced digestibility of certain nutrients (Pasha *et al.*, 2008). Several studies have shown that adding SB to poultry feed improves productive performance and nutrient digestibility in broilers (Santurio, (1999) and Salari *et al.*, (2006)). Supplementation of diets by SB increased retention time, decreased passage rate of ingesta and improved productive performance (Damiri *et al.*, 2012).

The insignificant negative effects of high levels dietary OP (10 or 15%) on BWT, BWG and FI could be attributed to that OP includes a high percentage of insoluble fibers, it has a negative impact on nutrient utilization, as well as the difficulty of digesting fiber in poultry and intestinal lumen erosion (Knudsen *et al.*, 2008). The high fiber content in the diet contributes to increased swelling and water binding capacity. It also has an adverse effect on the mucosal layer of the intestine, which can act as a barrier to protect the epithelial surface from potential luminal assaults (Forstner and Forstner, 1994).

Carcass characteristics:

No significant interactions were found among all levels of SB and OP on carcass characteristics (Table 8).

Table (8) shows that no significant effects of dietary SB on carcass, hind parts, heart, liver, spleen, and abdominal fat weights (g) at the end of experiment (35 day of age). However, dietary level of 2.5% of SB showed significantly (p≤0.0008) higher front parts weight and significantly (p≤0.0001) lower gizzard weight than that of 0 level of dietary SB, where front weights were 661.90 and 685.26 g and gizzard weight were 47.98 and 39.03 g for the two dietary SB levels 0 and 2.5%, respectively (Table 8). The lack of significance of dietary SB was regardless of dietary OP levels (Table 8).

Many previous studies showed no significant effect of dietary SB on carcass characteristics as found by Khanedar *et al.*, (2012) who stated insignificant effect of three dietary SB levels being 0, 1 or 1.5% on carcass characteristics (carcass yield, breast, thigh, liver and abdominal fat percentage of live weight) when fed to male Ross[308] broiler chicks. Also Pour *et al.*, (2021) found that there were no significant differences among 0, 0.75 or 1.5% dietary SB levels on carcass characteristics (carcass, breast, thigh, gizzard, heart, spleen liver and abdominal fat relative to live body weight) fed to male Ross[308] broiler chicks.

Dietary supplementation with 2.5% SB decreased, but non-significantly, liver weight compared to the control (non-supplemented group), where liver weights were 50.73 and 46.32 g for the two dietary SB levels 0 and 2.5%, respectively (Table 8). The suppressive effect of dietary SB on liver weight found in the present study was noticed before by Damiri et al., (2012).

Table (8) shows that no significant effects of dietary OP on carcass characteristics viz., carcass weight, front parts, hind parts, heart, liver, and spleen (g) at the end of experiment (35 days of age). The lack of significance of dietary OP was regardless of dietary SB levels. Similar results were obtained by Abd El-Ghani, (2000) who found insignificant effect on carcass, hind parts, liver, and heart weights. The values of five dietary OP levels that fed to broiler chickens were (0, 2.5, 5, 7.5 or 10 %). Also, Abo Omar, (2005) found that no significant effect on carcass cuts (hind parts, thigh and breast) of five dietary OP levels 0, 25, 50, 75 and 100 g/kg on unsexed Hybro broiler.

Concerning the effect of dietary OP on gizzard and abdominal fat weights, dietary levels 10 or 15% of OP showed significantly (p≤0.0067) higher gizzard weight compared to the control group that fed OP non-supplemented. Meanwhile, dietary levels of OP showed no significant differences between 5 and 0% and among 5, 10 or 15% OP (Table 8). Also, dietary levels (10 or 15%) of OP showed significantly (p≤0.0003) lower abdominal fat weight compared to dietary levels 0 or 5% of OP where, gizzard weights were 38.22, 42.85, 44.12 and 48.82 (g) and abdominal fat eights were 52.01, 20.98, 48.35 and 46.90 (g) for the four dietary OP levels 0, 5, 10 or 15%, respectively (Table 8). The above-mentioned effects of dietary OP were regardless of dietary SB levels.

The effect of high levels dietary OP on gizzard and abdominal fat values was noticed before by many authors as was found by ELbaz *et al.*, (2020) who found that high levels of OP (10 and 15%) decreased significantly the abdominal fat compared with the control or 5% groups fed to Ross[308] broilers. They also found that gizzard percentage was significantly decreased with 15 % OP compared to other experimental groups. Also, Saleh *et al.*, (2020) compared the effect of three dietary olive cake meal (OCM) levels (0, 2 or 4 %) on carcass characteristics of male broiler chickens. They found that abdominal fat was significantly decreased with 2 or 4 % of OCM compared to OCM non-supplemented group.

