African Journal of Biotechnology Vol. 6 (15), pp. 1848-1853, 6 August 2007
Available online at http://www.academicjournals.org/AJB
ISSN 1684–5315 © 2007 Academic Journals

Full Length Research Paper

Supplementation of olive mill wastes in broiler chicken feeding

EL HACHEMI Ahmed[1], EL MECHERFI Kamel Eddine[1], BENZINEB Khaled[2], SAIDI Djamel[1], KHEROUA Omar[1]*

[1]Laboratoire de Physiologie de la Nutrition et de Sécurité Alimentaire, Faculté des Sciences, Université d'Oran Es-Sénia, Oran, Algérie.
[2]Centre Algérien de Contrôle de la Qualité et de l'Emballage, Oran, Algérie.

Accepted 13 April, 2007

This work was conducted in order to study the value of olive mill wastes as diet on the growth performance, abdominal and muscle fat deposition, adipose and muscle tissues fatty acid composition in broilers. 200 male chickens that were 2 weeks old, 50 for each diet, were assigned to one of the three diets containing 5, 10 or 15% olive mill wastes (OMW) compared to control diet (CD). There were no significant differences in body and weight gain, final body carcass, thighs and pectoral muscle weight between birds. The same observation was seen for abdominal tissue fat (% of body weight) of which no differences were detected in birds fed OMW diet compared to those fed on the control diet. Linoleic acid proportion increases significantly in the pectoral muscle ($p < 0.0001$) with the three diets containing OMW, but its level decreases in tight muscle with 5 and 10% OMW diets ($p < 0.0001$) and remain unchanged in abdominal fat. Oleic acid proportion increases in thigh muscle ($p < 0.006$) and remain unchanged in pectoral muscle and in abdominal adipose tissue. Palmitic acid proportion decreases significantly in pectoral muscle ($p < 0.0001$) and in abdominal adipose tissue ($p < 0.002$), but increases significantly in thigh muscle ($p < 0.05$). In conclusion, OMW diet gives attractive results. It brings identical growth performances and affect abdominal and muscle fat deposition and fatty acid composition.

Key words: Olive mill wastes, broilers, growth performance and lipids.

INTRODUCTION

Olive mill wastes (OMW), sub-product extracted from olives, remains largely unexploited in Algeria and represents a significant environmental problem because of its great availability as a result of the large agricultural surfaces devoted to the cultivation of olive-tree. This product contains high phenol, lipid and organic acid concentrations that turn them into phytotoxic materials. However, these wastes also contain valuable resources such as a large proportion of organic matter and a wide range of nutrients that could contribute animal nutrition (Roig et al., 2006). Many mediterranean countries have tried to study the use of this product in the ruminant's food (Eraso et al., 1978; Gomez et al., 1982; Alibes and Berge, 1983). However, no studies were carried out on broilers chicken. Indeed, the olive mill waste could be of particular interest in broilers chicken for at least two reasons. On the one hand, for its level of residual oil (6.8%), this can constitute a complementary energy source. Secondly, for its particular composition of unsaturated fatty acids (62.4% of oleic acid, 18.2% of linoleic acid, 1.1% of linolenic acid, and 2.7% of palmitoleic acid) which could influence the accumulation of fatty acid in the various body compartments during the animal's life and as such could have a certain impact on the quality of

*Corresponding author. E-mail: omar_kheroua@hotmail.com. Tel: 213 41581925. Fax: 213 41 513025.

meat (Crespo and Esteve-Garcia, 2001; Du and Du, 2002).

The aim of this work is to evaluate the olive mill wastes in the broilers' food by substituting it partially with 5, 10 and 15% of corn in the ration feed. The outcome could have an economic interest in exploiting the level of olive mill wastes' unsaturated fatty acid in order to improve the growth performances, fat deposition, the fatty acids composition in the muscle and adipose tissue and meat quality in broilers.

MATERIALS AND METHODS

Animals and diets

200 male Hubbard ISA chicks day-old are distributed in four boxes of 4 m^2 of surface, at a rate of 50 subjects per section. At the beginning, all the animals are fed during the first and the second week with a starting standard diet of 3100 kcal/kg containing 22% proteins. As of the third week of the experimentation, the animals with a weight of 306, 37 ± 1, 68 g receive until the eighth week, according to batches, a control diet (CD) (3563 kcal/kg, 19.44% of proteins) and of the diets containing OMW substituting corn at a rate of 5, 10 and 15%, respectively.

Olive mill wastes preparation, protein and lipids contents

The OMW is recovered after pressing olive according to the traditional method. Thereafter, it is spread out to dry for 20 to 25 days at ambient temperature in a covered and quite ventilated room. When the relative humidity of the OMW reaches 8%, the product is crushed until a powder with a homogeneous consistency is obtained. Proportion of lipid and protein in OMW are 6.8 and 4.79%, respectively. Fatty acids composition is as follows: palmitic acid 9.2%; palmitoleic acid 2.7%; stearic acid 3.8%; oleic acid 62.4%; linoleic acid 18.2%; arachidic acid 1.3%; and gondoic acid 0.6%.

Weight and isolation of organs

At the end of the second, fourth, sixth and eighth week, the subjects of each batch were weighed. At the end of the experimentation, 10 chickens of each batch were sacrificed by decapitation. The body weights, eviscerated carcass, liver, abdominal adipose tissue and pectoral and thigh muscles were measured. Samples of these organs were kept frozen immediately at -30℃ until further analyses.

Quantification of the lipids and the fatty acids in the organs

The abdominal fat, the pectoral and the thigh muscle lipids were extracted by chloroform/methanol (Folch et al., 1957). The fatty acids are analysed by CPG (Fisons Instruments, series 9000 G.C) after saponification and methylation by methanol. The methylic esters of fatty acids are analysed by CPG (column of bonded silica 30 m length phase, 0.25 mm diameter), with volume of injection of 100 µl, furnace temperature of 180℃, (FID) detector temperature and injector at 240℃ and vector gas flow (nitrogen) of 2 ml/min.

Statistical analysis

Data was analysed using analysis of variance (ANOVA) followed by a comparison post hoc of averages using the Newman-Keuls test.

RESULTS

Growth and body weight of broiler chickens

During all the experiment, the weight gain of the broilers fed on OMW diets at 5, 10 and 15% is similar to that of the group receiving the control diet (Figure 1). At the end of the eighth week, both broilers and the eviscerated carcass have similar weights. Similar result is observed for the abdominal adipose tissue (Table 2), thighs and pectoral muscle weights (Table 3). The liver weight is the only one to increase significantly in the broiler chickens fed on diets containing OMW (Table 2).

These results suggest that the administration of diets containing OMW at 5, 10 and 15% (substitution of corn) bring identical growth performances to those of the control diets. This favorable aspect of the mill waste might be due to the richness of its lipid energy.

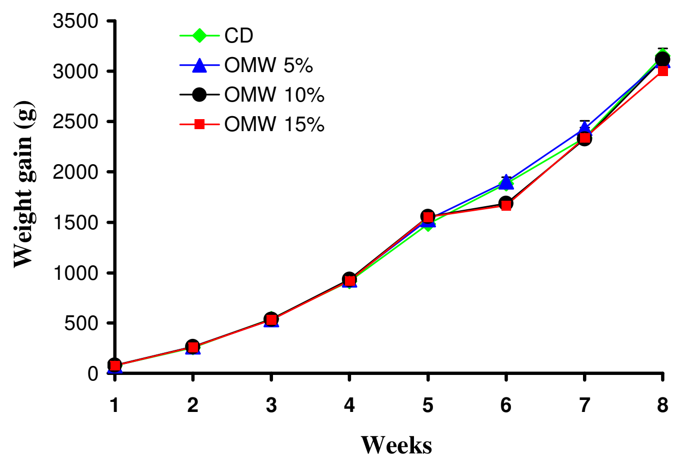

Figure 1. Weight gain measured for the broiler chickens fed control diet (CD) and olive mill wastes (OMW) diets, Values are means ± SE, n = 50.

Fatty acids composition of diets after olive mill wastes incorporation

The linoleic acid is the major fatty acid in all the diets used (Table 1). Its proportion is highest in the control diet (49.40%) and decreases to 46.33, 43.40 and 40.81%, respectively, for the diet containing 5, 10 and 15% of OMW. The amount of oleic acid is 30.10% in the control diet and increases after substitution of corn by OMW to reach 32.96, 36.45 and 39.23% in the diets with 5, 10

Table 1. Composition of the experimental diets (%).