It could be noticed that a trend of steep increase in gizzard weight with increasing dietary OP levels could be due to the increase in mechanical digestion and thence increase the musculature of gizzard required for digesting the OP fibers. One important role of the gizzard is to regulate digesta particle size in the gastrointestinal tract (Hetland *et al.*, 2004 and Svihus, 2011). Factors such as fiber type and particle size are determinant factors that stimulate the muscular activity of the gizzard, resulting in increasing its size (González-Alvarado *et al.*, 2008).

The increase in dietary fiber content resulted in a reduction in abdominal fat relative weight. Numerous studies found that providing a high fiber diet reduced abdominal fat in broiler breeders (Mohiti-Asli *et al.*, 2012). Feeding high fiber diets to broiler chickens reduced abdominal fat significantly (Mourão et al., 2008). Olive pulp is rich in lipids (7.95% linoleic acid, 13.43% palmitic acid and 73.01% oleic) as percentage of lipids content (Ranalli *et al.*, 2002).

In conclusion, it could be recommended that the use of dietary SB with level of 2.5% and/or dietary OP with levels up to 15% in broiler feeds have no adverse effects.

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Table 1: The experimental design and treatments:

<table>
<tr><td rowspan="2">Sodium Bentonite levels</td><td colspan="3">Olive pulp levels</td><td></td><td></td></tr>
<tr><td colspan="3">0%</td><td>5%</td><td>10%</td><td>15%</td></tr>
<tr><td rowspan="2">0%</td><td colspan="3">T[1]1 (Control) N[2]= 30</td><td rowspan="2">T2</td><td rowspan="2">T3</td><td rowspan="2">T4</td></tr>
<tr><td>N= 10</td><td>R[3]</td><td>R</td></tr>
<tr><td>2.5%</td><td colspan="3">T5</td><td>T6</td><td>T7</td><td>T8</td></tr>
</table>

[1]T=Treatment [2]N= Number [3]R= Replicate

Table 2: Compositions and analyzed values of the starter experimental diets.

Ingredients	Dietary treatments							
	T1	T2	T3	T4	T5	T6	T7	T8
Yellow corn	56.90	50.50	43.70	37.00	51.60	45.10	38.40	32.00
Soybean meal (44 %)	28.00	28.20	28.70	29.10	29.00	29.30	29.70	30.00
Concentrate [1]	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Olive pulp	0.00	5.00	10.00	15.00	0.00	5.00	10.00	15.00
Sodium bentonite	0.00	0.00	0.00	0.00	2.50	2.50	2.50	2.50
DL-Methionine	0.16	0.18	0.20	0.22	0.17	0.18	0.20	0.22
Limestone	1.50	1.40	1.35	1.28	1.50	1.41	1.35	1.25
Pre-mix[2]	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Lyse	0.07	0.08	0.08	0.08	0.05	0.06	0.06	0.07
Sodium Chloride	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Sunflower oil	2.82	4.09	5.42	6.77	4.63	5.90	7.24	8.41
Total (Kg)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis:[3]								
Crude protein (%)	22.06	22.01	22.05	22.06	22.02	22.00	22.01	22.01
ME (Kcal / kg)[4]	3032	3033	3033	3036	3036	3036	3038	3033
Ether extract (%)	2.535	2.916	3.283	3.654	2.342	2.719	3.09	3.471
Crude fiber (%)	3.592	4.656	5.733	6.807	3.548	4.618	5.691	6.763
Lysine (%)	1.327	1.327	1.326	1.321	1.324	1.327	1.322	1.326
Methionine (%)	0.984	0.985	0.988	0.989	0.989	0.980	0.982	0.984
Calcium (%)	0.913	0.904	0.915	0.918	0.914	0.910	0.917	0.908
Av. phosphorus (%)	0.463	0.462	0.461	0.461	0.460	0.459	0.459	0.458
Analyzed values:								
Crude protein (%)	21.94	21.88	21.96	22.01	21.92	21.95	21.91	21.89
Crude fiber (%)	3.323	4.281	5.288	6.303	3.343	4.293	5.275	6.291

[1]Composition of broiler concentrate: Crude protein 50%, Crude fiber 2.96%, Calcium 2.5%, Available P 3.3%, Methionine 1.7%, Methionine + Cystine 2.5%, Lysine 3% and ME 2530 Kcal/kg.