Diet	CD	5% OMW	10% OMW	15% OMW
OMW	-	5.0	10.0	15.0
Soybean meal	22.0	22.0	22.0	22.0
corn	50.0	45.0	40.0	35.0
Lipids	5.0	5.0	5.0	5.0
Wheat bran	20.0	20.0	20.0	20.0
MCV/C	1.0	1.0	1.0	1.0
Calcaires	1.0	1.0	1.0	1.0
Phosphates	1.0	1.0	1.0	1.0
AME (Kcal/Kg)	3563	3409	3255	3100
Calculated composition (%)				
Crud protein	19.44	19.06	18.56	18.16
Lipids	8.45	9.65	11.01	11.94
Fatty acid composition (% of the identified fatty acid)				
C16:0	18.06	17.55	16.85	16.50
C16:1	0.12	0.11	0.19	0.13
C18:0	1.90	1.59	1.48	1.90
C18:1	30.10	32.96	36.45	39.23
C18:2	49.40	46.33	43.40	40.81
C18:3	0.32	0.32	0.34	0.44
C20:0	Trace	Trace	Trace	Trace
UFA/SFA	4.0	4.16	4.38	4.38

MVC: Mineral vitamin premix provided (in mg per kg of diet).
OMW =Olive mill wastes, and CD = control diet.
UFA/SFA: Unsaturated fatty acid/Saturated fatty acid.

and 15% of OMW, respectively. The palmitic acid is the third prevalent fatty acid with 18.06% in the control diet and 17.55, 16.85 and 16.50% in the diets with 5, 10 and 15% of OMW, respectively. These indicate that the incorporation of the OMW in the diets constitutes a source of fatty acids which results in a modification of the unsaturated fatty acid (UFA)/saturated fatty acid (SFA) ratio, from 4 in the control diet to 4.38 in the diet of 15% OMW.

Effect of the OMW on the lipids deposition in organs

Pectoral muscle: The incorporation of OMW in broiler chickens' diets leads to significant increase in the content of lipids in the pectoral muscle compared to the control diet ($p < 0.05$) (Table 3). The oleic acid is the predominant fatty acid in the pectoral muscle and its proportion is not significantly modified by the OMW. On the other hand, the OMW increases significantly the deposition of linoleic acid which increases from 24.99% in the control diet to 27.03, 28.05 and 30.83% for the diets with 5, 10, and 15% OMW, respectively ($p < 0.0001$). Palmitic acid is present at a rate of 19.23% in the control diet and its deposition in the pectoral muscle decreases significantly ($p < 0.0001$) in the broilers fed on OMW diets.

Thigh muscle: The total lipids content is 2.90% for the control diet. It decreases to 2.7 and 2.82% with 5 and 10% OMW diets. This proportion reaches 2.98 with 15% OMW diets, but remains non significant. It is the oleic and linoleic acids which are the predominant fatty acids in the thigh muscle for all the diets. Oleic acid content increase significantly in broilers fed 5, 10 and 15% OMW diets ($p < 0.006$). The linoleïc acid deposition decreases significantly, changing from 31.84% for the control diet to 27.75 and 28.61% with 5 and 10% OMW diets ($p < 0.0001$). Its level is 30.33% with 15% OMW diets. Palmitic acid rate of deposition in the muscle of the thigh is 13.96% for the control diet. The OMW diets administration increases significantly its deposition to 14.58, 15.58 and 14.66% in the diets with 5, 10 and 15% of OMW, respectively ($p < 0.05$).

Abdominal fat: The abdominal fat represents 1.44% of the body weight in the broiler chickens fed on the control diet. The abdominal fat deposition of chickens fed the OMW diet at 5, 10 and 15% were 1.68, 1.64 and 1.34%, respectively. Linoleic acid deposition in the abdominal

Table 2. Body, liver and abdominal adipose tissue (AAT) characteristics of broilers fed standard (CD) and OMW diet at the end of experimentation (8th week).

Diets	CD	5% OMW	10% OMW	15% OMW	Dietary effect
Body weight (g)	3342.97	3237.38	3360.32	3115.27	NS
Weight gain (g)	3154.29	3108.33	3171.16	3004.89	NS
Eviscerated weight (g)	2357.01	2221.73	2325.36	2170.14	NS
% of body weight	74.66	71.50	73.29	72.21	NS
Liver (g)	59.48 ^{a}	71.16 ^{b}	88.24 ^{c}	79.83 ^{d}	***
% of eviscerated weight	2.51	3.19 ^{b}	3.79 ^{b}	3.66 ^{c}	*
Abdominal adipose tissue (g)	48.46	54.54	55.38	41.86	NS
% of body weight	1.44	1.68	1.64	1.34	NS
Lipids (g/100 g AAT)	32.21	35.92	30.99	27.82	**
C14:0 (%)	0.25 ^{a}	0.63 ^{b}	0.23 ^{a}	0.3 ^{a}	**
C16:0 (%)	15.79 ^{a}	13.05 ^{b}	13.83 ^{b}	14.52 ^{b}	**
C18:0 (%)	21.66	15.46	16.33	17.06	NS
C18:1 (%)	23.65	27.91	28.78	27.14	NS
C18:2 (%)	33.06	34.22	34.12	34.35	NS
C18:3 (%)	0.26	0.32	0.34	0.39	NS
UFA/SFA	1.51	2.09	2.03	1.87	

Each value is the mean of 50 chickens (body and weight gain) and 10 chickens (eviscerated and liver weight and fat analysis).
*P < 0.05; **0.001< P< 0.01; ***P< 0.0001; NS: not significant.
UFA/SFA: unsaturated fatty acid/Saturated fatty acid.
AAT: Abdominal adipose tissue.

are 33.06, 34.22, 34.12 and 34.35% with CD, and for the diets with 5, 10 and 15% OMW, respectively. The oleic acid deposition represents 23.65% in the control diet. The OMW did not modify its deposition in the abdominal fat. However, the diets containing OMW decrease significantly the deposition of the palmitic acid which decreases from 15.79% in the control diet to 13.05, 13.83 and 14.52% in the diets with 5, 10 and 15% OMW, respectively ($p < 0.002$).

DISCUSSION

Our results show that body weight and abdominal adipose tissue observed in control diet are similar to those mentioned in the literature (Pikul, 1985; Legrand et al., 1987). OMW incorporation in food ration at a level of 5, 10 and 15% in substitution of corn leads to growth performance that could be compared to those obtained with the control diet. In our work, the OMW introduction did not lead to a big modification in the protein level of the diets, which remains between 18.16 and 19.44%. This level permits maximal growth of the broiler chickens (Grisoni et al., 1990). Besides, the OMW constitute an important energetic source due to its lipids leading to the observed weight gain. These results are encouraging because they reinforce the ideas of adopting the OMW as food in the broiler chickens breeding. However, its preparation conditions must avoid possible rancidity due to its richness in fatty acid that can make its consumption impossible for animals (Sansoucy, 1984).

The study of lipid composition shows in general that our results are in accordance to the literature and shows that the pectoral muscle is less rich in lipids then thigh muscle (Lessire, 2001; Szymczyk et al., 2001). However, we have shown that OMW at different proportion leads to varied effects depending on the considered organs. It clearly increases the lipid deposit in the pectoral muscle but only slightly in the thigh muscle. In addition, it clearly decreases the abdominal fat at 10 and 15% OMW. This result agrees with the previous reports that indicate that broiler chickens fed diets rich with unsaturated fatty acids have less abdominal fat (Sanz et al., 1999; Crespo and Esteve-Garcia, 2002; Villaverde et al., 2005) or total body fat (Sanz et al., 2000a,b) deposition than do broiler chickens fed diets containing saturated fatty acids. Using OMW in diets increase UFA/SFA ratio in all the considered bird's tissue. This increment does not seem to alter meat's quality.

In conclusion, OMW can constitute potentially a basic ingredient for broiler chickens' food. It can be incorporated in substitution of corn until a proportion of 15% in broilers' ration without modifying growth performance. Abdominal fat deposit decreases while pectoral and thigh

Table 3. Body, pectoral and thigh muscle characteristics of broilers fed standard (CD) and OMW diets at the end of experimentation (8th week).

Diets	CD	5% OMW	10% OMW	15% OMW	Dietary effect
Pectoral's muscle Weight (g)	543.96	504.42	557.06	507.84	NS
% of eviscerated weight	23.11	22.76	24.02	23.36	NS
Lipids (%)	1.11 a	1.41 b	1.46 b	1.89 c	*
C14:0 (%)	0.87 a	0.47 b	0.21 c	0.29 c	**
C16:0 (%)	19.23 a	12.83 b	14.73 b	15.95 b	***
C18:0 (%)	3.69 a	11.31 b	9.18 b	7.35 c	***
C18:1 (%)	32.35	30.15	30.87	31.78	NS
C18:2 (%)	24.99 a	27.03 b	28.05 b	30.83 c	***
C18:3 (%)	0.74	0.43	0.42	0.6	NS
UFA/SFA	1.8	1.52	1.75	2	
Thight's muscle weight (g)	321.74	312.71	341.51	311.15	NS
% Eviscerated carcass	13.66	14.04	14.80	14.30	NS
Lipids (%)	2.90 a	2.70 b	2.82 b	2.98 a	**
C14:0 (%)	0.17 a	0.34 b	0.17 a	0.35 b	**
C16:0 (%)	13.96 a	14.58 b	15.58 b	14.66 b	*
C18:0 (%)	9.15 a	10.95 b	9.52 a	6.58 c	**
C18:1 (%)	27.61a	29.63 b	31.22 b	34.06 c	**
C18:2 (%)	31.84a	27.75 b	28.61 b	30.33 a	***
C18:3 (%)	0.32	0.31	0.3	0.37	NS
UFA/SFA	1.87	1.52	1.7	2.16	

Each value is the mean of 10 chickens (thight and pectoral muscle weight and fat analysis).
Fatty acids are expressed as % of the identified fatty acids.
*P < 0.05; **0.001< P< 0.01; ***P< 0.0001; NS: not significant.
UFA/SFA: unsaturated fatty acid/Saturated fatty acid.

muscle are enriched with linoleic and oleic acid, respectively, which can represent an important nutritional and health benefit.