[2]Each 3 Kilo gram contain: 12000000 IU vit. A; 3000000 IU vit. D3; 10000 mg vit. E; 2000 mg vit. K3;1000 mg vit. B1; 5000 mg vit .B2; 1500mg vit .B6;10 mg vit. B12; 30000 Mg Nicotinicacid ; 1000 mg Folicacid vit.; 10000mg Pantothenicacid; 75 mg Biotin; 60000mg Zn; 80000mg Mn; 30000mg Fe; 40000mg Cu; 500 mg I; and 100mg Se.

[3]Calculate analysis values according to NRC (1994)

[4]ME=Metabolizable energy

Table 3: Compositions and analyzed values of the grower experimental diets.

Ingredients	Dietary treatments							
	T1	T2	T3	T4	T5	T6	T7	T8
Yellow corn	62.60	56.00	49.50	42.90	57.45	50.60	44.00	37.60
Soybean meal (44 %)	22.30	22.65	23.00	23.30	23.25	23.80	24.20	24.40
Concentrate [1]	10.00	10.00	10.00	10.00	29.00	10.00	10.00	10.00
Olive pulp	0.00	5.00	10.00	15.00	10.00	5.00	10.00	15.00
Sodium bentonite	0.00	0.00	0.00	0.00	2.50	2.50	2.50	2.50
DL-Methionine	0.13	0.15	0.16	0.18	0. 14	0.15	0.17	0.18
Limestone	1.37	1.30	1.20	1.15	01.35	1.30	1.20	1.13
Pre-mix[2]	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Lyse	0.10	0.10	0.10	0.11	0.08	0.08	0.08	0.09
Sodium Chloride	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Sunflower oil	2.95	4.25	5.49	6.81	4.68	6.02	7.30	8.55
Total (Kg)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis:[3]								
Crude protein (%)	20.05	20.04	20.04	20.02	20.01	20.05	20.07	20.01
ME (Kcal / kg)[4]	3107	3108	3107	3108	3108	3108	3108	3108
Ether extract (%)	2.706	3.080	3.458	3.832	2.518	2.884	3.259	3.639
Crude fiber (%)	3.301	4.372	5.446	6.514	3.257	4.338	5.413	6.471
Lysine (%)	1.204	1.198	1.193	1.196	1.199	1.199	1.195	1.195
Methionine (%)	0.898	0.900	0.891	0.892	0.903	0.896	0.898	0.889
Calcium (%)	0.848	0.851	0.843	0.853	0.842	0.853	0.845	0.848
Av. phosphorus (%)	0.453	0.452	0.452	0.451	0.450	0.450	0.449	0.448
Analyzed values:								
Crude protein (%)	19.99	20.03	19.88	19.95	20.03	19.91	19.86	20.02
Crude fiber (%)	3.035	4.005	5.029	6.022	3.022	4.001	5.017	6.031

[1]Composition of broiler concentrate: Crude protein 50%, Crude fiber 2.96%, Calcium 2.5%, Available P 3.3%, Methionine 1.7%, Methionine + Cystine 2.5%, Lysine 3% and ME 2530 Kcal/kg.

[2]Each 3 Kilo gram contain: 12000000 IU vit. A; 3000000 IU vit. D3; 10000 mg vit. E; 2000 mg vit. K3;1000 mg vit. B1; 5000 mg vit .B2; 1500mg vit .B6;10 mg vit. B12; 30000 Mg Nicotinicacid ; 1000 mg Folicacid vit.; 10000mg Pantothenicacid; 75 mg Biotin; 60000mg Zn; 80000mg Mn; 30000mg Fe; 40000mg Cu; 500 mg I; and 100mg Se.

[3]Calculate analysis according to NRC (1994)

[4]ME=Metabolizable energy

Table 4: Compositions and analyzed values of the finisher experimental diets.

Ingredients	Dietary treatments							
	T1	T2	T3	T4	T5	T6	T7	T8
Yellow corn	68.53	61.70	55.30	48.65	63.00	56.50	49.90	43.30
Soybean meal (44 %)	16.50	17.00	17.20	17.60	17.70	18.00	18.40	18.70
Concentrate [1]	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Olive pulp	0.00	5.00	10.00	15.00	0.00	5.00	10.00	15.00
Sodium bentonite	0.00	0.00	0.00	0.00	2.50	2.50	2.50	2.50
DL-Methionine	0.11	0.13	0.15	0.17	0.12	0.14	0.15	0.17
Limestone	1.20	1.11	1.05	1.00	1.20	1.10	1.04	1.00
Pre-mix[2]	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Lyse	0.11	0.11	0.12	0.12	0.08	0. 09	0.10	0.10
Sodium Chloride	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Sunflower oil	3.00	4.40	5.63	6.91	4.85	6.12	7.36	8.68
Total (Kg)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis:[3]								
Crude protein (%)	18.01	18.05	18.00	18.02	18.03	18.02	18.04	18.01
ME (Kcal / kg)[4]	3181	3186	3184	3182	3185	3185	3182	3183
Ether extract (%)	2.885	3.252	3.632	4.052	2.685	3.062	3.436	3.810
Crude fiber (%)	3.008	4.085	5.150	6.224	2.974	4.044	5.119	6.187
Lysine (%)	1.058	1.056	1.057	1.052	1.050	1.053	1.059	1.052
Methionine (%)	0.821	0.824	0.824	0.826	0.828	0.829	0.821	0.822
Calcium (%)	0.768	0.763	0.770	0.781	0.770	0.762	0.769	0.783
Av. phosphorus (%)	0.463	0.462	0.461	0.461	0.460	0.459	0.459	0.458
Analyzed values:								
Crude protein (%)	18.02	17.99	17.89	17.99	17.88	18.04	18.01	17.93
Crude fiber (%)	2.762	3.775	4.709	5.761	2.759	3.770	4.701	5.744

[1]Composition of broiler concentrate: Crude protein 50%, Crude fiber 2.96%, Calcium 2.5%, Available P 3.3%, Methionine 1.7%, Methionine + Cystine 2.5%, Lysine 3% and ME 2530 Kcal/kg.

[2]each 3 Kilo gram contain: 12000000 IU vit. A; 3000000 IU vit. D3; 10000 mg vit. E; 2000 mg vit. K3;1000 mg vit. B1; 5000 mg vit .B2; 1500mg vit .B6;10 mg vit. B12; 30000 Mg Nicotinicacid ; 1000 mg Folicacid vit.; 10000mg Pantothenicacid; 75 mg Biotin; 60000mg Zn; 80000mg Mn; 30000mg Fe; 40000mg Cu; 500 mg I; and 100mg Se.

[3]calculate analysis according to NRC (1994)

[4]ME=Metabolizable energy

Table 5: Energy and major nutrient contents in olive pulp (OP) and olive cake (OC):

Approximate analysis / References	DM[3] %	CP[4] %	CF[5] %	NFE[6] %	EE[7]%	Ash %	AME[8] (kcal/kg)
Present study							
OP[1]	93.90	8.00	23.82	44.23	12.44	5.41	2000
OC[2]	95.05	6.10	34.44	38.2	10.00	6.31	------
Lotfollahian and Hosseini, (2007)							
OP with nucleolus	92.5	6.3	55.3	17.45	10.6	2.85	821.2
OP without nucleolus	92.0	6.6	41.3	28.95	9.0	6.15	2305.5
Zarei *et al.*, (2011)							
OP	93.0	6.06	48.2	23.74	7.6	7.4	------
El-Sheikh, (2012)							
OC	92.38	7.68	38.81	31.01	9.2	5.6	------
Sayehban *et al.*, (2015)							
dried only	93.57	7.11	35.00	36.76	8.5	6.2	1250
partly destoned	93.45	10.73	25.60	35.71	13.00	8.5	2980
Pečjak *et al.*, (2020)							
OC	97.61	9.19	23.94	35.95	22.6	5.93	------
Abd El-Dayem, (2021)							
OP	91.85	8.76	26.10	48.76	12	8.17	2201

[1]OP= olive pulp [2]OC= olive cake [3]DM= dry matter [4]CP= crude protein
[5]CF= crude fiber [6]NFE= nitrogen free extract [7]EE= ether extract
[8]AME= Apparent metabolizable energy

Table 6: Screening of Aflatoxins (AFs) and OTA concentrations (ppb) in OP and all diet ingredients:

Mycotoxins	Aflatoxins (AFs) ppb[1]					OTA[2] ppb
	AFB1	AFB2	AFG1	AFG2	Total AFs	
OP	0.9	ND	0.6	1.5	3.0	8.4
all diets ingredients	ND[3]	ND	ND	ND	ND	ND

[1]ppb = parts per billion [2] OTA= Ochratoxin A [3] ND= not detected

Table 7: The effect of dietary Sodium Bentonite (SB) and olive pulp (OP) on productive performance at total period.