ACKNOWLEDGEMENT

This work was financially supported by the Ministère de l'Enseignement Supérieur et de la Recherche Scientifique, Algérie.

REFERENCES

Alibes X, Berge P (1983). Valorization de los subproductos del olivar como alimentos para los ruminates en Espana. Division de la Production Animale, FAO, Rome 1983.

Crespo N, Esteve-Garcia E. (2001). Dietary fatty acid profile modifies abdominal fat deposition in broiler chickens. Poult. Sci. 80: 71-78.

Crespo N, Esteve-Garcia E (2002). Dietary polyunsaturated fatty acids decrease fat deposition in separable fat depots but not in the remainder carcass. Poult. Sci. 81: 512-518.

Du M, Du A (2002). Effect of dietary conjugated linoleic acid on the growth rate of live birds and on the abdominal fat content and quality of broiler meat. Poult. Sci. 8: 428-433.

Eraso E, Olivares E, Gomez Cabrera A, Garcia De Siles YJL, Sanchez J (1978). Utilizacion de la pulpa de accituna en la alimentation animal. En: Nuevas Fuentes de Alimentos para la production animal. Gomez Cabrera A, Garcia De Siles (Eds), pp 25-45 (ETSIA Cordoba).

Folch J, Lees M, Sloane-Stanley GH (1957). A simple method for the isolation and purification of total lipids from animal tissues. J. Biol. Chem. 233:311-320

Gomez Cabrera A, Parellada J, Garrido A, Ocana F (1982). Utilizacion del ramon de olives en alimentation animal. Valor alimenticio. Av. Aliment. Mejora Anim. 23: 75-77.

Grisoni ML, Larbier M, Uzu G, Geraert PA (1990). Effect of dietary protein level on lipid deposition in broilers during the finishing period. Ann.Zoo. 39: 179-186.

Lessire M (2001). Matières grasses alimentaires et composition lipidique des volailles. INRA Prod. Anim. 14 : 365-370.

Legrand P, Mallard J, Bernard-Griffith MA, Douaire M, Lemarchal P, (1987) Hepatic lipogenesis in genetically lean and fat chickens. In vitro studies. Comp. Biochem. Physiol. 87B: 789-792.

Pikul J (1985). Total lipids, fat composition and malonaldehyde concentration in chicken liver, heart, adipose tissue and plasma. Poult. Sci., 64: 469-475.

Roig A, Cavuela ML, Sanchez-Monedero MA (2006). An overview on olive mill wastes and their valorization methods. Waste Manag. 26: 960-969.

Sansoucy R (1984). Utilisation des sous-produits de l'olivier en alimentation animale dans le bassin Méditerranéen. Etude FAO Production et Santé Animales, Rome, FAO No.43.

Sanz M, Flores A, Perez De Ayala P, Lopez-Bote CJ (1999). Higher lipid accumulation in broilers fed saturated fats than in those fed unsaturated fats. Br. Poult. Sci. 40: 95–101.

Sanz M, Flores A, Lopez-Bote CJ (2000a). The metabolic use of calories from dietary fat in broilers is affected by fatty acid saturation. Br. Poult. Sci. 41: 61-68.

Sanz M, Flores A, Lopez-Bote CJ, Menovo D, Bautista JM (2000b). Abdominal fat deposition and fatty acid synthesis are lower and □-Oxidation is higher in broiler chickens fed diets containing unsaturated rather than saturated fat. J. Nutr. 130: 3034-3037.

Szymczyk B, Pisulewski PM, Szczurek W, Hanczakowski P. (2001). Effects of conjugated linoleic acid on growth performance, feed conversion efficiency and subsequent carcass quality in broiler chickens. Br. J. Nutr. 85: 465-473.

Villaverde C, Baucells MD, Cortinas L, Hervera M, Barroeta AC (2005). Chemical composition and energy content of chickens in response to different levels of dietary polyunsaturated fatty acids. Arch. Anim. Nutr. 59: 281-292.