Variables		Initial BWT(g)	Final BWT(g)	Total BWG(g)	Total FI(g)	Total FC FI(g) / BWG(g)
SB%						
0		43.17±0.066	1824.84±10.968	1781.09±18.038	3131.24[a]±32.520	1.758[a]±0.005
2.5		43.18±0.066	1818.49±10.968	1774.21±18.038	3022.45[b]±32.520	1.703[b]±0.005
OP%						
0		43.15±0.093	1840.17±15.350	1797.77±25.509	3097.18±45.990	1.723±0.006
5		43.16±0.093	1832.45±15.512	1788.26±25.509	3102.54±45.990	1.735±0.006
10		43.21±0.093	1808.81±15.512	1764.61±25.509	3052.52±45.990	1.730±4.851
15		43.19±0.093	1805.24±15.518	1759.96±25.509	3055.13±45.990	1.736±4.851
SB*OP						
0	0	43.12±0.132	1843.04±21.941	1801.43±36.075	3144.75±65.040	1.746±0.009
	5	43.20±0.132	1858.14±21.940	1812.03±36.075	3157.33±65.040	1.765±0.009
	10	43.21±0.132	1804.15±21.941	1761.60±36.075	3098.66±65.040	1.759±0.009
	15	43.17±0.132	1794.05±21.941	1749.30±36.075	3084.22±65.040	1.763±0.009
2.5	0	43.19±0.132	1837.29±21.474	1794.11±36.075	3049.61±65.040	1.700±0.009
	5	43.11±0.132	1806.76±21.941	1764.49±36.075	3007.76±65.040	1.705±0.009
	10	43.20±0.132	1813.48±21.941	1767.63±36.075	3006.38±65.040	1.701±0.009
	15	43.20±0.132	1816.44±21.941	1770.62±36.075	3026.05±65.040	1.709±0.009
Source of variance		P ≤ values				
SB		0.9786	0.6819	0.7914	0.0330	0.0001
OP		0.9701	0.2944	0.6803	0.7990	0.4991
SB*OP		0.9470	0.3619	0.8003	0.7716	0.8836

[1]Least squares means± pooled standard error.

[a,b] Means having different letter exponents within column are significantly different (p≤0.05).

Table 8: The effect of dietary Sodium Bentonite (SB) and olive pulp (OP) on carcass characteristics (g) at 35 days of age.

Variables		Carcass WT (g)	Front parts WT (g)	Hind parts WT (g)	Gizzard WT (g)	Heart WT (g)	Liver WT (g)	Spleen WT (g)	Abdominal fat WT (g)
SB%									
0		1302.31[1]±8.116	661.90^{b}±4.524	526.05±6.796	47.98^{a}±1.416	12.46±0.552	50.73±1.564	3.19±0.171	49.31±0.583
2.5		1306.61±8.116	685.26^{a}±4.524	519.98±6.796	39.03^{b}±1.416	13.15±0.552	46.32±1.564	2.38±0.171	49.81±0.583
OP%									
0		1301.19±11.639	677.56±6.487	520.23±9.747	38.22^{b}±2.030	12.45±0.792	49.92±2.243	2.80±0.246	52.01^{a}±0.837
5		1313.26±11.480	677.79±6.399	525.38±9.613	42.85^{ab}±2.090	13.02±0.781	49.58±2.212	3.34±0.242	50.98^{a}±0.825
10		1297.94±11.982	665.58±6.678	528.73±10.034	44.12^{a}±2.002	12.02±0.815	45.60±2.309	3.15±0.253	48.35^{b}±0.861
15		1305.48±11.617	673.40±6.475	517.71±9.728	48.82^{a}±2.026	13.72±0.791	49.00±2.239	2.87±0.245	46.90^{b}±0.835
SB*OP									
0	0	1297.78±16.304	669.38±9.087	517.60±13.653	44.06±2.844	12.07±1.109	51.64±3.142	3.02±0.344	52.18±1.172
	5	1302.33±16.278	661.08±9.073	523.96±13.631	46.09±2.875	12.39±1.108	52.92±3.137	3.25±0.343	50.29±1.170
	10	1300.31±16.483	657.19±9.187	534.47±13.803	48.71±2.839	12.38±1.122	46.96±3.176	3.20±0.348	48.27±1.185
	15	1308.82±16.352	659.94±9.114	528.17±13.693	53.05±2.852	12.98±1.113	51.40±3.151	3.30±0.345	46.52±1.176
2.5	0	1304.60±16.396	685.75±9.139	522.86±13.730	32.38±20860	12.84±1.116	48.21±3.160	2.58±0.346	51.84±1.179
	5	1342.12±16.243	694.50±9.053	526.81±13.602	39.53±2.833	13.64±1.105	46.23±3.130	3.42±0.343	51.68±1.168
	10	1295.56±16.718	673.96±9.318	522.98±13.100	39.61±2.916	11.65±1.138	44.25±3.222	3.09±0.353	48.43±1.202
	15	1302.15±16.309	686.85±9.090	507.25±13.657	44.60±2.845	14.473±1.110	46.60±3.143	2.43±0.344	47.28±1.173
Source of variance			P ≤ values						
SB		0.7099	0.0008	0.5313	0.0001	0.3809	0.0538	0.2061	0.5551
OP		0.8052	0.5383	0.8696	0.0067	0.4775	0.5431	0.4004	0.0003
SB*OL		0.8090	0.7409	0.7462	0.8340	0.7506	0.9251	0.4773	0.8915

[1]Least squares means± pooled standard error.

[a,b,] Means having different letter within column exponents are significantly different (p≤0.05).

تأثير استخدام تفلة الزيتون بدون أو بإضافة الصوديوم بنتونايت على الأداء الإنتاجي لكتاكيت التسمين

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الملخص العربي:

أجريت تجربة عاملية (2x ٤) بهدف دراسة تأثير إضافة مستويين من الصوديوم بنتونايت (٠ و٢,٥) و4 مستويات تفلة الزيتون) ٠، ٥، ١٠ و١٥٪)والتفاعل بينهما على الأداء الإنتاجي وصفات الذبيحة. بدأت التجربة على كتاكيت تسمين بعمر يوم واحد وانتهت عندما كان عمر الطيور ٣٥ يوم. تم توزيع ٢٤٠ كتكوت تسمين (Cobb500) على ٨ معاملات بكل منها ٣٠ دجاجة، في كل معاملة ٣ مكررات. في كل مكررة ١٠ طيور (٥ ذكور + ٥ إناث). أشارت النتائج إلى أن إزالة معظم أجزاء النواة الخشبية في تفلة الزيتون أدى إلى زيادة نسبة البروتين الخام والمستخلص الخالي من النيتروجين ومستخلص الأثير وانخفاض الألياف الخام. أشارت النتائج إلى أن إضافة ٢,٥٪ صوديوم بنتونايت الى العليقة أدى إلى انخفاض معنوي في استهلاك الغذاء وحسن معنويا معامل تحويل الغذاء مقارنة بمستوى ٠ ٪. دلت النتائج على أن إضافة ١٠ أو ١٥٪ تفلة الزيتون خفضت غير معنوي) وزن الجسم النهائي والزيادة الوزنية واستهلاك الغذاء. أشارت النتائج إلى أن إضافة ١٠ أو ١٥٪ تفلة الزيتون خفضت معنويا وزن دهن البطن مقارنةً بمستويات ٠ أو ٥٪. أيضا مستويات ١٠ أو ١٥ ٪ تفلة الزيتون زادت معنويا وزن القونصة مقارنة مع المستوى ٠ ٪ من تفلة الزيتون. أشارت النتائج إلى عدم وجود تأثير معنوي لمستويات الصوديوم بنتونايت أو تفلة الزيتون على أوزان (الذبيحة ،الأجزاء الخلفية ،القلب ،الكبد والطحال). أشارت النتائج إلى عدم وجود تأثيرات تفاعلية بين جميع مستويات الصوديوم بنتونايت أو تفلة الزيتون على جميع قياسات التجربة. في الختام، يمكن التوصية بأن إضافة الصوديوم بنتونايت بمستوى ٢,٥٪ و / أو تفلة الزيتون بمستويات تصل إلى ١٥٪ في علائق دجاج التسمين ليس له آثار ضارة.

الكلمات الاسترشادية: صوديوم بنتونايت، تفلة الزيتون، كتاكيت التسمين، الأداء الإنتاجي، وصفات الذبيحة.